OUR £20 CAR—*and* HOW TO MAKE IT!

NEWNES

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Notes, News, and Views

A Lathe Which "Sees"

A NEW photo-electric lathe which can work to a complicated design without human aid, has been invented by a Russian engineer, according to the Taso Agency. With the aid of a photo-electric cell, the lathe can "see" any drawings that are placed in it, and shaping instruments are automatically adjusted.

The "Turbomotive"

THE first turbine-locomotive to be built by a British Railway Company, was recently taken out on a test run. The locomotive is now running on the L.M.S. Liverpool–London main line service.

Largest Diesel Engine

A 3,500 h.p. Diesel engine, the largest ever manufactured in Britain, is to be built at Stafford and Rugby, for Bermuda.

A New Monoplane

SIDE-BY-SIDE seating, and a speed of 100 m.p.h. with 33 m.p.g. are interesting features of the Praga monoplane which was recently tested out at Heston.

A Thames Tunnel

IT is hoped that the proposed tunnel under the Thames between Dartford and Purfleet will be started towards the end of the summer. The tunnel will take five years to build, and the original estimate of the cost, £3,000,000, is expected to be greatly reduced.

The Latest About Television

WHEN television is introduced on a large scale in this country, the B.B.C. will broadcast films, but at first this will not include dramas and comedies. The reason for this limitation is a clause in the proposed new contract which has just been drafted between film renters and exhibitors.

Four New Flying-Boats

WE learn that the Commonwealth Air Board is ordering four new flying-boats, with a range of 500 miles, for coastal patrol duties in North Australia and Papua.

Fastest Train in Japan

A NEW streamlined locomotive has just been completed at Kobe, Hyogo Prefecture, which will run on the Tokaido Line, connecting Tokyo with Osaka. It will do this 350-mile run in six hours.

Land Speed Record for Cars

AN attempt on Sir Malcolm Campbell's 301 m.p.h. land speed record, is to be made at Utah, by Lou Moore, U.S. racing motorist.

A Ship With Fins

SINCE it is not possible to straighten out the waves in the Channel, a device is to be tried out on a Southern Railway cross-Channel steamer, to prevent it from rolling when at sea. The device consists of two metal fins to be fitted on the sides of the steamer and controlled by a gyroscope on the bridge. The gyroscope remains level in spite of the rolling of the ship, and will operate the fins so that whenever there is the slightest tendency to roll, they will tend to keep the ship on an even keel.

A New Speed Plane

A NEW passenger plane, which, it is claimed, will break all records by conveying 10 passengers at a maximum speed of 254 m.p.h., was recently shown in Berlin. The new machine is a monoplane constructed entirely of light metal, and not only its landing wheels, but also its tail wheels, are retractable. It has twin engines, each of 600 h.p.

Holland's First Streamlined Locomotive

A NEW streamlined locomotive has been put into service by the Royal Dutch Railways.

"Heads" or "Tails"

A FORMULA which takes guess work out of coin-spinning and makes "heads I win, tails you lose" a certainty, has been revealed at the Imperial College of Science by Dr. G. F. C. Searle. The trick is worked by placing a penny in a small gadget and taking certain vertical measurements. Then, releasing a spring, you can make the coin always land "heads" or, if you wish, "tails"; it never fails. The gadget was invented to prove that the speed of an object is accelerated in its downward flight.

World's Largest Piece of Glass

PICKED workmen of the Corning Glass Works, New York, recently removed from its annealing oven, the world's largest piece of glass, the 200-in. mirror, or "eye" for the world's largest telescope.

Photographs Printed on the Wall

PHOTOGRAPHS can be printed directly on to the walls of a house by a process invented by Eugene Mollo. The process consists of an emulsion, with which surfaces are sensitised. The surface is sprayed with the emulsion and the photograph then printed by means of a projector. Developing, printing and fixing are all carried out by spraying.

London–Paris Record

THE Imperial Airways liner *Heracles* recently completed the 203-mile journey from Paris to London in 80 minutes flying time, at an average speed of 150 m.p.h. The previous record for machines of the *Heracles* class was 90 minutes.

Television in Germany

THE German high-definition television service, which was put out of action by the fire at the radio exhibition last August, is now in operation.

Pocket Wireless Sets

THE Watch Committee of the Maidstone Town Council are to consider providing the members of their Borough Police Force with pocket wireless sets.

A Coincidence

TWO aeroplanes, heading in opposite directions, recently passed and saluted each other in mid-Atlantic. It is believed to have been the first time that such a thing has happened.

The Third Dimension

IN a short film under the title of "Audioscopic," the amazing results of third dimension will be seen for the first time, on a large scale.

Luminous Cars

A FRENCH manufacturer of well-known cars, recently brought out models painted with a luminous compound—not radium, but one of the barium preparations which store up sunlight. Thus, safety will be promoted on the roads at night by higher visibility.

Austrian Railway Speed Car

A DOUBLE-ENDED motor car operated by internal combustion engines, is now operating between Vienna and the Polish frontier. Its speed is estimated at between 75 and 90 m.p.h.

OUR £20 CAR AND HOW TO MAKE IT !

The First Article of a Series Describing the Construction of an Ingenious, Simple and Well-designed Three-Wheeler, which May be Built for even less than £20. Its Annual Tax is Only £4, and it is Capable of 50 Miles an Hour. Petrol Consumption is over 65 Miles per Gallon, and it may be driven by any reader over 16 years of age ! The Illustration Below Indicates its Really Attractive Lines. Any Unskilled Amateur Can Make it With Ordinary Tools.

By F. J. Camm.

IF you have ever thought of the possibility of building for yourself a small runabout car, you have probably dismissed the idea as being outside the bounds of possibility for amateur construction, or as requiring a heavy initial outlay and the possession of tools and equipment usually associated with the factory. Therefore, I wish to disabuse your minds on these various points at the outset.

It is probably not known to many of my readers that several thousands of midget cars are built in America annually, and so intensely enthusiastic is the movement over there, that race meetings are held all over that vast country practically every night on the various dirt and hard tracks. There are hundreds of midget-car clubs in America and Canada, and a few in Australia, and the rules of membership and of the various midget-car competitions are firstly that the car must be amateur built, and, secondly, that the engine must not exceed a specified cubic capacity. Midget-car racing has become, in fact, a craze, and the sport bids fair to become popular in England.

Note the Simplicity and Really Attractive Lines of this Fast Baby Car. You Can Build It!

Floodlit Racing Tracks

The American midget-car events draw enormous crowds, and after dark the tracks are floodlit. It is a fascinating sight to witness these tiny vehicles, most of which are capable of speeds of over 60 miles an hour, hurtling round the track and performing amazing evolutions demanding little of the skill which is required to drive more orthodox cars round Brooklands.

These tiny cars, however, are not built merely for racing purposes, and vast numbers of them are used for ordinary touring purposes. They have the great advantage, of course, of low taxation, require a minimum amount of garage space, are cheap to run (the petrol consumption is at least 65 miles to the gallon), are cleaner than motor cycles, and they have the added advantage of providing weather protection, which a motor cycle does not. They can also be used for touring along the narrow lanes and picturesque by-ways which would be impossible for larger cars, and above all, they are perfectly safe.

Simple Construction

The greatest advantage, perhaps, is that they may be built for as small an amount as £15, depending upon the number of refinements which are fitted. Given a motor-cycle engine of the air-cooled type of from 250 c.c. to 600 c.c., a motor-cycle type of countershaft three-speed gearbox with integral clutch, and three wheels, and you have the material for building a midget car. The veriest amateur possesses the ability to construct one. Many years ago the cycle-car movement in England was extremely popular, and as with radio, there was a considerable number of amateurs who built them. No doubt owing to the unreliability of early engines and the difficulty of obtaining the requisite parts, the midget-car movement fell by the wayside. Nowadays, however, there is a plentiful supply of material. Motor-cycle engines of the required capacity can be picked up quite cheaply from garages and other firms who specialise in spare parts. So, too, can gearboxes, whilst the wheels can be purchased new for a very small sum.

Many years ago I designed a similar small car to that forming the subject of the present article and marketed it, and it proved extremely popular.

You require a motor-cycle engine of either the side or overhead valve type of not more than 350 c.c. for the design here given, and as 1 horse-power is approximately equivalent to 100 c.c. the power range required is from 2½ to 3½. If you fit a 2½ horse-power engine, the top speed would be an easy 40 miles an hour, whereas with a 350 c.c. engine the top speed would be in excess of 50 miles an hour. Naturally, the overhead-valve engines will be the faster.

Why a Three-Wheeler was Chosen

I will anticipate the reader's question of explaining why a three-wheeler has been chosen in preference to a four-wheeler. In the first place the legal definition of a three-wheeler is that it is a motor cycle! As such, it comes within the same taxation class as a motor cycle and sidecar. Secondly, it is cheaper to build, for the excellent reason that there are only three wheels and three tyres, instead of four wheels and four tyres, thirdly, the three-wheeler dispenses with the need for a differential gear. Fourthly, it is easier to build and has less

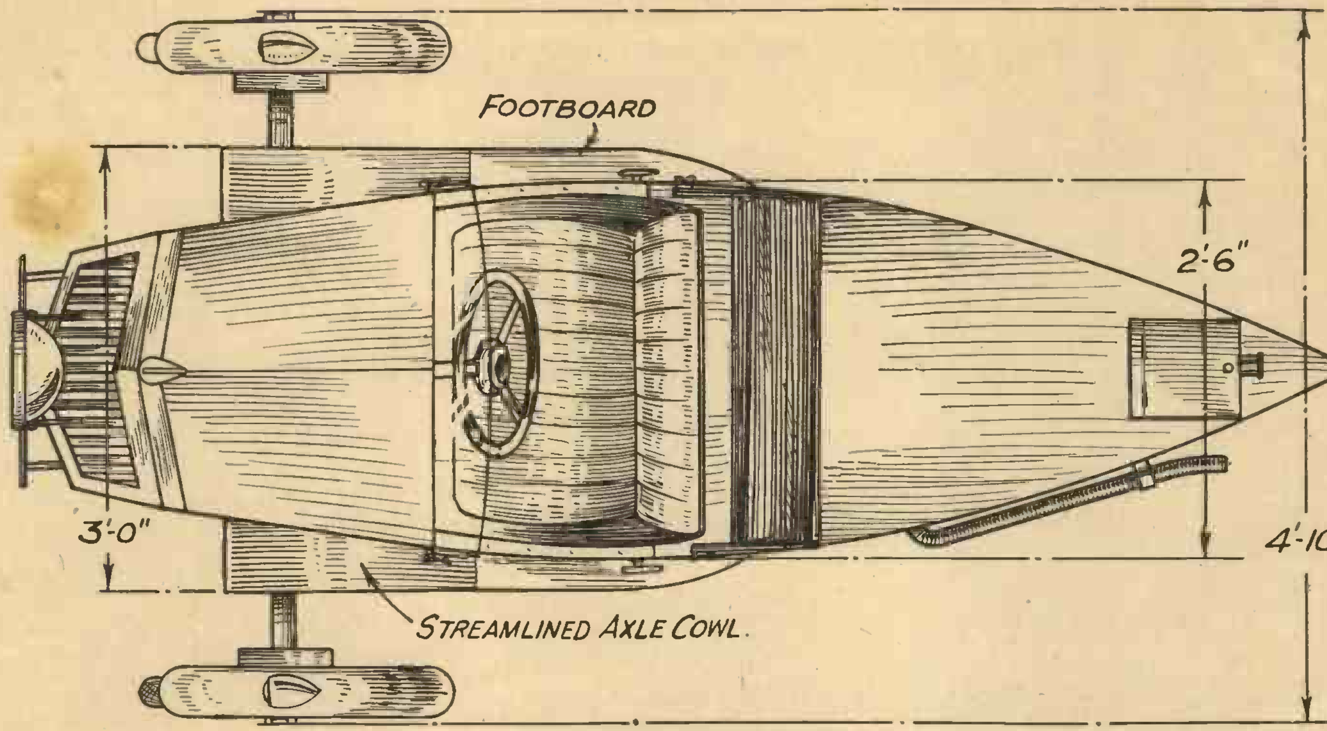


Fig. 1.—Plan View of the £20 Car!

working parts. The annual tax is £4 only. If you add to these advantages the fascination of building it, and finally of using it on the road you have the entire case for the tiny car.

Legal Requirements

In the absence of proved designs, the beginner may make expensive mistakes. There are the legal requirements, for example, which stipulate that brakes must apply to each wheel, and that there must be an independent hand-brake; the head lamps, in order to satisfy the Lighting Act, have to be mounted at a certain height from the ground and not more than a certain distance in from the extreme outside line of the vehicle. The number plates and the figures and letters thereon, must be to legally prescribed dimensions, and a silencer must be fitted. The machine must not be noisy. Those are just a few of the legal requirements. The mechanical requirements are a little more detailed. We have to bear in mind the loading per horse-power so that the engine does not labour. The steering angle needs to be worked out for wheel clearance, and provision must be made for cooling the engine. The gear ratios must be carefully selected, so that the engine is enabled to rev. at its peak revolutions in order that it may develop maximum power.

Detailed Blueprints will be Issued for a Nominal Sum

The chassis must be free from whip, otherwise there would be frequent breaking of chains and undue wear on the transmission and tyres. The suspension system needs to be just right in order to absorb road shocks. The centre of gravity needs to be accurately disposed, so that the machine is stable and does not turn over, and the driver's seat needs to be disposed approximately midway between the two points of road support. Hence, the amateur who endeavours to *design* his own car finds this array of technical and legal considerations disconcerting.

The Problems Solved for You

In the design here presented the problems have been solved for you. Our £20 car complies with all of the legal requirements, and it is technically sound. In

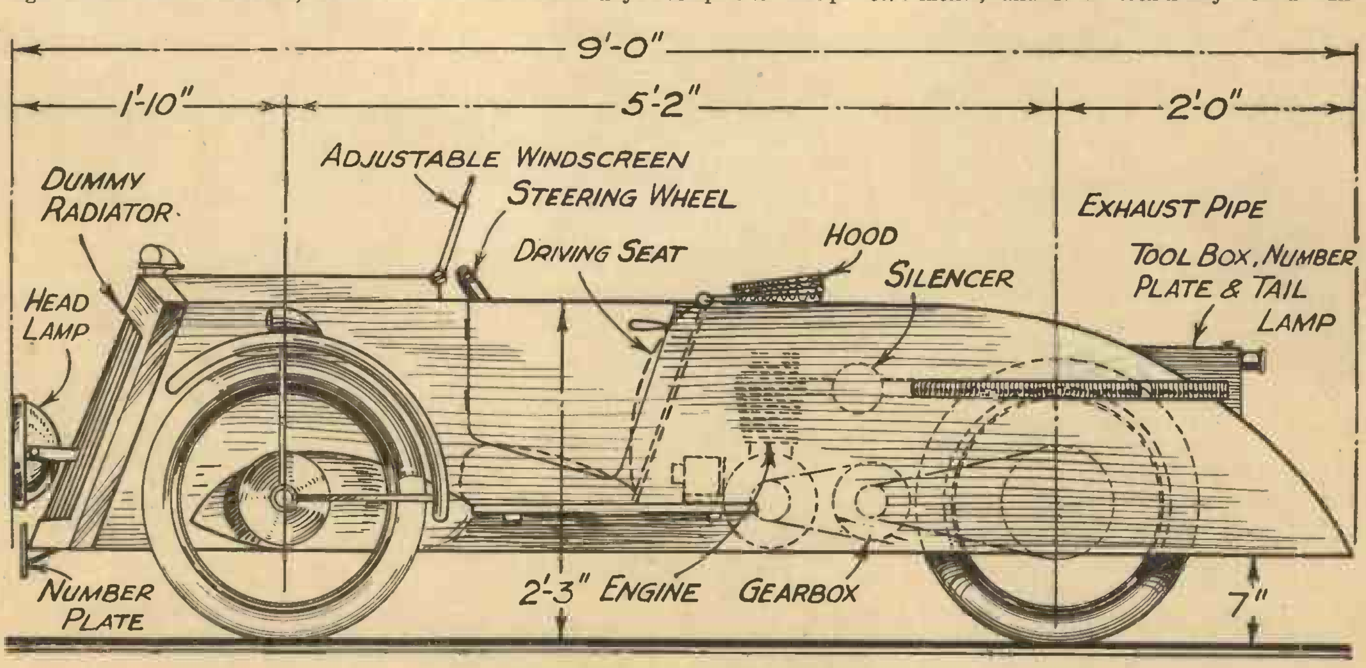


Fig. 2.—Side Elevation of the £20 Car.

later articles dealing with its construction I shall show you photographs of the various stages, and photographs of the car under test. Additionally, we shall sell detailed blueprints and an announcement will be made when they are ready. All of the constructional details, however, including dimensioned drawings will be given in this series, thus enabling the reader to build the car. The blueprints will be issued to those who are unaccustomed to laying out the various parts from scale drawings.

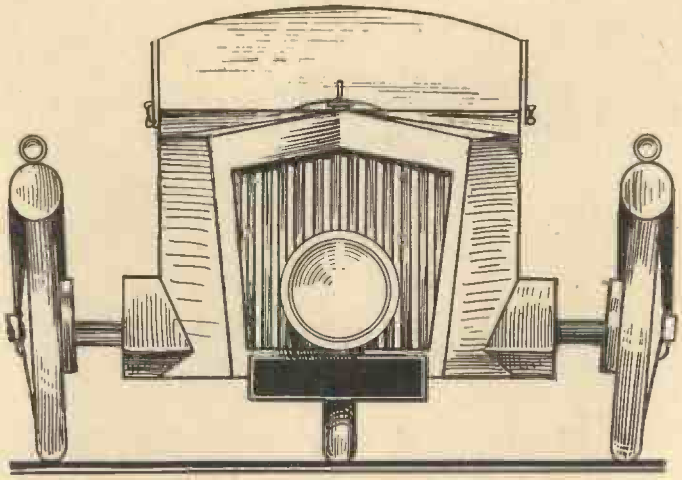


Fig. 3.—Front Elevation of the £20 Three-Wheeler.

A Driving Licence

Another question which will arise in the mind of the reader who is under 17 years of age (the minimum age for which a driving licence for a car-owner is issued), is whether he is entitled to drive this three-wheeler within the meaning of the Act. Anyone over 16 years of age may drive a motor cycle, so the age limit is 16 years. If you are over 17 years of age, you will apply for a car-driving licence in the ordinary way. If you have not held a driving licence before, it will be necessary for you to pass the driving test; for details of this you must apply to the local County Council Offices, when a provisional driving licence will be issued to you. You will have to carry the "L" plate and be accompanied by an experienced driver. As, however, the latter can easily be accommodated pillion-passenger fashion, there is no difficulty here, although I recommend the beginner to teach himself to drive in private grounds. No doubt permission can be obtained locally for this.

Driving the Car

You will find that you will be able to drive the car within about five minutes, after you have become familiar with the operations of starting the engine, accelerating, changing gear, and braking. Actually it is much easier to drive than a motor cycle.

I shall confine my remarks this month to a general description of the design, so that the reader can collect together the necessary material. An inspection of the plan and side elevation, Figs. 1 and 2, indicate the racy lines of the body. The engine is mounted behind the driver's seat and the gearbox, of course, behind the engine. You will require any good second-hand motor-cycle engine of the type and power previously named, and a three-speed gearbox capable of transmitting the power of the selected engine. For example, you must not fit a gearbox from a 250 c.c. engine, if you are using a 350 c.c. engine, although it will be in order for you to use a gearbox which has been used in conjunction with a 350 c.c. engine on a 250 c.c. engine.

The Gearbox

The gearbox must be of the countershaft type with an integral clutch, and later I shall show how to calculate the size of sprocket required on the rear wheel in order to obtain the correct gear ratio. You will also require a silencer of the type fitted to 7 h.p. cars if you desire the engine to be extremely silent, otherwise the ordinary motor-cycle style of gearbox will suit. I cannot, for obvious reasons, prepare designs suitable for all of the engines available, but as the only thing which is affected is the method of mounting, the reader will experience no difficulty in obviating this. The kick-starter will, of course, need to be extended by means of a piece of tube so that it protrudes outside the body. It will then be carried as a starting handle, and placed under the cushion of the driving seat when the car is started. The wheels are of the light motor-cycle type, having internal expanding brakes operated from a quick pedal, whilst the chassis and body consist of ash members and three-ply respectively.

The Second Article on this Remarkable Car, Specially Designed for Readers of Practical Mechanics, will appear next month. Order your copy now!

The Car Controls

Car controls are used, that is to say, there are the usual three pedals, namely (from right to left facing the front of the car), accelerator, brake, and clutch. The steering wheel is centrally disposed, since this is a monocar and not intended for passenger-carrying owing to the low power. The radiator in front is, of course, a dummy; it is made by overlaying pieces of three-ply wood and picking it out in a different colour to that of the body colour. Two doors are fitted so that entry to the driving seat can be effected from either of the near or off side. A motor-cycle sidecar hood is used, whilst the mudguards are of the motor-cycle type. These have the advantage that they move with the wheels, and thus do not throw mud when locked over as does an ordinary car.

Accessories Required

The windscreen is one of the Auster aerotype as fitted to small aeroplanes and some sidecars, whilst the steering wheel is of the Bluemel type. The tool-box, number-plate and tail-lamp are combined. Ackerman steering is used, enabling the car to be turned within a very sharp radius since the wheel base is only 5 ft. 2 in.

The overall length being only 9 ft., the car may thus be comfortably stored in the space normally required for a cycle and sidecar. The total weight of the vehicle will be not more than 280 lb.

I have estimated that the total cost of the material will be approximately £18, and if the reader happens to strike bargains in his purchase of the various parts, it *can* be made for less than £10. For this particular car I have selected the Blackburn 350 c.c. side-valve engine, but, of course, the reader will endeavour to obtain from the sources mentioned, a second-hand car engine and gearbox.

Just a word about the petrol consumption; it will work out, with a 350 c.c. engine, at 65 miles per gallon at least, whilst the oil consumption should be in the neighbourhood of 2,000 miles to the gallon.

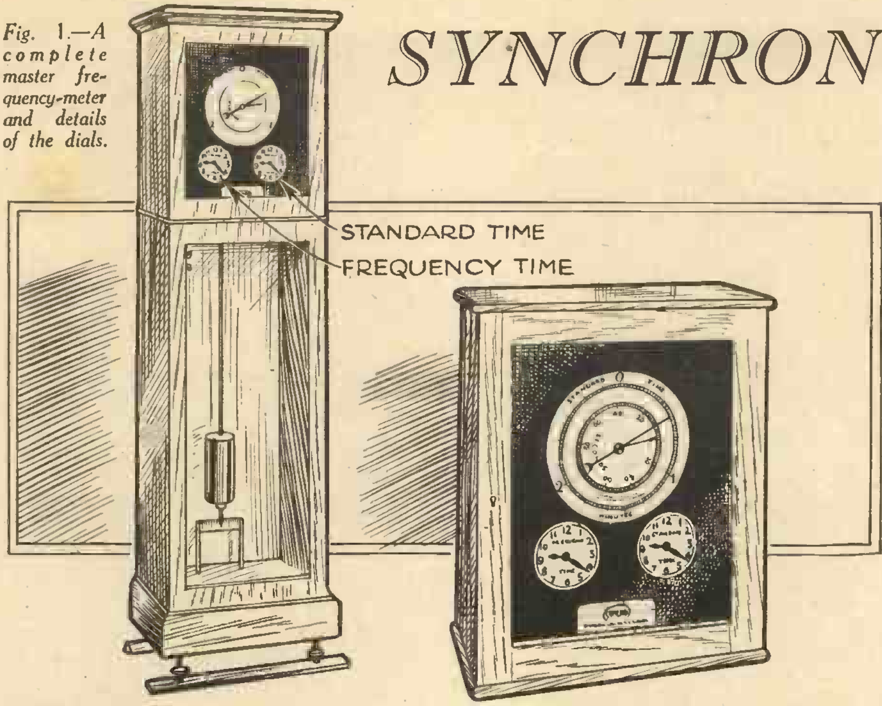
I shall, of course, be pleased to answer any questions which readers care to address to me provided that they enclose the Query Coupon and a stamped and addressed envelope. These queries should be confined to the present design, and I make the offer so that those readers who are able to follow the present illustrations and who wish to proceed with the work in advance of publication of the scale drawings next month, may be able to do so.

I want to make it clear, however, that I cannot, for obvious reasons, undertake to vary the design to suit individual needs. For example, some readers perhaps prefer to make a four-wheeler; I cannot undertake to prepare the many special diagrams which would be necessary to enable them to do so.

I shall be quite willing to advise readers regarding suitable engines, gearboxes and materials; to advise them on the lighting question and passing the driving tests. I shall also be pleased to indicate sources of supply for the various parts.

Here I would advise the reader to study the advertisement columns of papers like the *Practical Motorist* (3d. every Friday), particularly the Classified Advertisements. They may thus be able to pick up reliable second-hand gearboxes quite cheaply. A word of warning is necessary, however: make quite sure that any engine you purchase locally is in good condition, for it is just possible that some of the parts have been sold as spares, and the engine is therefore not complete. If the manufacture has been discontinued, you may experience difficulty in obtaining replacements and they will thus have to be specially made—which can be quite costly!

Fig. 1.—A complete master frequency-meter and details of the dials.



SYNCHRONOUS ELECTRIC MOTORS

A Motor may be Kept at a Constant Speed by the Electric Supply which Drives it. This is the Principle of the Synchronous Motor which is the Subject of this Article

SMALL electric motors play a very important part in everyday domestic life. They drive all manner of light machinery, and operate cream separators, refrigerators, etc.

The most prominent type is the so-called "Universal Motor," or series commutator machine, which, being series wound, operates on both A.C. or D.C. circuits without any alteration. It has advantages both to the user and manufacturer of the appliance, the chief of which is its universal nature, since the maker can incorporate the same type of motor in all his articles.

Other motors are not very common in domestic circles, chiefly because of their higher initial cost coupled with the fact that they must be used only on A.C. The synchronous motor is met with in all forms of electric clocks, and timing and recording apparatus.

Controlled Frequency

Before dealing with A.C. clocks, it is necessary to describe how the frequency of the mains is controlled, and what is the advantage of a controlled frequency. Dealing with the last question first, it will be found that in generating practice when the load increases, it is usual to run up an extra plant to deal with this, and as there are generally two rush hours per day, some simple and efficient means of paralleling the alternators must be evolved. Before putting the second generator on the line, its voltage and frequency must be the same as that of the first. On the Grid, for economical operation, it is essential that generators at different stations must be able to share their load with other machines and stations during the rush hours. It is at once apparent that from the generating point of view, exact frequency control is essential. All timing apparatus, from workman's recorders to traffic lights, can be operated from the mains of standard frequency. In large works and factories, it is essential that the synchronous and induction motors run at a constant speed; in paper and flour mills and all other continuous operations, the constant speed factor is very important. In pumping and A.C.-D.C. generating sets, a variation in speed causes a variation in the output or voltage; many similar instances could be cited.

The Warren Synchronous Motor

The heart of all frequency meters and control depends on the Warren synchronous motor, which is a tiny motor running at a high speed and developing about one millionth of a h.p. It consists of a laminated field of two poles, each of which is fitted with a shading coil. The armature, which runs on special bearings and is connected to a small gearbox running in an oil bath, consists of a ring of hard steel with one diametric spoke. The speed of the motor is 3,000 revs., hence the need for the reduction gearing. If an increased output is required, two or more rotor sections can be combined on the shaft, and the field increased to the necessary thickness. The shading coils consist of a copper band that encircles about half a pole. When the motor is switched on, the alternating current produces an alternating flux, which causes a heavy eddy current to circulate in the short-circuited shading coils. This causes a phase difference in the magnetism in the two portions of the pole face, that in the shaded part being behind, or lagging by about 50°, that in the non-shaded part. Hence, we have a rotating field, and the motor runs up to speed almost at once. Quite wide variations in the supply voltage do not affect the speed of the motor, but a small change in the frequency is at once apparent. Fig. 2 shows details of the Warren synchronous motor.

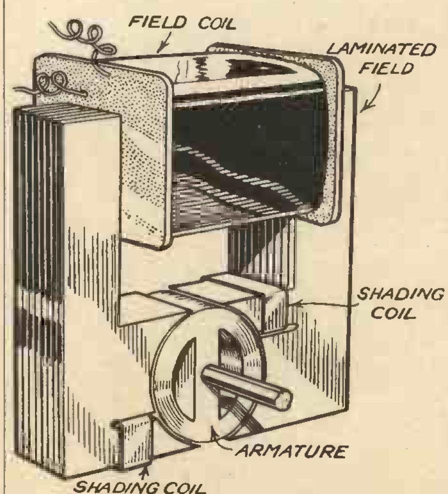


Fig. 2.—Details of the Warren synchronous motor.

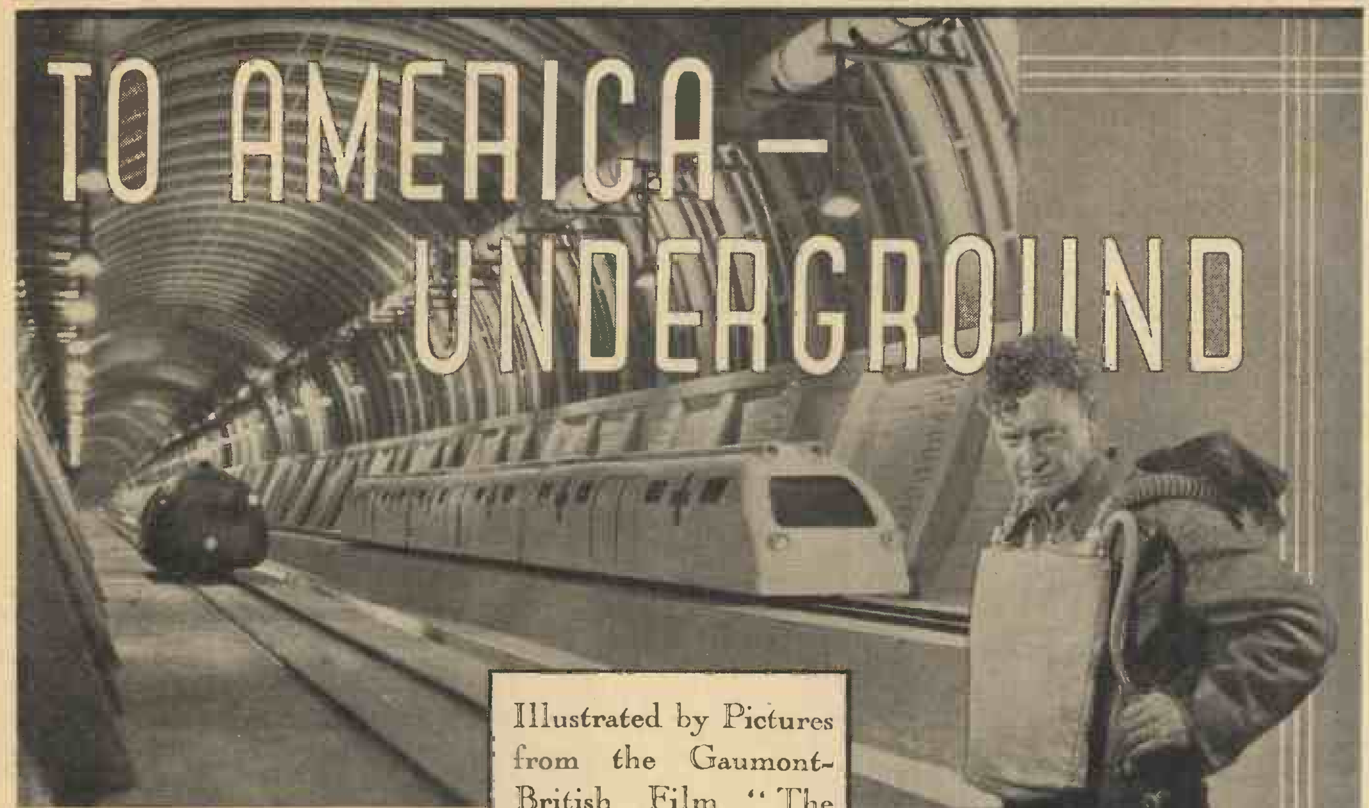
The Master Frequency-meter

On the front of the master frequency-meter there are three faces. The large centre one has two dials, the outer is fixed, and the centre one revolves and has a small red pointer painted on it. Concentrically over the outer dial a larger finger revolves. Each dial is divided into seconds, and it takes three minutes for the fingers to make one complete revolution. The outer finger is controlled by a standard pendulum and shows standard time, while the inner disc shows frequency time. Both finger and disc are driven by the same Warren motor, but the finger has a synchronising wheel and slipping clutch mounted on the end of its shaft. This wheel has a certain number of teeth or indentations cut in its periphery, and into one of these, a small wheel is forced every thirty seconds by an electro-magnet. Thus, if the frequency time corresponds to the standard time, i.e. the large finger and disc rotate exactly together, then the small clutch will not slip. As soon as the frequency changes, however, the small wheel will not exactly fit the indentations, hence the clutch slips, and the variation is shown on the face. The standard pendulum is carefully compensated, and is driven by an electro-magnet working through a transformer and rectifier, from the mains. The smaller dials showing, respectively, standard time and frequency time, will, of course, show any large errors, and are used to check the instrument against the time signals (Fig. 1).

The master frequency-meter is mounted in the main control room. It is checked from Greenwich by the wireless "pips." In the control room there is a small receiving set which is switched on by a small synchronous motor a few moments before the pips are due, thus the shift engineer can always check up his instruments.

(To be continued)

TO AMERICA— UNDERGROUND



Illustrated by Pictures from the Gaumont-British Film "The Tunnel," this Article Discusses the Problems and Possibilities of Subterranean Transport Between London and New York

JUST imagine stopping a policeman in Trafalgar Square and asking him to direct you to the station for New York! At the moment it is—just imagination—but, after all, it is only imagination which has been responsible in the first place, for the locomotive, the motor-car, and the aeroplane! If Newton had been content to let the apple fall on his head without wondering why it should do so, and if Watt had watched the kettle boil without worrying just why the steam came out, we should probably still be living in an unscientific world. These two men were however, puzzled, and armed with only imagination, they set to work and solved their problems. When one considers the enormous strides which have been made in the realms of science and invention during even the past twenty years, an Atlantic tunnel is surely not too fantastic a problem or too great a strain on our imagination.

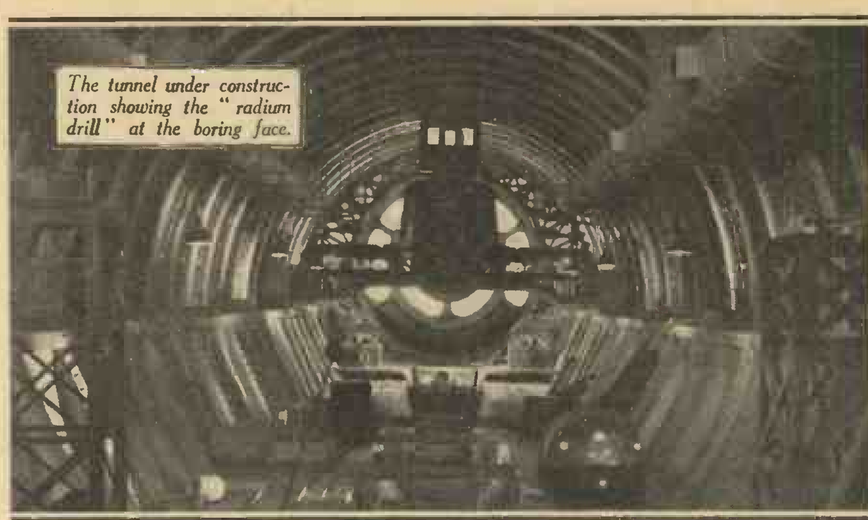
At one of the control boards. Note the television screen.

The Simplon and Mersey Tunnels

Ever since the dawn of time, man has burrowed his way into the earth for one purpose or another, and the amazing accuracy and skill which have been displayed in contemporary workings such as the Simplon and the Mersey Tunnels, serve to show that even the most formidable tasks are not insurmountable.

Those readers who have seen the Gaumont-British film, "The Tunnel," will remember the truly impressive and convincing structural scenes which were shown. Although these sets were, of course, only built for the film, it must be realised that only by going about the job as if an actual Transatlantic tunnel was going to be built, was the amazing realism obtained. Kurt

Siodmak, who was responsible for the screen story, had treated the tunnel as a piece of real engineering, and although only based on imagination and without making any precise calculations in physics or mechanics, the germ of his scheme is of great interest and, who knows, may one day be the basis of an actual Transatlantic tunnel. Stranger things have happened, and it is interesting to note that Mr. Siodmak, in his film story "F.P.1," visualised floating Atlantic aerodromes which are now actually in the experimental stages in America, and formed the text of an article which appeared in this magazine a few months ago.



The tunnel under construction showing the "radium drill" at the boring face.

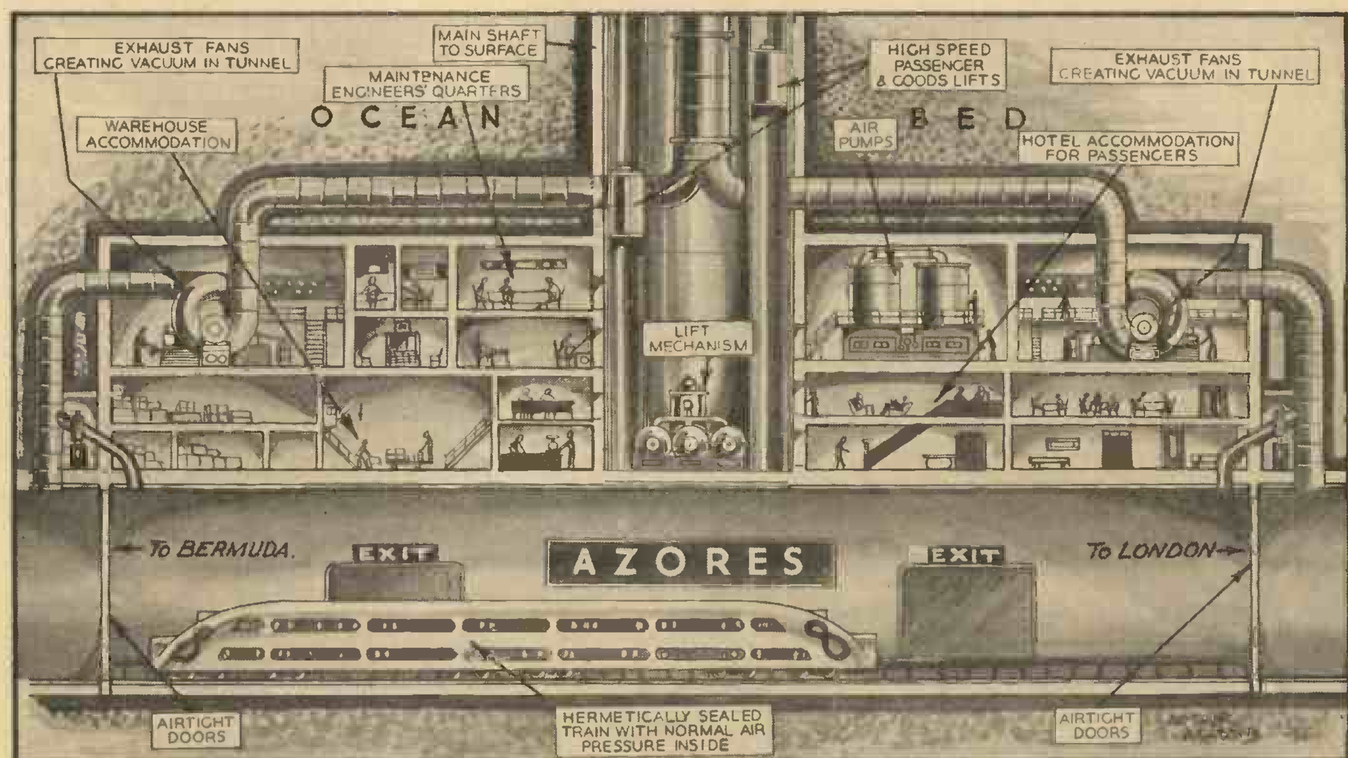
3,000 Miles Long

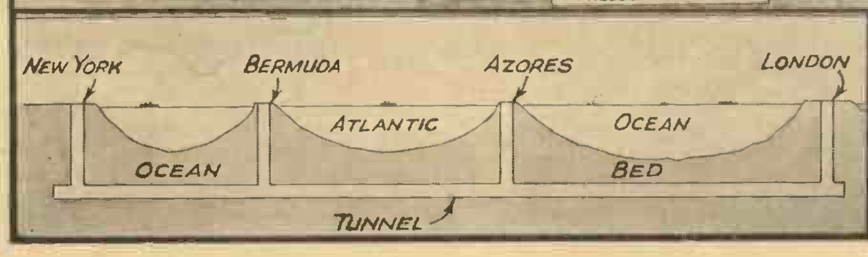
The tunnel, as planned, would be roughly 3,000 miles long, and would follow a route from England to America via the Azores and Bermuda, with entrances at the two intermediate stations as well as at each end. The actual boring implement is really the only imaginative piece of apparatus used, and so feasible is it in theory, that one feels that it is only a matter of time before the drill will actually be in existence. Called the "Radium Drill," it is a huge radio-active boring machine, which is capable of reducing rock to liquid, without heat and consequent danger. The liquified slag is subsequently used, in part, to form a waterproof lining for the tunnel. Estimating the rate of progress at the rate of 2 ft. per minute, and assuming that the boring operations were carried out simultaneously from each end of the four locations, the tunnel could be completed in a few years. During construction it would be split up into sections, each insulated from the other by air-tight doors, so that should any mishap occur at the boring face, that particular section could be cut off from the portion already constructed and thus localise any damage.

Four Train Tracks

The diameter of the tunnel would be sufficient for four train tracks to be laid, and in the space under these tracks an auxiliary and miniature tunnel could be constructed for carrying telegraphic cables.

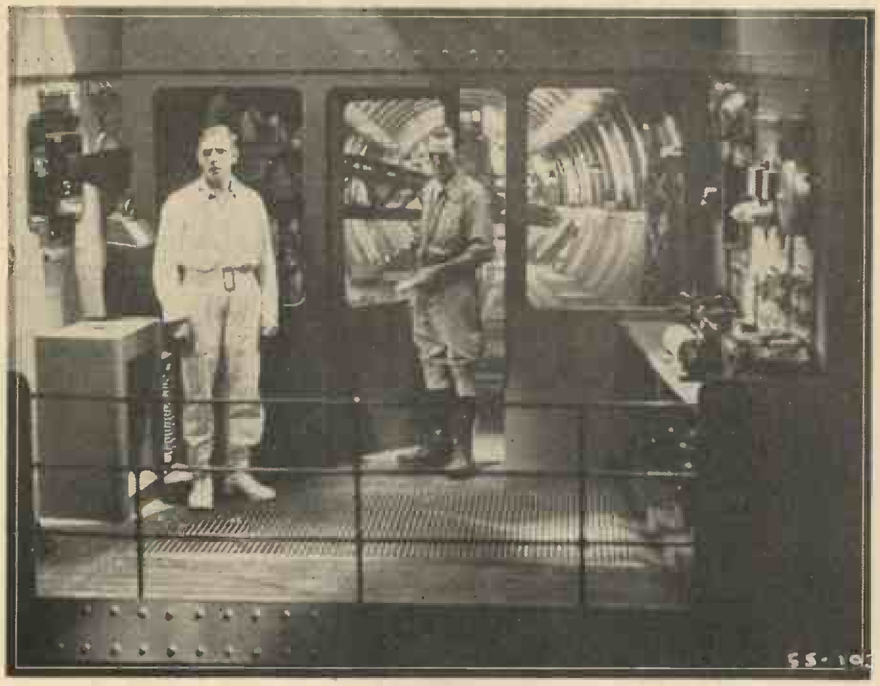
The tunnel, having been completed, the question of atmosphere in it has to be considered. During operations air would, of course, have to be pumped into the tunnel, but once completed, the situation changes. One of the primary objects of the tunnel is to expedite transport, and thus, if the air is exhausted from it and the trains run in a vast vacuum tube, their speed could be limitless. This may sound a fantastic statement, but Mr. Siodmak argues that although under normal, present-day conditions the human body cannot stand forward movement at speeds past a certain point, it is only true when movement is in an ordinary media offering resistance to moving bodies, such as air and water, and when movement is sudden. The train,





Our artist's impression of a section of the tunnel forming the interchange station at the Azores. The diagram on the left shows a possible route for the tunnel.

moving in a vacuum, would not set up these conditions, and as the rate of acceleration could be made definitely gradual, it has been proved that no ill-effects would follow. Assuming that the trains would have a maximum speed of 600 m.p.h., the journey



Inside the control cabin of the huge " radium drill " which ploughs its way through the tunnel.

from London to New York would occupy only about five hours.

Sealed Cars in a Vacuum

Using the tunnel as a vacuum, each train would naturally be a sealed car and would carry its own supply of synthetic atmosphere, but provision would, of course, have to be made for passengers entering or leaving the trains. We will assume that the train has reached the Azores and passengers are to disembark. The section of the tunnel forming the Azores station would be capable of being atmospherically insulated from the rest of the tunnel by means of air-tight doors at each end. When the train had reached the station, these doors would close and the atmosphere in the station section equalised with that in the actual train. The train doors would now be opened, the interchange of passengers effected, and they would again close. The air would now be pumped out of the station, and the air-tight doors opened, thus allowing the train to continue on its journey. A glance at the cross-sectional drawing will enable one to visualise this process more clearly. As will be seen, a miniature hotel would be built underground, and transport with the surface would be by means of high-speed lifts. Pumping plant would be accommodated, and auxiliary pumps placed at intervals in the main shaft.

Motive Power

The question of the motive power for the trains is one which suggests several alternatives, one of the most feasible of which is, perhaps, an electro-magnetic method. By this means the train is drawn by electro-magnetic force towards a magnet housed in the tunnel. As it approached, the train would cut-out this magnet by means of trip-switch gear, and bring the next magnet into operation. Thus the train would be drawn forward by the series of magnets and gain momentum. The acceleration by this method would be gradual. Perhaps, however, by the time that the actual tunnel is built, wireless transmission of power will be an accomplished fact. This would, of course, greatly simplify the motive problem, for power stations, built at each end of the tunnel would " broadcast " power, and receiving apparatus in the train would pick it up and utilise it for driving the motors of the train.

The advantages of such a tunnel are obvious, and although the project would be one of colossal magnitude, it is really more useful and feasible than the theory of rocket transport through the stratosphere. Not only is it possible to handle transport problems on a large scale, but weather conditions would not affect its services.

Make Your Own Electric Radiator

An efficient and safe electric radiator which will work from the mains, can be made with a minimum of trouble. Fig. 1 shows the design of the heater. You will probably find the materials in your workshop, or you may buy them quite cheaply.

The heating element consists of high-resistance wire, wrapped on slate or asbestos. Nickel-chrome wire S.W.G. No. 32 will be found suitable, and has a resistance of 17·5 ohms per yard. The length of wire needed depends on the voltage of your supply, and the current you wish to use, and may be calculated simply by means of Ohm's law. Assuming that the voltage of your mains is 240, and that you wish to use a current of $2\frac{1}{2}$ amperes, which is quite big enough for the ordinary lighting circuit, the required resistance of the wire will be found by putting these values in the formula: Ohms equals volts divided by amperes. Thus, 240 volts divided by $2\frac{1}{2}$ amperes will give a value of 96 ohms for the resistance of the heater. On dividing this result by 17·5 ohms, the resistance per yard, we find that approximately $5\frac{1}{2}$ yards of wire are needed.

The Heating Element

By means of a hacksaw, cut a piece of slate about 14 in. $\times$ 2 in. or $2\frac{1}{2}$ in. Rub smooth with sandpaper, but discard the piece if it shows metallic streaks. Four holes are drilled, two at each end, to take wood screws and terminals respectively. This may be done with ordinary twist drills, but go slowly and avoid applying too much pressure. The slate must be dried thoroughly before use.

Now coil the wire into a thin spiral about $\frac{1}{8}$ in. in diameter, by wrapping it tightly round a rod of the required thickness. The terminals should now be inserted in the slate, and the wire wrapped round and fixed to each terminal nut. Wrap the wire fairly tight, so that each loop of the spiral is separated from the next one. The tension will then keep the wire in place as it expands.

Assembling the Heater

Screw two wooden supports to the base, and fix the slate to these by means of two wood screws. See that the bare wire does not touch the wood as, should this be damp, there will be no danger of shock. The reflector is a sheet of tin plate which is bent into a suitable shape, and screwed to the base. This reflector should pass beneath the heating element so as to reflect the radiations from the lower side. It may be made more rigid by fitting protecting bars of iron wire at the front of the radiator.

Connect a length of stout twin-flex to the terminals, and fix it to the baseboard by insulated staples. You may then connect up with the mains in the usual way by a plug or adapter.

Care must be taken to see that the wood or metal parts do not, in any position, come in contact with the bare wire. The heater will then be perfectly safe, since obviously a shock can only be obtained from this bare wire or the terminals, and if the radiator is carefully constructed they are efficiently insulated by the slate.

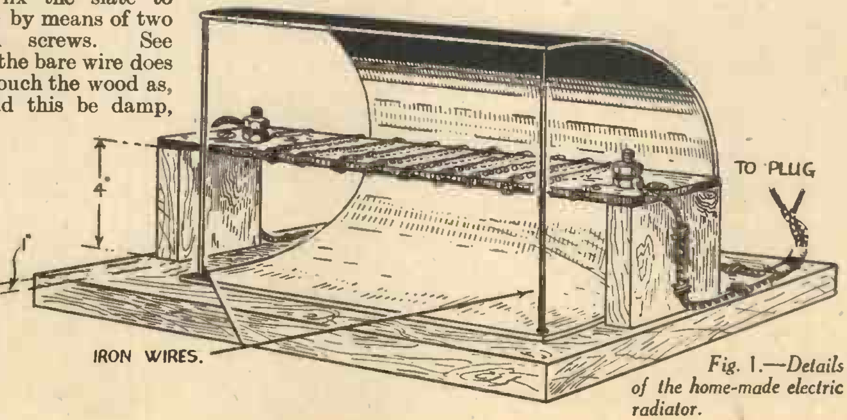
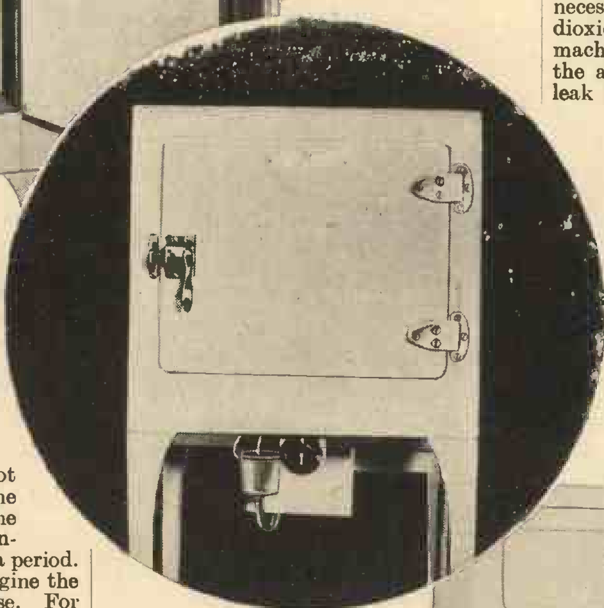


Fig. 1.—Details of the home-made electric radiator.

Domestic Refrigerators

In the Following Article is Outlined, and as far as Possible made Clear and Understandable, with Little or no Technicalities, the Principle, Theoretical and Practical, of a Refrigerating Machine



Figs. 1 and 2.—(Above) Showing the ice trays and ample food space in a modern domestic refrigerator; and (right) a small air-cooled refrigerator having a capacity of 1 cubic foot.

ONE of the most important, if not the most important machine used in a kitchen larder, is the cooling apparatus, or that which enables foodstuffs to be preserved for a period. Without it, it would be hard to imagine the many difficulties which would arise. For instance, all food would have to be bought daily, and bought in such a manner that none would be left at the end of the day, because all portions left—especially in the summer months—would have to be thrown away, as they would be unfit for consumption.

The ice-box and refrigerator have overcome all this worry, and, especially in the case of the refrigerator, food can be stored indefinitely, and the food will be just as good when it comes out of cold storage as the day it went in, providing it is properly stored at the correct temperature.

The Ice-box

In some of the small kitchen larders throughout the country, the old ice-box is still relied upon as a preserving medium, and in many of the remote country districts, it would be impossible for them to have anything else, there being no motive power and no means of driving a mechanical refrigerator.

An ice-box consists of a wooden box or cabinet, with a hinged lid or door. Between the outer walls and inner chamber an insulating material, such as silicate cotton or compressed cork slabs, is tightly packed. This prevents the warm air outside entering the cooling chamber. The cooling chamber is built in two or more sections, the lower section being so constructed that shelves or trays may be fitted, on which are placed the foodstuffs to be preserved.

The upper chamber is used as the ice receptacle; necessary arrangements are made for collecting the water from the melted ice by means of a drip-tray and draining-pipe, the latter being brought to a suitable position outside the cabinet. If this cabinet be kept tightly closed, the inside temperature will be reduced to about 35° to 40° F. While this system is good it is very costly—a medium-sized cabinet will use about 1 cwt. of ice in 24 hours.

This method of preserving foodstuffs would be most impracticable in a large hotel, not only from the point of view of cost but the amount of space that would be required for the ice portion, so mechanical refrigeration is resorted to as it is much better in every respect. The installation cost is the main cost, and the running and maintenance costs are not high. The machine pays for itself in a very short period.

Mechanical refrigerators vary considerably, from the large ammonia ice-making plant (also used in large cold storages) to the small sulphor dioxide (chemical formula SO_2) machine (automatic) used in household delicatessens.

Ammonia Machines

The ammonia machine is rarely used in hotel kitchens, chiefly because hotel kitchens are nearly always situated on the ground floor and often in the basements, and any leak that may occur in the ammonia system, such as a burst pipe, leaky joint, gland, etc., would have disastrous results.

The most common type used—but not necessarily the most efficient—is the carbon dioxide (chemical formula CO_2). This machine has one distinct advantage over the ammonia plant, and that is that if a leak does occur in the system, no danger can ensue, the mixture being practically harmless. This, everyone will agree, is a great asset, especially when it can be fitted in any nook and corner.

In the smaller type of machine, such as for ice-cream making and storing, also the household delicatessen, the sulphur dioxide (chemical formula SO_2) is the most popular.

The cost of this machine is not high, running and maintenance costs being particularly low. The electrical consumption of these small machines is only about 10 units per month. They are automatic in

Fig. 3.—A domestic refrigerator with the compressor unit mounted in the cabinet above the food-storage space.

action, and when the automatic switch is properly set, will keep the temperature to within 5°–8° of the setting. When installing this type of machine, great care must be exercised that there is plenty of ventilation, both from a running point of view and also a maintenance point. Often insufficient thought is given when choosing a site, and when the machine has to be overhauled it is found that the machine has to be moved to a better ventilated part of the building. This need not arise if care is exercised when installing. It is rather a good idea when it is not possible to have an out-building or well-ventilated room, to instal an electric-fan with reversing switch and necessary air-trunking attached, leading to the outside atmosphere, so that when the machine is running, cold air can be blown on to the machine, and when overhauling, the fan can be reversed to discharge any fumes outside.

The Principles of Mechanical Refrigeration

Refrigeration, no matter in which way it is carried out, is the transference of heat from one body to another, or from one substance to another. To explain, when a block of ice is placed into an ice-box the heat of the chamber, together with the heat of the contents, is transferred to the ice. In a mechanical refrigerator the heat of the cooling chamber and contents is transferred to the refrigerant, that is the ammonia, carbon dioxide or sulphor dioxide, whichever system may be used. Ice is comparatively hot to boiling ammonia at 25° below zero. When one thinks of a refrigerator one thinks of intense cold, yet heat is being supplied to the refrigerant to make it boil. The cooling chamber and contents supply the heat, and in giving up their heat, become cold.

To explain it more clearly, it will be necessary to detail the difference between heat and temperature. If heat is applied to a body, changes in its formation will take place, such as, if sufficient heat be applied to a metal it will change to a liquid. If heat be applied to a piece of ice it will melt, change from the solid to a liquid. If this heat is continued the water will boil. Its temperature then is 212° F. (atmospheric pressure), but no matter how much more heat is applied, it is impossible to raise its temperature above that point, but another change will take place in that the water will vapourise—turn to steam—that is the gaseous state.

It must be understood that heat can flow in one direction only, and that is from the warmer body or substance to the colder. If a vessel be tightly packed with ice, and in the centre of that ice pack is placed a vessel filled with water, say at 60° F., the ice being 32° F., the water being 60° F. will make the heat from the water flow to the ice. But it must be remembered that while this change is taking place, that is the heat leaving the water, the ice will not change its temperature from 32° F. until all the ice has melted, then and only then will the temperature of the melted ice commence to rise.

It has been stated that the temperature of boiling water is 212° F.—this is, of course, at atmospheric pressure. This boiling-point can be raised considerably. In a steam-boiler when the water is under pressure, and the pressure-gauge reads say 50 lb. per sq. inch, the temperature of that boiling water will be 298° F., and at 150 lb. per sq. inch it will be 363° F. Inversely, it can be made to boil at a much lower temperature than 212° F. If the pressure on the steam-gauge is reading 9 lb. (absolute pressure) per sq. inch (atmospheric pressure is 14·7 lb. per sq. inch) the boiling-point will be 170° F. This also applies to all liquids, as they all have a maximum boiling-point at atmospheric pressure, a higher boiling-point under pressure, and a reduced boiling-point under vacuum.

Boiling-point of Liquids

The boiling-point of liquids varies considerably—ammonia will boil at 25° below zero, mercury at about 660° F., and sulphur dioxide at 14° F. It will now be quite clear to the reader that if a vessel is filled with ammonia and allowed to vapourise into the atmosphere, and a constant pressure is kept on the liquid (so that its boiling-point remains at the same temperature), the ammonia will draw heat from its surroundings, and that while under the same pressure its own temperature will not rise, and the objects or substances giving up their heat will naturally go cold. This condition could go on indefinitely (if there were sufficient ammonia in the vessel) until the substance supplying the heat to boil the ammonia, became the same temperature as that of the refrigerant, when the ammonia would stop boiling and refrigeration would cease.

This, of course, would not be possible under ordinary conditions, owing to the enormous amount of refrigerant that would be wasted. In refrigerating machines, it is used over and over again; it is boiled or vapourised, and then condensed or liquified, and so the process goes on.

It has already been explained that to vapourise or boil a liquid, heat must be added, but to alter its form and change it from its gaseous state to liquid state, the opposite is necessary—that is the heat must be extracted. This is done in either one of two ways.

The refrigerating machine is built in three separate units, (1) the pump, (2) the condenser, and (3) the evaporator or boiler. The pump is to circulate the refrigerant round the system, the condenser to extract the heat from the refrigerant and so liquify, and the evaporator or boiler to draw the heat from the surrounding objects or substances and so make them cold. Fig. 4 illustrates how the refrigerant is circulated.

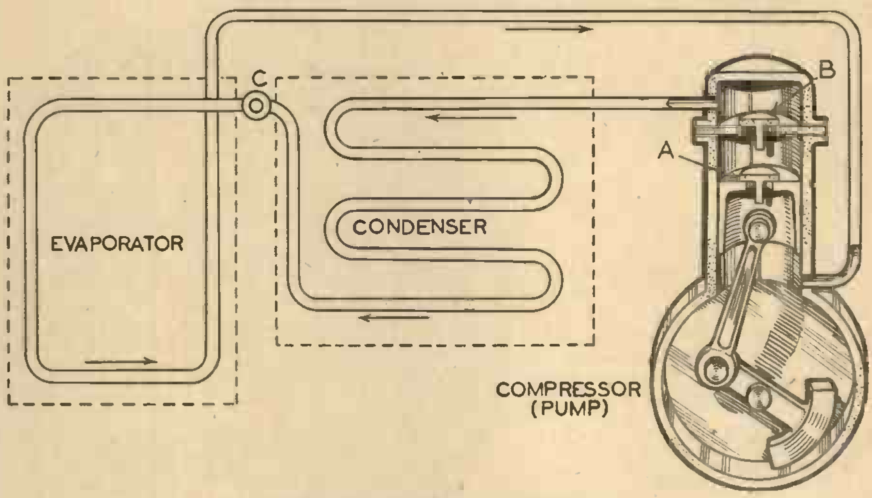


Fig. 4.—How the refrigerant is circulated.

The Inside Working

It will be seen from Fig. 4, that the pump is so constructed as to enable the piston or bucket to take a sliding, up-and-down motion. (In large machines they are made to work backwards and forwards in an horizontal direction.) Fitted in the top of the piston is a non-return valve "A," so that when the motion is downward, the gas lifts the valve and passes through. On the return stroke, or when the piston is moving upwards, this valve "A" is forced on to its seating, and prevents the gas from again passing through the piston. By this means the gas is pushed onward. Above the piston, and bolted to the cylinder, is a valve plate and a non-return valve "B" working in the same direction as the piston-valve. This allows the gas to be forced through by the upward movement of the piston but allows none to pass back. This action is continuous and, as in some cases two pistons are connected to one crankshaft, the flow of gas is kept at a steady rate.

The gas is then forced through into the condenser. Between the condenser and the evaporator or boiler, a regulating-valve is fitted (expansion-valve or needle-valve) and a float-valve in the automatic type. This valve regulates the flow of the refrigerant into the evaporator or boiler. This will, of course, increase the pressure in the condenser, and in so doing raises its boiling-point, which is most essential. To bring the gas back to its liquid state, the heat must be extracted. The methods adopted for extracting the heat, are either a circulation of cold water round the condenser, or a circulation of cold air round or through the condenser by an electric blower.

A Question of Temperature

If the atmospheric temperature around the condenser is 60° F., then it is necessary to raise the temperature of the refrigerant in the condenser to over 60° F. to be able to extract the heat. Also, if the temperature of the circulating water is 40° F., then it is only necessary to raise the temperature of the refrigerant to above 40° F. The pipe between the condenser and the evaporator, is termed "the liquid line."

The liquid is forced through the regulating valve at a steady pressure, and in passing into the evaporator expands and, having no pressure, its boiling-point is greatly reduced. After passing through the evaporator the refrigerant goes to the suction line of the pump; the process is thus continued.

After a running period, the temperature in the cooling chamber is reduced by reason of the refrigerant collecting the heat in the evaporator from the surrounding warm substances. The major portion of the gas being under pressure in the condenser, the evaporator has a minus pressure or vacuum.

WORLD FAMOUS FOUNTAINS

The Dragon Fountain, Versailles, believed to be the world's mightiest single jet.

The Griffon Fountain, Copenhagen, is a splendid modern example.

The Fountain, Rosenburg Square, Versailles.

Neptune Fountain, Bologna, Italy.

A FOUNTAIN is defined as an arrangement permitting water to gush into an ornamental bowl, or by which it is forced into high jets.

There are two principal kinds of fountains, the useful and the ornamental. The former are fountains provided in public streets or squares, from which people can draw water for domestic use. Such are still common in backward countries, but are being rapidly superseded by mains water supply laid on in dwelling-houses.

Ornamental fountains, which are used to beautify a street, garden, or public square still are popular, and have been built from the very earliest times. They are not only exceedingly beautiful objects, but in many cases represent a high degree of scientific and mechanical skill. This is especially the case with the very large and important fountains, which fling huge jets very high into the air, such as the fountains at Versailles, France, Aranjuez and Granada, Spain, and the great Buckingham Memorial at Chicago.

Some of these magnificent displays can almost be styled artificial geysers, or waterfalls.

Their Origin

The origin of the fountain is lost in the mists of antiquity, but it is certain that they were first made long before man had invented the water-pipe. Thus there is a Babylonian fountain, *circa* 3000 B.C., at Tello, the Lagash of antiquity, which is fed by a stone conduit. Layard, in his book on Nineveh, mentions an Assyrian example in a gorge of the river Gomel. This also is served by a stone channel and consists of a series of basins cut in the solid rock, and descending by steps to the stream.

It is certain that the ornamental fountain originated in a warm climate, and probably many centuries before Christ. In Greece and Rome, the commonest type had the water gushing from a grotesque human or animal mouth into a marble basin, but there were some which had a vertical jet. These are very beautiful, and also cool the air by spraying the water through the atmosphere, and consequently are much found in the mansions of the great, or the palaces of kings. In Greece and Rome, main water supply was often laid on to the mansions of the rich, but humbler folk had to draw their supplies from a street fountain. The Greeks were very fond of handsome marble basins, having cut stone openings through which the water gushed. Of all Greek cities, Corinth was the richest in this respect, and its most famous example was dedicated to the nymph Pirene—whose tears for her sons slain by Artemis were held to be the mythical origin of the spring.

Public Fountains

Ancient Roman cities were well supplied with public fountains. In Pompeii we can still see some good examples in the main streets, and some splendid specimens of ornamental fountains in the courtyards of private houses. There is one magnificent example in a villa, which to-day is named after it. There is a large plunge bath of coloured marbles into which water gushes from two old men's mouths. A little cupid stands in the water, through which a jet of water is squirted into the air. A flight of marble steps permits the bather to descend into the pool; the whole effect is not only very beautiful, but represents a wonderful amount of mechanical skill when we remember it is two thousand years old. There are numerous public water-supply fountains in the streets. The Romans sometimes constructed gigantic ornamental fountains for the adornment of their cities. They were almost as large as temples, and were known as Nymphæa. One of the best examples now remaining is near the agora at Ephesus.

When Rome crashed, Europe went back to barbarism, and street fountains did not re-appear till the twelfth century, but thereafter progress was rapid, and many beautiful fountains which are still running date from the mediæval period. The Schöne Brunnen at Nuremberg is very charming, with its graceful gothic spirelet, and numerous statues.

Ornate Structures

With the cult for classical models in the Renaissance, many fine fountains were designed. Some were exceedingly ornate, especially in Italy, where the most usual design consisted of a series of basins one above the other, but diminishing in size, and a lofty jet falling into the uppermost basin. Some of these are so elaborate that the water seems to be merely an afterthought; as, for instance, the Aqua Paola by Fontana (1600), and the Fountain of Tivoli, which was built from designs by Bernini in the eighteenth century. At the Villa D'este in the same Italian town, there is a most ingenious so-called "Water-Organ" or fountain, controlled by certain stones in the pavement. When certain of these are stepped on the water gushes out. This was a favourite joke in the Renaissance period, and there are many of these "secret fountains" which smother the unwary walker with jets of water when hidden stones are trodden on.

This was considered highly amusing by the *haut monde* of the period, and the guides play the joke on modern visitors to-day.

Many of these booby-traps are marvels of ingenuity; the idea is to make sure the unwary visitor is thoroughly soaked, and so the path is usually shut in by hedges, and the water-works begin when he is in the middle of a long alley way. Sometimes the jets are turned on by stepping on a paving stone, and in other cases there is a concealed tap which is operated by the practical joker.

One of the best examples of this kind known to me is in the gardens of the Palace at the Alhambra, where a very long path, shut in by hedges, connects two buildings. As you go along it appears perfectly normal, but when a tap is turned a long line of vertical spouts of water rise about 15 ft. into the air, and deluge the pathway.

"Les Grands Eaux"

The finest fountains in Europe are in France, Italy, and Spain. The most imposing spectacle of its kind in the world, can be seen on those days when "Les Grands Eaux" are showing in the gardens at Versailles, near Paris. The cost is so enormous that the water is only turned on for an hour at a time, on certain selected Sundays during the summer. Then at a given moment all the fountains in the grounds begin to spout in succession. There are 607 of them to-day, but originally (when first installed by Louis XIV), there were 1,400, and the cost was so ruinous, that the place was called "L'Abime des depenses," or the abyss of expense. There are twelve miles of underground pipes, and a display consumes six thousand million

The Palm Tree Fountain, Monreale, Sicily, which is believed to be the most graceful and artistic on earth.

cubic yards of water, which is used several times over, the fountains in the lower part of the grounds being worked by the overflow from those higher up.

The Basin of Apollo has one magnificent jet 60 ft. high, and three others of 47 ft., but the Bassin d'Eneclade has an artificial geyser over 70 ft. high, and surrounded by a large number of smaller jets. The finest group is the Basin of Neptune with sixty-three large jets which plunge down into the pool in masses of creamy foam.

The largest jet of all is in the Dragon Basin, which hurls a mighty column of water 82 ft. into the air. It will be remembered that the shameful extravagance of the French kings was a main cause of the French Revolution, and it is satisfactory to notice that these fountains — constructed to amuse a pampered Court—now give pleasure to millions of hard-working ordinary folk. When the fountains are playing, special trains are run, and the grounds are crowded.

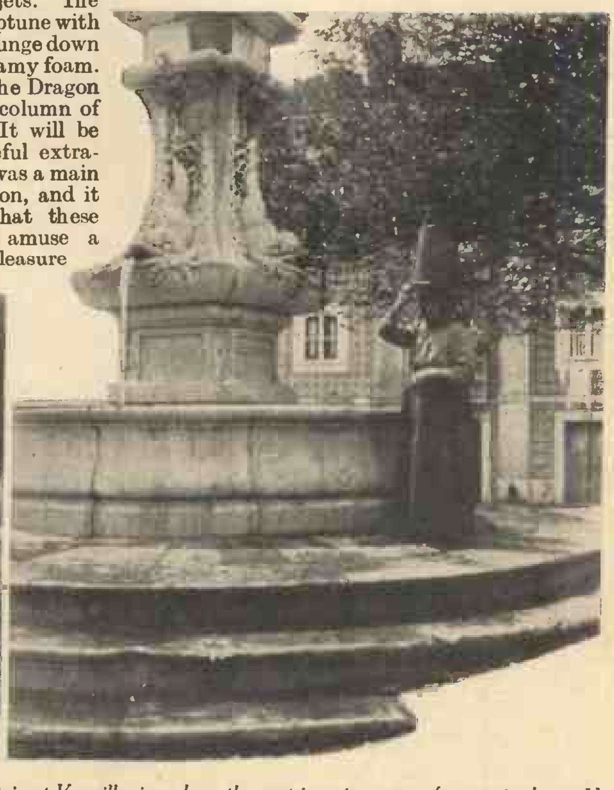
Two of the most dignified and imposing fountains in the world are the wonderful pair that stand in front of St. Peter's Cathedral at Vatican City. The fountains are 45 ft. high, and hurl a jet more than a 100 ft. into the air. Unlike many Renaissance models of this kind, there is no extravagant detail, and the beauty of the lovely design is increased by its simplicity.

The Palm Tree Fountain

The fountains of Sicily are justly famous, and among them there is one which I believe to be the most graceful and artistic on earth. It is called the Palm Tree Fountain of Monreale, and is in the cloisters of Monreale Cathedral. The artist has chosen a palm tree as his model, with lofty trunk with zig-zag markings like the cut-off leaves on a date palm, and a circular crown from which issue a halo of jets of water, resembling palm fronds.

Spain and Portugal are very rich in fountains. Most of them are placed in the streets for domestic water-supply—since none is laid on to the smaller homes—but many of them are strikingly beautiful. One of the most picturesque works of this kind is the famed "Horses Fountain" at Santiago-de-Compostella, where four gigantic horses vomit a stream of water from their mouths, and busy housewives can be seen at all hours of the day filling their jugs and buckets. Maid-servants come too, and carry the large water-cans away on their heads, a trick learned from their Moorish ancestors.

The Moors, too, have left behind them in Spain some of the loveliest fountains ever made. In the old Moorish Palaces of long-dead Sheikhs or Sultans, we can see graceful marble fountains, and silvery pools, as in the Alhambra and the Alcazar. In the first-named palace is the Fountain of the Lions, perhaps the most celebrated of all these works of art.



(Left) The Neptune Fountain at Versailles is perhaps the most imposing group of spouts in the world, and (right) a picturesque fountain at Belem, Portugal.

A Model of a Tudor Ship

A Simple Model which, when Suitably Finished in Colours, has Considerable Decorative Value

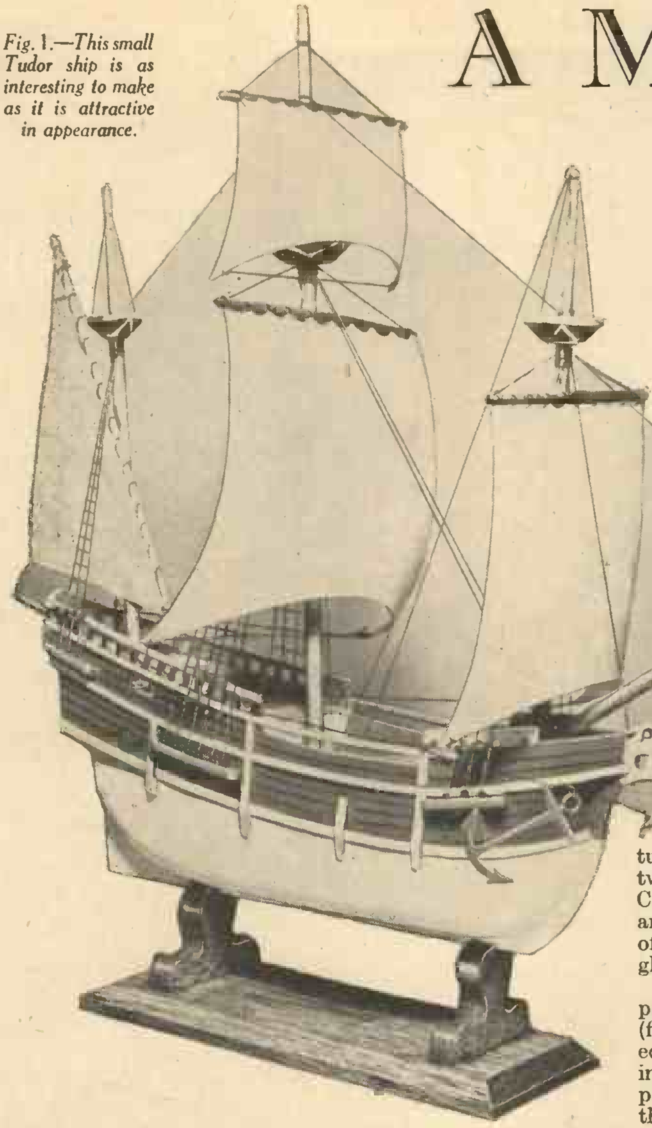


Fig. 1.—This small Tudor ship is as interesting to make as it is attractive in appearance.

THIS model represents the type of ship that was used for carrying merchandise during the time of Henry VIII. It is founded on a drawing made by Holbein in 1532, in which the crew are shown going about their various duties. Amongst them are several soldiers carrying pikes suggesting that the ship, even when engaged peacefully as a merchantman, would be prepared against attack. In emergency she would be pressed into service as a fighting ship.

As was invariably the case with Tudor ships, that shown in Fig. 1 is brightly finished with gay colours, thus making it a splendid subject for a model, because it has such decorative value. The hull is built up rather in the form of bread and butter, this being simpler than making it in a single piece, and it is just as satisfactory.

Practically any close-grained wood can be used. Satin walnut is quite satisfactory, or a good grade of pine. Common deal has the disadvantage of having hard and soft grain, and this is liable to show in the form of ridges as shrinkage takes place. Some hardwoods such as sycamore, are certainly close-grained, but they are so hard that the carving out is made difficult. For the keel $\frac{1}{8}$-in. plywood is used, and for the bulwarks which are bent around the hull, $\frac{1}{16}$-in. plywood answers well. Masts, spars and the stand, can be of oak.

The Main Hull

Begin by cutting out the keel piece *A* shown shaded in Fig. 5. It is in $\frac{1}{8}$-in. plywood, and will eventually be sandwiched between the two hull pieces. Cut out with the fretsaw, and round over the edges of the figurehead with glass-paper.

For the hulls *B*, two pieces of $1\frac{3}{8}$-in. by $1\frac{3}{16}$-in. (finished) section are needed. Plane them square in the first place, and prepare a full-sized plan of the side views from Fig. 5. Transfer the plan on to opposite sides of each block, and the side view to the *inner* surface only. Take care that the bows of both tracings are always at the same end and are level. Note also that the two hulls are right and left hand.

The plan shaping is done in its entirety first. The fact that the shape has been marked out on two sides, enables the correct line to be maintained at both edges. Much of the waste can be sawn away. This is followed by vertical paring with the chisel, and the entire curve is finished off either with the spokeshave or wood file.

Now follows the elevation shaping. Put the hull in the vice and cut across with the chisel, keeping the latter square, and complete the whole curve. This will produce a shape which is correct in both plan and elevation, but the outer corner needs to be taken off to give the true shape when viewed from the front. The left-hand piece in Fig. 2 is shown at this squared-up stage, and that on the right shows the rounded shape partly produced, and being tested with a template.

Fig. 2.—Testing the shape of the hull with a template.

This template is the reverse of the correct section amidships, and the line can be traced from the stern view. Form this centre shape first. The chisel can be used to remove the majority of the waste, the hull being held in the vice during the operation. Test frequently with the template, remembering that wood can always be removed easily, but cannot be replaced if too much is taken off.

Finishing the Hull

The shape towards bow and stern can continue in a gentle curve without lumps. View the hull from all directions, and take off a shaving where required. The wood file can follow. This should be worked with a sliding movement both along and across the shape, so that all chisel marks are taken out. A thorough glass-papering follows. The portion immediately adjoin-

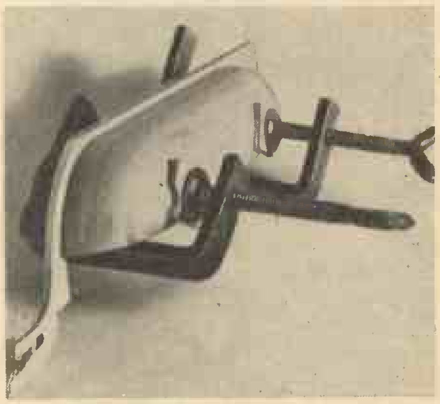


Fig. 3.—How the hull is glued to the keel.

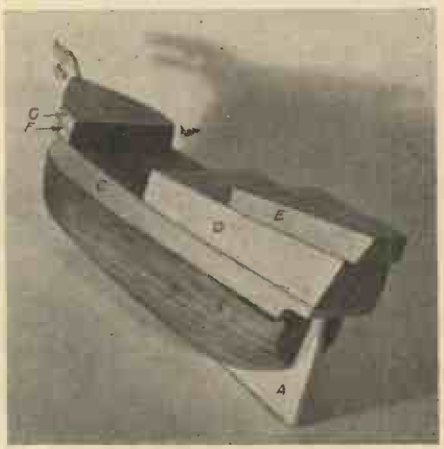


Fig. 4.—The superstructures glued to the hull.

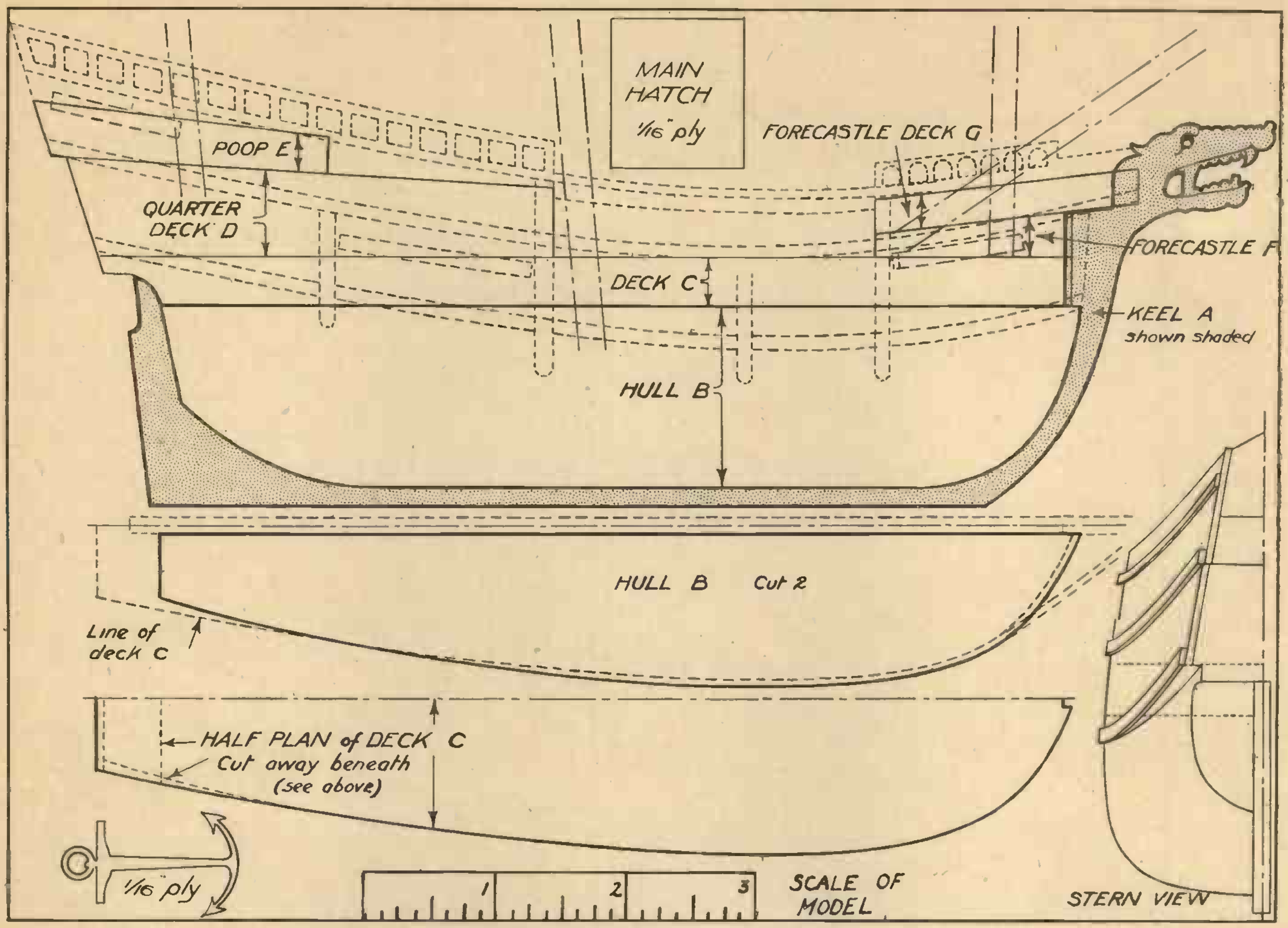


Fig. 5.—Constructional details of the hull, keel, etc.

ing the keel must be finished off true, because after gluing up, it would be extremely difficult to touch this portion. Towards the deck it is not so important, because a further smoothing down has to follow after the bulwarks are added.

It is now ready for gluing up. One or two nails can be driven through the keel into one hull piece, but this is not possible in the other. Instead, a nail can be driven in at an angle through the thin part of the hull. These nails serve to hold the parts in position, so that thumbscrews can be put on as in Fig. 3. Note the little blocks of wood under the cramps, to prevent damage to the surface.

The Superstructures

Begin with the deck *C*, one half of which is given in Fig. 5. Fold a piece of tracing paper and trace the shape, keeping the fold on the centre line. The opposite half of the shape is then traced directly from this. Transfer on to the wood ($\frac{3}{8}$-in.), and cut out. It will be found that it stands in at the bow and right round until near the stern, where it projects. This is shown by the dotted line in the plan shape of the hull. This standing-in forms a rebate in which the bulwarks can be fitted, so that the whole thing is flush. The bulwarks project at the stern. At the underside, a hollowed-out shape is cut at the stern, so that it fits over the projecting rudder portion of the keel. The *side* shaping (see dotted line) is not cut until later. Fig. 4 shows the deck in position.

The various other superstructures are now cut out and glued on, as also shown in Fig. 4. Certain of these have to be tapered in section (see side view in full-size design), and both the quarter deck and poop are taken off at an angle at the rear. If the stern view is examined, it will be seen that both quarter-deck and poop taper inwards towards the top ("tumble home" as it is called), and this shape is best worked after they have been fixed. If a bull-nose plane is available, this will prove very handy in working the shape. Alternatively, a wood file can be used.

At the bows, the forecastle does not taper, but rises vertically. Note that the forecastle deck is pointed and thus projects towards the beak. Before proceeding further, an imitation of the deck planking can be given, by drawing in a series of pencil lines.

Fig. 6.—Fitting the bulwark into place. Note how the cut at the bow enables it to fit against the forecastle and hull.

The Bulwarks

These can both be fretted out at the same time, by pinning together two pieces of $\frac{1}{16}$-in. plywood. The grain must be upright. To save the tedious job of fretting out the holes, a $\frac{1}{8}$-in. chisel can be used to cut them. The shaped ones at the bow can be bored in, and the bottom square, side cut with the chisel. If this method is adopted, the holes must be cut before the main outline is fretted, otherwise the grain may split away.

Fig. 6 shows the fixing. The cut at the bow enables the top part to bend along the forecastle deck, whilst the lower part can fit to the hull. Glue is used, and a few fine nails which are afterwards punched in, will hold down the plywood whilst it sets. Afterwards, the poop back can be added.

It is inevitable that a certain amount of unevenness will occur at the joint, and this can now be smoothed down. Where the bulwarks slope upwards towards the stern, the deck *C* can be cut away so that it is level with the hull. This is shown in the stern view, side view, and half plan of the deck.

Wales and Channels

For the wales, cut six pieces to the shape shown and fit them in the positions indicated by the dotted lines in the side view. The exact length can be measured from the actual hull, and they will bend easily one way or the other. The top wale is a trifle narrower than the others. Upright wales are also fixed in the positions shown, these again being in $\frac{1}{16}$-in. ply. They can be bent right over the horizontal wales, and be fixed with glue and nails.

Coming now to the channels, fine holes

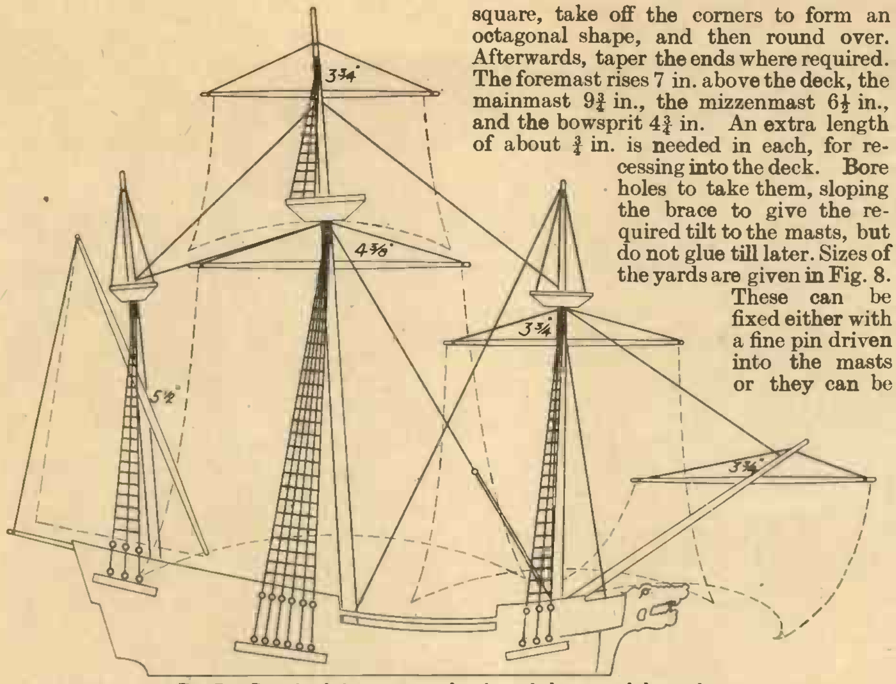


Fig. 7.—Details of the rigging and sails, and the sizes of the yards.

are drilled through these to take the shrouds, and at the ends, rather larger holes are made through the width to take the fixing screws (see dotted lines). The channels with curved edges, are fixed at the bow end.

Masts and Yards

These are cut in oak. Plane the wood square, take off the corners to form an octagonal shape, and then round over. Afterwards, taper the ends where required. The foremast rises 7 in. above the deck, the mainmast 9¾ in., the mizzenmast 6½ in., and the bowsprit 4¾ in. An extra length of about ¾ in. is needed in each, for recessing into the deck. Bore holes to take them, sloping the brace to give the required tilt to the masts, but do not glue till later. Sizes of the yards are given in Fig. 8. These can be fixed either with a fine pin driven into the masts or they can be bound on with fine thread. The crows' nests are fretted out, and the underside bevelled away. The centre holes are drilled before fretting out, their size being made to fit the masts.

Poster or showcard colours are excellent for the purpose, as they are opaque and cover well. Two coats are advisable. The lower hull is white or cream, and the bulwarks a mid-brown. Wales are picked out in yellow, and red and green are used to colour the handrailing, beak detail, and crows' nests. When dry (this is important), the whole is given a coat of clear cellulose lacquer.

Rigging and Sails

Begin with the main shrouds. Dealing with the mainmast, cut off 12 pieces of carpet thread (brown shade No. 50), each long enough to stretch from beneath the crow's nest to well below the channels. Remove the mast, put a coat of glue on the mast under the crow's nest, and lay the shrouds six to each side. When set, a piece of fine thread can be bound tightly round. Glue in the mast, and, threading two small glass beads on each shroud to form the dead eyes, pass the shrouds through their holes in the channels. Now fix the main stay from under the crow's nest to the base of the bowsprit, draw the shrouds taut, and tie them in pairs under the channels. A touch of glue on each knot prevents them from becoming undone. To hold the dead eyes in position, put a small dab of glue on each shroud, and raise the dead eyes to the required position.

Fig. 7 shows the remaining rigging and sail positions. The sails can be cut in lampshade vellum, to the sizes given in Fig 8. The edges to be attached to the masts, can be scolloped out with a gouge or scissors as in Fig. 1. Fine thread laced through the ends will hold them to the yards, and dabs of glue along the edge will hold them in the centre. The free ends are roped to the rear bulwarks.

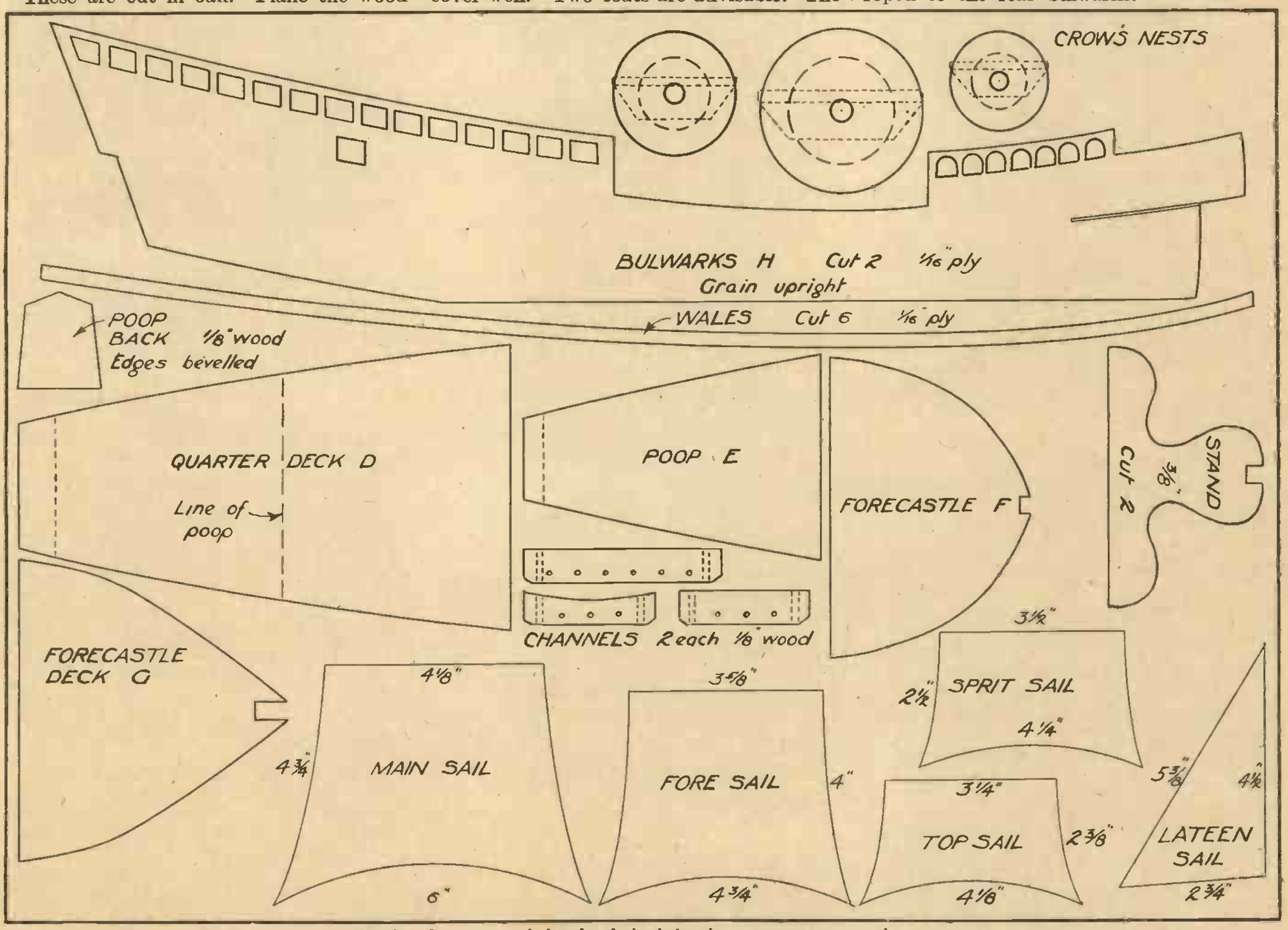
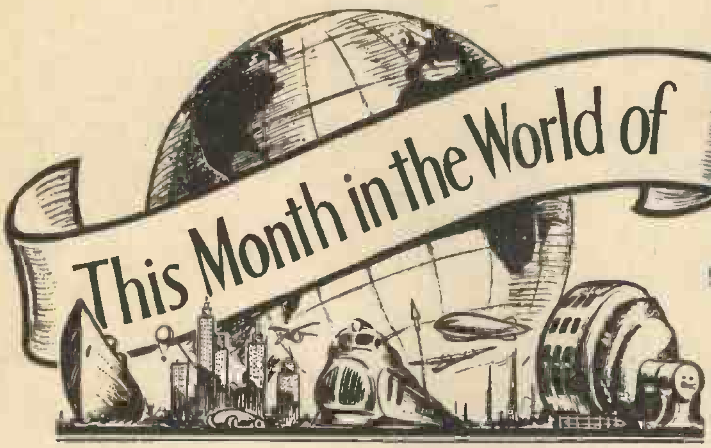


Fig. 8.—Constructional details of the bulwarks, superstructures, sails, etc.



This Month in the World of Science,

New Laboratories

THE past few months has seen the opening of two new specialised laboratories, the Fire Officer's Testing Laboratory at Elstree, and the new London, Midland and Scottish Railway Laboratory at Derby. They represent the increasing importance of the relation of science to everyday life.

Fire Testing Laboratory

THE hazards of modern buildings from fire are great. Present day buildings are less inflammable than older types of structure, but their very size, and their rigid construction of steel and concrete, threatens collapse if they do take fire.

At Elstree one building is given over to the testing of building materials at high temperatures under load. Specially built gas-fired furnaces are installed for the purpose. There are separate types to deal with three main types of structural elements, a " floor " furnace, a " wall " furnace, and a " column " furnace.

The Floor and Wall Furnaces

FLOORING structures are built over the " floor " furnace. Gas burners play on the underside, while loads of iron weights are added on the top till the floor fails.

The " wall " furnace heats one side of a wall structure built into the frame of a hydraulic press. A load of 500 tons can be applied. Heating is from one side only. To make the test more stringent, water is sometimes hosed on to the cool side of the wall. The " column " furnace is similar, except that the built up column is completely surrounded by impinging gas burners.

" Foamed " Concrete

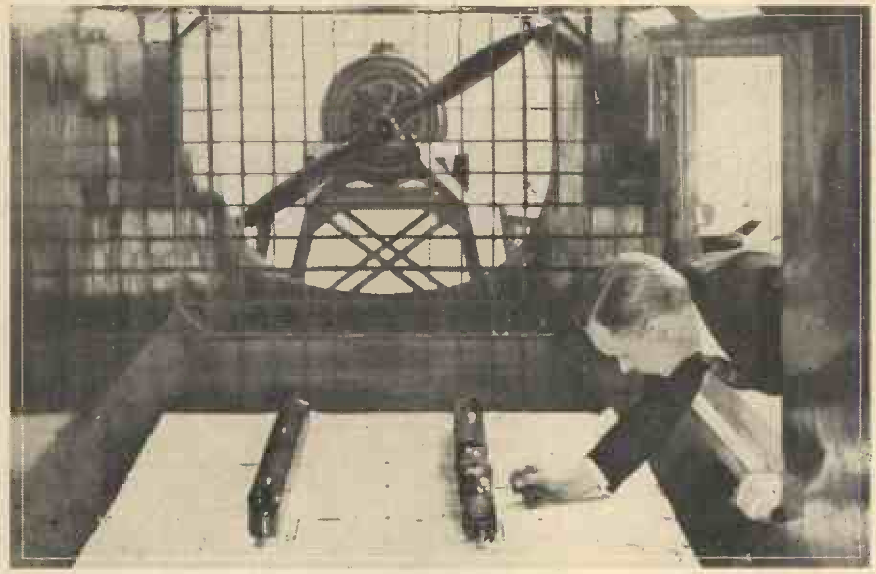
THE interior of the building naturally gets extremely hot. All operations are therefore conducted from a control room behind heat-resistant glass windows. Load indicators, and the leads of pyrometers indicating furnace temperatures, are brought into an instrument panel. A second building is given over to the testing of extinguishers and automatic sprays, and other fire fighting appliances. An interesting feature of the buildings is that it is constructed with the latest heat-resistant material known as " foamed " concrete, which is made from blast furnace slag.

The Train of the Future

THE object of the London Midland and Scottish Railway's Research Laboratory, which was opened last December, is to produce the perfect railway train which will give the highest speeds with maximum comforts at the lowest cost. In a special wind tunnel, the ideal stream-lined model is placed side by side with a model of an ordinary train.

Saving 1,000 h.p.

BOTH models have tufts of cotton-wool attached at various points, which show, as the wind rushes past, where the obstructions and resistances are. The research workers take as their basis of their stream-lining experiments, a speed of 100 m.p.h. At that speed, the stream-lined train requires only a quarter of the horse-power of the ordinary train, a saving of 1,000 h.p.



The large wind-tunnel built by the L.M.S. Railway at their new laboratory at Derby, for the purpose of streamlining experiments. The illustration shows a research engineer comparing air resistance of a standard and a streamlined train. In the background can be seen the tractor screw which provides an 80 m.p.h. wind, in the mouth of the tunnel.

A Year's Wear Produced in a Few Weeks

IN another part of the laboratory instruments produce the effects of a year's wear in a few weeks. They reproduce even the wear caused by passengers moving on the seats, and the rust of years on metal parts.

Grained Metal

THE number of coats of paint necessary for railway carriages has already been reduced from eighteen to eight. The scientists have also made a " cloth-paint," which gives to wood the soft "feel" of artificial silk or cotton, and have reproduced on metal the delicate grains of the rarest timber.

Rail-plane Trains

SERIOUS thought is being given to the development of rail-plane cars as a means of providing high-speed, long-distance transport. Unless the present railways are considerably modified, it is improbable that present railroad speeds can be increased much above their present limits. The problems of radius curves and maintenance of track, are too great.

Gas from Coal Mines

THE gasification of coal without mining, is a long dreamt of solution of the difficulties and dangers of coal mining. It has been tried in Russia on two disused coal mines. The method used is to cause a controlled explosion in the coal mine which sets the coal on fire, and air is then blown into the mine to keep it burning. Then steam is mixed in with the air to generate water gas from the burning products. So far, however, it has proved unsuccessful, as the gas coming off from the pithead contains over 60 per cent of nitrogen and carbon dioxide, both of which are useless incombustible gases. The calorific value, or heat producing quality of the gas, is only 120 British Thermal Units per cubic foot of gas. Ordinary gas-works coal-gas has a value of 500–600 British Thermal Units per cubic foot. Thus the results, so far, are very poor, but the experiments are, however, still being continued.

200 m.p.h.

THE suggestion is, a stream-lined car suspended from bogies, running on a single overhead rail. Motive power is to be provided by air-screws fore and aft, and speeds up to 200 m.p.h. are predicted. A few years ago the idea would have been thought futuristic. To-day, it seems the next step in the development of high-speed rail transport.

Invention & Progress

Silica Gel

A NOVEL drying agent in a convenient form, is provided by silica gel. This substance is identical in composition with quartz sand (SiO_2), but it is so prepared that it is has a microscopic spongy structure which confers on it a remarkable power for absorbing water vapour from the air and other gases. It will absorb up to 30 per cent of its own weight of water vapour.

It has the appearance of small granules of dried, white gum, and does not change in the least either to eye or to touch when completely saturated with water. To give an indication of saturation, it is impregnated with cobalt nitrate, which, as is well known, changes from blue to pink when it absorbs water.

Desiccating Agent

BY heating up to 250–300° F., the gel can be dried, and its drying powers regenerated. It can thus be used over and over again. It finds a number of uses wherever storage away from damp and rust is required, as in storing tools, silver, and small metal parts, etc. It is a most convenient desiccating agent for the amateur chemist.

Bright Colours for Stream-lined Trains

THE coming of diesel-engined flyers and stream-lined trains, heralds a brighter era in rail-road finishes. In America, this movement is already in being. *Hiawatha*, stream-lined engine of the Chicago, Milwaukee, St. Paul and Pacific line is finished in black, grey, yellow, and maroon with gold lettering. The *Comet*, New York, New Haven and Hartford's stream-liner is an aluminium train finished in wide bands of blue and burnished aluminium. The *Rebel*, of the Gulf, Mobile and Northern is aluminium banded with Chinese red. M1001, of Union Pacific, is finished in canary yellow. Colours are in cellulose lacquer, spray painted, which takes well on the smooth all welded carriage work. Bright colours not only attract travellers, but emphasize stream-line design.

A New Type of British 'Plane

IT is learned that a new type of aeroplane, in which a saving in structure weight of 35 to 40 per cent, with a consequent increase in load and range, is now in production in Britain. The machine, which is known as the Vickers' "Wellesley," is constructed on the "geodetic" principle; a new method invented by Mr. B. N. Wallis, who was the chief designer of the airship R 100. It can be used for both military and commercial aviation.

Telescopic Wings

ONE of the features of the machine is that it is possible also to design a telescopic wing, by which the span could be increased by sliding extensions at the right and left extremities. The left could thus be increased for the take-off, or greater speed attained when the extremities were withdrawn into the wing towards the body. This system is suitable for mass production, and on that basis would certainly be economical.

Proof Against Bullets

THE "geodetic" principle is based on a path taken between two points on the curved surface of a cylinder or globe. The frame of a wing or an aeroplane body, by this method, consists of a large number of members strictly placed on this principle, making up a comparatively light web of metal crossing and recrossing, but leaving the wing or body hollow. So strong is the structure that it has retained the essential qualities even when parts have been damaged, as they might be, for example, by bullets. The complete absence of interior bracing makes it possible to carry inside the wing, fuel or stores, or in a very big deep-section wing, the passengers' cabins.

A New Type of Cruiser

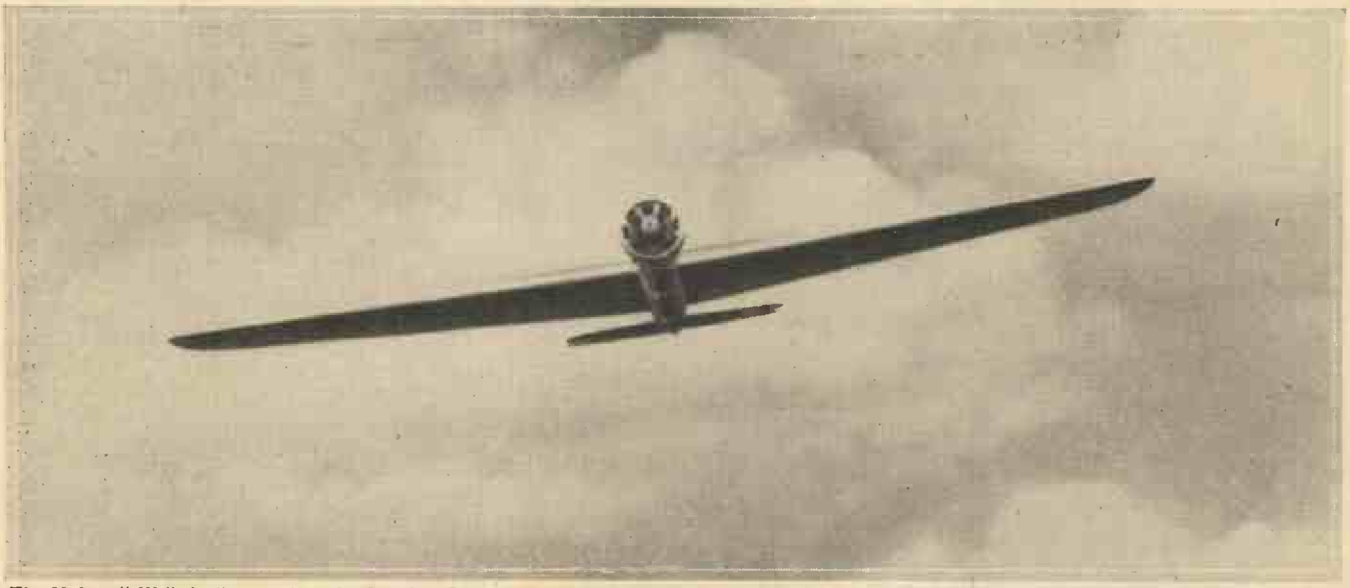
RECENTLY launched at the Vickers-Armstrong yard at Walker-on-Tyne the *H.M.S. Newcastle*, the first of a class of eight large and powerful cruisers, is the largest British ship of this type to be launched for seven years. The *Newcastle* is 581 ft. long by 61 ft. 8 in., and will have turbine engines of 96,000 h.p. for a speed of 32 knots. She will carry her 6-in. guns in triple turrets and will have, besides, an anti-aircraft armament of eight 4-in. guns. Twenty-two smaller guns and eight torpedo tubes are to be mounted. Other equipment includes two aircraft and a catapult.

Boring for Water

AN artesian well nearly two miles deep, is to be sunk near Paris in the hope of finding a new water supply for the city.

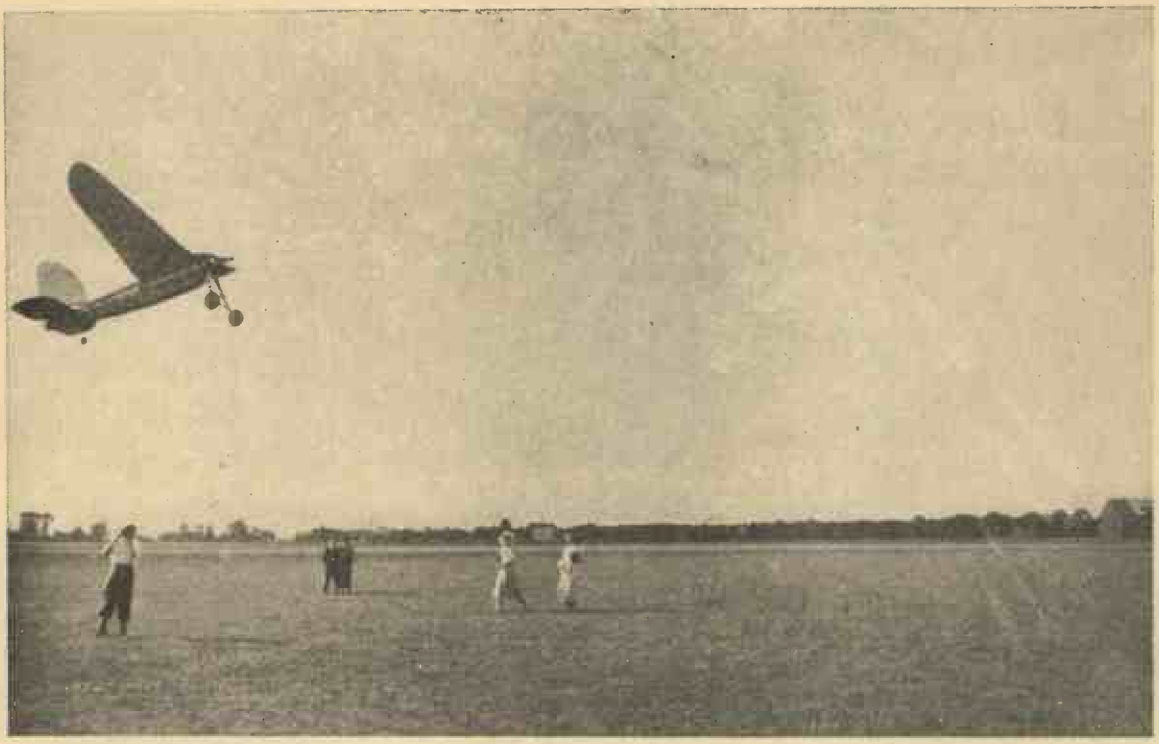
A Map Tuning Dial

A RADIO set has recently been produced which "spotlights" on a map of Europe, the station to which it is tuned. As the tuning is altered, the name of the station from which the set is receiving at any moment, is automatically illuminated in its correct geographical position, on an illuminated map of Europe placed above the controls.



The Vickers "Wellesley" monoplane fitted with a Pegasus air-cooled engine. An order has been placed by the Air Ministry for a number of this new type of aircraft in which the system of "geodetic" construction is employed.

Model Aero Topics



Capt. Bowden's Blue Dragon—just after taking off in 1934, when the machine established a record of 12 min. 48 sec.

By F. J. Camm

Nonsense About Downthrust

I NOTICE a growing tendency on the part of some model makers to give a negative thrust-line to their models, that is to say, the thrust-line is not normal to the geometrical centre of the fuselage. I have not yet been able to discover what peculiar line of reason induces them to do this. I can understand such a method being adopted on a wrongly-designed model in an effort to reduce stalling tendency, but if a model is properly designed on paper, it is absurd to incline the thrust-line, and in any case the same effect could be obtained by altering the incidence of the wings. Perhaps some of the "experts" who talk so glibly about this sort of thing, might care to justify this whim. Unfortunately, beginners with petrol-driven models are copying this "idea" with disastrous results. I cannot too strongly recommend them not to do so.

A Thick-wing Section

ANOTHER so-called improvement, is to endeavour to make the model fly slowly by using a thick wing section with a fairly hefty lift/drag ratio. Here again, this merely advertises lack of knowledge and wrong design. With a petrol-driven model it merely indicates a too high crankshaft speed with a directly coupled airscrew. The wing loading and the wing section should be selected with the desired flying speed well in mind. If the loading is heavy, the model will fly fast. To fit a thick wing section to make it fly slowly, is patently ridiculous, since the same effect could be obtained, and more efficiently, by adopting a lighter wing loading. Thick wing sections are inefficient. I concede that with cantilever wings necessitating deep-section wing spars one must use a fairly thick wing section, but that is merely a necessary evil, since the most efficient wing would be that which has no thickness at all! I find a good deal of misconception exists in the minds of beginners on this subject. They think that because the Clark Y wing section is efficient on a full-size aeroplane, it must necessarily be so on a model.

A Rigid Unbraced Wing

THE full-size section is designed to effect the best compromise between lift, drag, and strength. If you want to make a rigid unbraced wing, you must use a deep wing section, and you endeavour to obtain the best lift/drag ratio in the circumstances. With a model, some of the problems which arise in full-size wing design vanish, and hence a new technique must be adopted. A wing section designed for a flying speed of 200 miles an hour is most inefficient at model speeds, and yet we find so-called "designers" recommend for models the Clark Y and other wing sections.

Many readers write to me on this point, and I have dealt with it in these pages many times before. I hope this paragraph finally disposes of the matter. Do not use a heavy loading for petrol-driven models, you are simply asking for crashes and damaged engines. Use the lightest loading possible—not more than 8 oz. to the square foot. Use a slow-running airscrew with as large a diameter as possible, fine pitch, and high-aspect ratio. Use the thinnest wing section you can, consistent with strength and lift, and low-drag. Don't incline the thrust line, no matter what you may hear to the contrary.

Geared-down Airscrews

I HAVE had a fair amount of experience with the miniature petrol engines on the market. I have certainly tested most of them, and find that they all, for obvious reasons, develop their power at high revolutions. I am therefore surprised to find that very few experimenters have tried the effect of using a geared-down screw. It seems to me that an efficient airscrew cannot be designed for speeds of 3,000 to 6,000 revolutions per minute, for the percentage of slip must be extremely high. If the airscrew is designed for a practical efficiency of 70 per cent., the airscrew must be geared down, and I feel that most of the troubles with petrol-driven models are caused by airscrews which are running too fast. In order to let the airscrew revolve at its best speed, airscrews of perhaps only 12 in. in diameter and of 10 in. pitch are used. Little wonder, therefore, that the models stall, dive, and are unstable, both laterally and longitudinally. A very light gearing of 2–1 ratio can be made, and I advise its use.

Model Autogiros and Ornithopters

I AM interested to note that several successful flying model autogiros driven by elastic have been made, and I hope to be able to describe the construction of one of them next month. The best duration, up to the time of going to press, seems to be 18 seconds, but the models, I am assured, are most consistent flyers. The model aeroplane has developed and advanced considerably during the last three years, largely

I think, due to the efforts of Capt. Bowden with petrol-driven models. A branch which is still nebulous, is that concerned with flapping-wing models. Only one or two of these have been built, although I have described the construction of a successful one in some of my books. If any reader has made a successful flapping-wing model, I shall be glad if he will get into touch with me.

Cash for Readers

I SHALL be pleased to award prizes of 7*s.* 6*d.* for all photographs sent in by readers, and which I publish, showing either a model aeroplane on the ground or in the air. The photographs may indicate some new system of construction, some new gadget, a model just taking off or landing, in fact, any interesting photograph if clear and sharp, will suit. If you require the photograph returned, a stamped and addressed envelope should been enclosed. Every photograph must bear the name and address of the sender, and it is understood that the competitor has the right to submit the picture, and that copyright is not owned by someone else. Send your photographs with a cardboard stiffener to prevent damage in the post.

The "Baby Cyclone" Petrol Engine

THE manufacturers of the above engine, which I reviewed in the January issue, have kindly promised to let me have one for test. I understand that this engine will shortly be placed on the English market at a competitive price. The little "Brown Junior" engine still holds the field over here, and I have nothing but praise for it. Many readers have purchased them to fit into the petrol-model aeroplane described by me in recent issues. Blue prints for this model are still available at 7*s.* 6*d.* a set from the Publishers, Geo. Newnes, Ltd., 8/11 Southampton Street, Strand, W.C.2.

The immense size of some of the American "gas" models may be gauged from this photograph. In spite of their large size they weigh only about 3 lb. A light loading is used, and thus the models fly slowly.

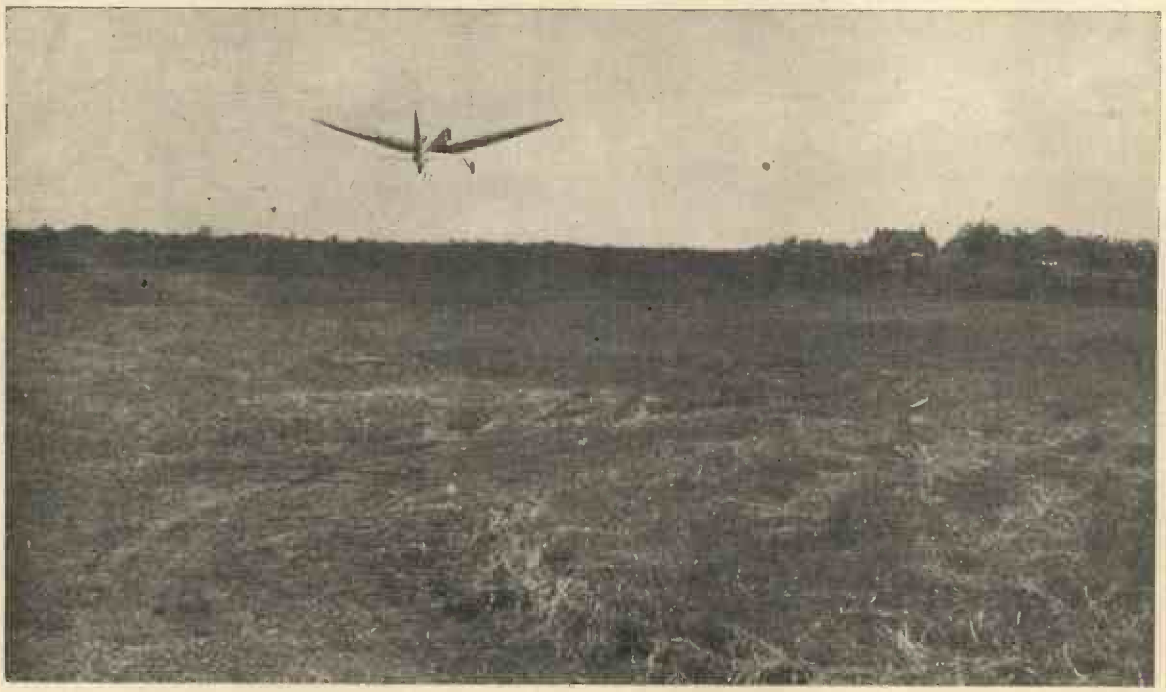
A Propeller Tester

MAXIMUM propeller efficiency on model aircraft is very important, making all the difference between excellent or mediocre flights, and in some cases, deciding whether the machine flies at all. Among other factors, the size and the shape of the propeller is important. This may be small but having an exceptionally high rate of revolutions, thus giving the machine capabilities for a high altitude initial flight and a long glide, or large, resulting in a slower speed but extending flight under power. Another factor is propeller pitch. The more open the pitch the more "grip" the blades will have, but resistance to rotation will also increase. The flatter the pitch, the faster will the propeller revolve, but non-productive slip will result if too flat. Where is the happy medium? Much of the experimental work necessary to find this out, can be done on the bench with the tester shown in Fig. 1. Essentially, the device registers the pull obtained with individual propellers, from which useful data can be obtained. The main portion is a dummy fuselage into which is fitted the rubber motive power in the usual manner. The fuselage should be of the same length as that of the plane to which the finished propeller will be fitted, so that the power obtained will be similar. This fuselage is carried on three more supports, sliding in three brass tubes soldered into brackets mounted on a baseboard. The wire slides and the tubes should be accurately mounted, to enable the fuselage to move forwards or backwards as easily as possible. The rear slide is continued to the rear, and is linked up, by another wire link, to the lower end of a long pointer. The pointer and the fuselage are drawn back by means of a spring which can be either of steel or elastic.

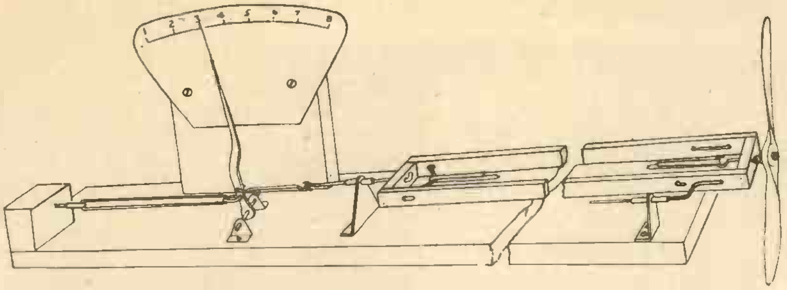
The Graph

THE readings are taken by winding up the motor to a similar number of turns which are obtained on the actual machine, and noting the position of the pointer on the scale. It is also necessary to take into account the time over which the propeller exerts a reasonable pull, and it is suggested that the pointer reading is taken every five seconds, and these readings converted into a graph as shown in Fig. 2. The curve *C* shows that a much longer flight can be expected from that propeller than *A*, in which, although more power is obtained during the first fifteen seconds, dies out much more rapidly. *B* shows a heavily pitched propeller which is far too heavy, as the rubber motor would be insufficient to drive it at its most efficient speed.

ACROSS COUNTRY



A fine view of the Bowden Drone low-wing petrol model just after taking off.



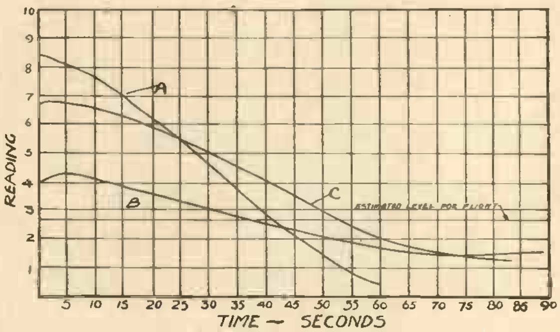


Fig. 1 (above).—The complete air-screw-testing apparatus.

Fig. 2 (left).—Specimen graph from readings obtained with the apparatus.

A Model Ornithopter

I HAVE all of the details of the Slinn Model Ornithopter which is, I believe, on sale in America. I have prepared working drawings and photographs, and shall publish these next month. Additionally, I have published, in *Hobbies New Annual*, details of my own successful model Ornithopter. I mention these facts so that any reader who wishes to experiment with flapping wing models will know the only sources of information.

The Wakefield Gold Challenge Cup Competition

LORD Wakefield has probably done more than any other man to encourage every branch of sport, and his name is famous throughout the world for the generous donations he has made to various branches of it. It is certain that England would be far behind other countries in motoring, aviation, cycling, and athletics were it not for the practical interest he evinces in the nation's welfare. Many years before the War, when aviation, and particularly model aviation, was followed by only a few enthusiasts who were looked upon as cranks, he donated to the then Kite and Model Aeroplane Association a splendid gold challenge cup which, excepting for the War years and for a period after the War, has been competed for annually. It was intended, of course, originally that the cup should form the subject of a National Competition, but after the War the K.M.A.A. went out of existence and it was not until I raised the question of the many cups which had been donated, of which the Wakefield Challenge Cup was one, that anything was done to collect the cups together again. After my efforts and appeal in the columns of *Flight*, they were at last found and handed over to the S.M.A.E. It is to be regretted that the competitions for a few years were not national in character, but it gives me pleasure to relate that the organisation of the S.M.A.E. has been radically overhauled during the past month and the competitions will, in future, be on national lines.

Financial Difficulties

HOWEVER, the point I wish to make was that the Wakefield Challenge Cup was won by the American team last year, and owing to lack of funds it seemed, until the timely assistance of Lord Wakefield, that the S.M.A.E. would not be able to afford to send a British team over to America this year in an effort to win the Wakefield Cup back for England. The cost of sending a team to America is fairly heavy, and Lord Wakefield has generously subscribed the considerable sum of £200 towards the cost of the expedition. Additionally, Mr. Fairey has given £20, the Cellon Dope Company £5, whilst financial assistance has also been promised by the Dunlop Rubber Company, the Balsa Wood Company, and many others.

Mr. Fairey is, of course, of the famous aircraft firm which bears his name, and before the War his name was equally famous as a successful competitor in model aircraft competitions. I do not know whether he ever won the Wakefield Cup, but it is my impression that he did so.

The First Winner

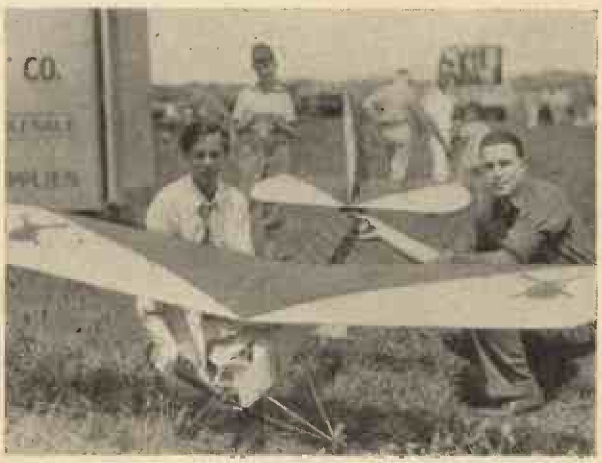
A NOTEWORTHY contributor to PRACTICAL MECHANICS, Mr. E. W. Twining, was, I believe, the first winner with a twin-screw T-frame Canard monoplane of distinctive design. Mr. E. W. Twining has been associated with models and model aircraft all his life, and is probably the most versatile of all modellers.

With the substantial funds now available I hope that the British team will have a successful visit, worthily uphold the traditions of British sport, and bring back the cup with them. I hope to be able to publish drawings and details of the winning design as soon after the competition as possible. One of the rules of the competition is that it must be competed for in the country of the present holder, and it is comforting to know that funds are now available to provide the opportunity of it being competed for over here next year.

Flying Scale Models

READERS may be interested to know that the Model Supply Stores, 46, Derby Road, Prestwich, are now the British agents for the Lawrence W. Brown Aircraft Co., Scientific Model Airplane Co., and Construct-a-Plane Co., of America. The sterling qualities and exclusive features of the kits manufactured by these firms are probably already well known to readers of this page, but for the first time they are able to obtain them in this country. Interested readers should write to the above firm for a copy of their latest catalogue which costs 3*d*.

IN AMERICA!



The great enthusiasm in America for "gas" models is evidenced by these two photographs recently received.

Adapting the Twin-Train Table Railway

By E. W. Twining

Some Suggestions by the Author for Adapting the Mechanism of the Twin-Table Locomotive to Other Engines Having British Outlines

IN his article in the December issue, Mr. W. J. Bassett-Lowke gave a full general description of this new miniature railway system. From this it will be gathered that, as it is now being sold to the public, the railway is essentially one—at any rate in its most simple form—which is intended for assembly on a dining-room table and after use, be packed up again. As may be gathered from the previous article, the scheme is capable of far greater possibilities by utilising the track for the planning of complete permanent layouts, such as the excellent ones designed by Mr. Beal and described in the January issue. In the following articles, it is proposed to go more fully into the technical details and, as far as possible, explain the complete system of working, following these details up with suggestions for adapting the locomotive mechanism to types of other engines having British outlines. Later designs and drawings will be given for railway equipment such as signals, station buildings, tunnel fronts, etc., and one or two designs for locomotives in which the use of this electrical mechanism shall be incorporated for a larger scale, that is to say 0 gauge, having a width between the rails of 1¼ in.

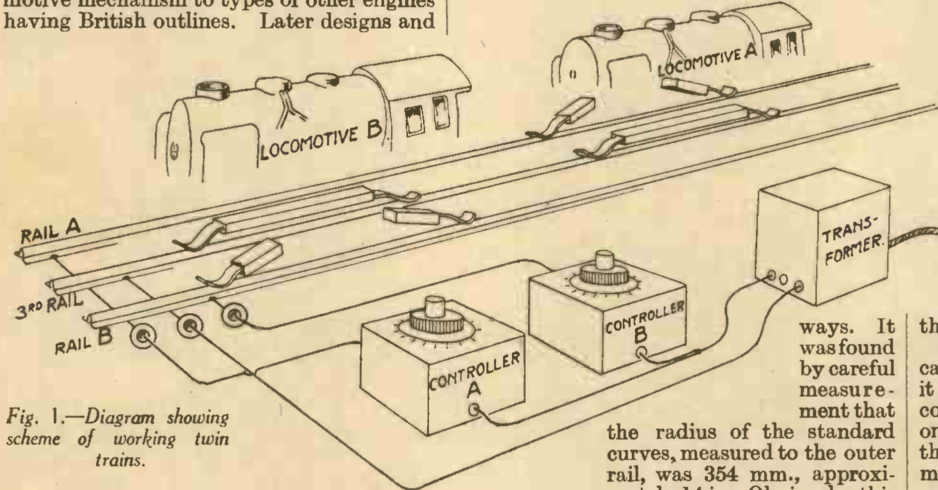


Fig. 1.—Diagram showing scheme of working twin trains.

Radius of Curves

Unfortunately, in this twin-train system as now manufactured, the radius of the curves is too small to allow of anything but a very limited wheel arrangement on the engines. Actually, very few more wheels can possibly be added to the four already fitted on the engine, which, as may be recognised, to a great extent follows the outline of the German state railways. It was found by careful measurement that the radius of the standard curves, measured to the outer rail, was 354 mm., approximately 14 in. Obviously, this is too sharp to take even an ordinary 2-4-0 type engine with a rigid wheel base, whilst a 4-4-0, that is to say a four coupled bogie engine, would require a side play to the bogie considerably in excess of what is possible. Where, therefore, a permanent railway is to be laid down, it is strongly advocated that the minimum radius shall be not less than the 2 ft. to the outer rail as advocated by Mr. Beal, and in the more complicated wheel arrangements for locomotives, which will be described later, the curves will be schemed accordingly.

Scale of Model

It was found that the twin-train railway was not strictly the 00- but H0-gauge (H0 means "half 0" gauge, 0-gauge being 7 mm.). The gauge is of the track supposed to be 16·5 mm. although upon measuring this, it was found to be 16 mm. only. If the scale is H0, i.e. 3½ mm. to 1 ft., then the gauge of the track scales exactly 4 ft. 8½ in. and therefore the rail gauge should be taken as the scale of any model railway. On this scale, the height of the chimney and cab equals 14 ft., which accords very well with the German loading gauge. If the scale were taken to be 00, i.e. 4 mm. to the foot, the height of the chimney would only represent 12 ft. 3 in., which is not, of course, nearly high enough, and on the 4 mm. scale the gauge is only 4 ft.

For utilising the mechanism to fit into casings having British locomotive outlines, it may be best to ignore the gauge and consider the scale to be 4 mm., because one is thus enabled to increase the height of the chimney, dome and cab roof, which may be necessary if it is wished to reproduce certain engines which have low boilers and

Fig. 2.—The locomotive mechanism, drawn full size.

long chimneys. The point is that the mechanism comes up so high, that there is a limit below which one cannot take the top of the boiler.

Twin-Train Working

Mr. Bassett-Lowke has already explained that not only the centre, which is generally known as the third rail, is insulated from the running rails, but these two outer rails are themselves insulated from each other and, in order to prevent these from being short-circuited, every wheel which rests upon one rail has to be insulated from those resting upon the other. It will be found that even between the driving wheels of the engine on opposite sides, there is no metallic connection. This feature is the essential one of the whole system, for it is only by means of it, that two trains can be independently operated upon the same track. The method adopted by the makers for preventing the train short-circuiting the track is the simple one of making all the wheels of every vehicle except the locomotive, of moulded plastic generally referred to as Bakelite. The engine wheels, however, are die-cast in metal with moulded plastic bushes fitting on to keys on the axle.

In order to make the system of working clear, a glance at Fig. 1 will show two locomotives standing upon, or running upon, the same track. Underneath these engines there are insulated brushes, or current collectors, rubbing upon the centre (third) rail. In addition to these there are other brushes which are not insulated, that is to say, they make metallic connection with the frame of the engine. Locomotive A has these latter brushes pressing upon the right-hand rail (right-hand in relation to the direction in which the engine is travelling chimney first); the other locomotive *B* has the brushes pressing on the left-hand rail. Suppose that both engines are required to stand on the track with their chimneys pointing the same way. If they were required to work chimney to chimney, or tender to tender, the brushes of both engines would be on either the right- or the left-hand side. The brushes, by the way, are so fixed by the makers that they are readily changed over from one side to the other.

When two trains are to be operated, two controllers are required, and these controllers should be connected up to the rails as shown in Fig. 1. Controller *A* has one side coupled to the transformer and the other to rail *A*; thus providing the necessary current for working locomotive *A*. Controller *B* is connected to the transformer and to rail *B*. Thus it will be seen that the movement of the two locomotives is entirely independent.

The Reversing Mechanism

Fitted to the controller is a milled knob or wheel which controls the speed of the trains, and a red knob or button by which reversing is effected. In Fig. 3 is shown, more or less diagrammatically, the essential parts of the electro-motor and reversing switch on the engine, and the electro-magnetic reversing gear which operates the switch. If the reader is already the possessor of one of the engines, it is suggested that he removes the boiler by taking out the two screws at the back on either side of the tender-coupling, and unscrewing the two front buffers. He will then see the mechanical action of the four-armed star wheel brought about by the movement of the armature on the electro-magnet, and the cylindrical commutator revolved by the star wheel. It is these items which are shown in Fig. 3. *E* is the electro-magnet and *a* the armature of the same, reference to which has already been made. The star wheel is lettered a^1, b^1, c^1 and d^1. *A* is the armature of the motor, B^1 and B^2 are the brushes which rub on the commutator, and *C* and *F* is the field winding.

The parts *A*, B^1, B^2, *C* and *F*, are exactly like all other electric motors in general. It is interesting to note, however, that in an ordinary series-wound machine, i.e. one in which current passes through the field and armature windings one after the other, a change of direction of rotation can be effected by reversing the passage of the current through the winding of either the armature or the field coil; it does not matter which. This means that if a motor is running in a clockwise direction and you wish it to run anti-clockwise, the connections to the brushes or field winding can be changed over, both of which will have the effect of reversing direction.

In this little locomotive motor with which we are dealing, the makers have elected to change the passage of the current through the armature, and this is effected by the commutator *Rc*. In Fig. 3, diagram 1, it will be seen that this commutator is in such a position—note that point a^1 on the star wheel is at the top—that the current picked up from the third rail passes through the field winding *F*, the brush which is pressing on the sleeve *c* on *Rc*, the motor brush B^1, the armature, the brush B^2, the right-hand barrel *d* on *Rc*, the frame of the engine and down to one of the running rails. Note that the current, besides passing through the motor via *Rc*, is also passing continuously through the electro-magnet *E*.

Supposing that the operator wishes to reverse the locomotive, he presses the red knob, see diagram 4, Fig. 3. This knob is spring loaded from underneath, and is held by the spring in the position in which it is shown. It will be seen that there is a barrel of insulation underneath the knob, with a brass band around it. In the up position, this band connects together two leaf springs through which all the current from the transformer to the running rails is passing. When the knob is pressed to the down position, the band passes beyond the range of contact with the leaf springs, and so the circuit to the locomotive is broken. This causes the armature *a* of the electro-magnet to fall away from the poles, since the magnet is no longer energised by coil *E*. Nothing further happens than that, except, of course, that current is also interrupted to the motor. When the knob is released, the armature *a* is again attracted to *E*. This brings a little pawl into action which, engaging with the star wheel, causes the wheel to make one quarter of a revolution. Point a^1 on the wheel is therefore brought around to the position in which it is shown in diagram 2, Fig. 3. It will now be seen that the commutator *Rc* has turned an amount sufficient to bring the brushes B^1 and B^2 off of *c* and *d*, and they are now pressing upon the insulating material which separates the plates. In this position, current is prevented from passing to the motor although it is passing through *E*, and so the engine remains stationary. If now the operator presses the knob a second time, exactly the same thing happens to the electro-magnet, the releasing of the knob again causing current to flow. This time, however, when the star wheel and commutator make a further quarter revolution, plate *d* remains cut out of the circuit and a new plate *e* is brought into action (see diagram 3). The current passes downwards through *E*, still flowing,

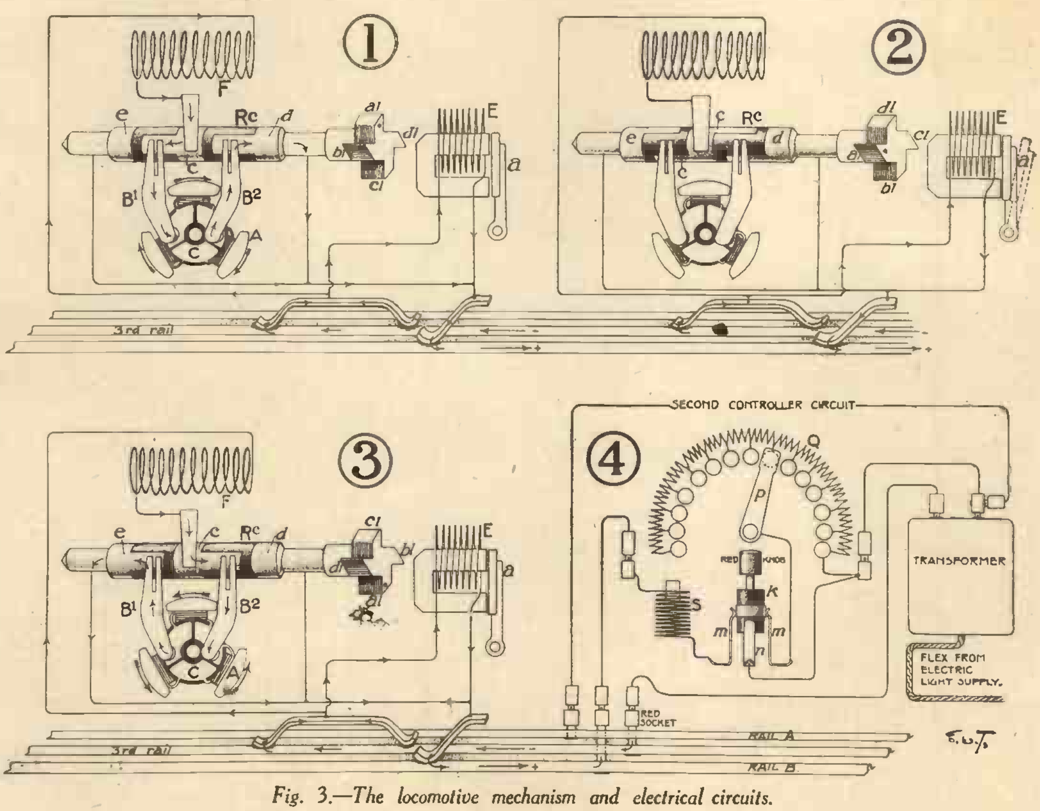
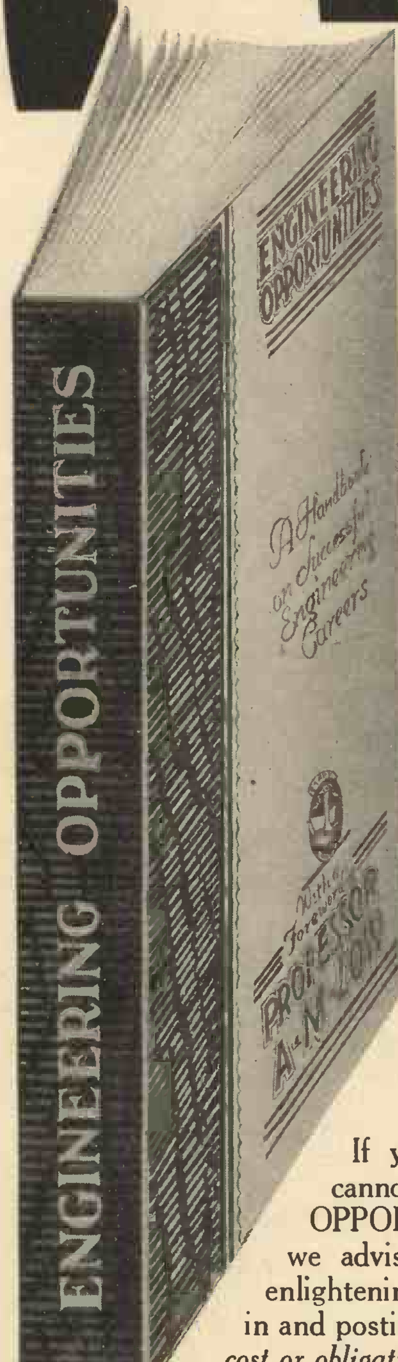


Fig. 3.—The locomotive mechanism and electrical circuits.

FREE!



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be it noted, in the same direction as before; then, turning right instead of left as it did in diagram 1, it passes down through brush B^7, through the armature, up through brush B^1, through plate e and so back to the running rail. This cycle of changes, it will be seen, has had the effect of reversing the direction of rotation of the armature, such direction being indicated by arrows in diagrams 1 and 3 in Fig. 3.

The Controller

The circuits of one of the controllers is shown in diagram 4, Fig. 3. In connection with this, the function of the red knob has already been referred to, for reversing where k is the insulating cylinder with its brass band and m, m the switch leaves. Q is a series of resistance coils, each having ends which terminate on contact points or plates arranged in a semi-circle. Moving over these points is the control lever p, which is moved by a milled knob on the outside of the case. These coils and lever constitute the speed control, since, by moving the lever around over the contacts, the resistance in the circuit is varied, so reducing or increasing the amount of current passing to the motor. Besides these items, there is in the controller case, a solenoid S, which is a coil having a sliding soft-iron core inside of it. It will be seen that the whole of the current from the transformer to the motor passes through this coil. Operated by the sliding core, there is a trip mechanism—not shown in the sketch—which, when the coil S receives an excess of current, comes into operation and releases the red knob, so cutting off all current from the track and locomotive. Such an excess of current would be allowed to pass, were the resistance introduced in the circuit by the windings of the motor, and electro-magnet E cut out by a dead short-circuit across the running rails. During normal operation, the full amount of current which can be passed through the motor and coil E is insufficient to actuate the sliding core of S, but if a piece of metal capable of causing a short circuit was inadvertently laid upon the track, then the coil S breaks the circuit and so protects the transformer from burning out or becoming overheated.

Besides the two switch leaves m, m, there is another leaf n at a slightly lower level. The object of this is not at first perfectly clear, but it will be seen that if the lever p were round to the left with a big resistance Q in the circuit and the current were broken by the operator pressing the red knob, there may not be a sufficient amount of current available for re-energising coil E on the engine and pulling up armature a. It will be noted, however, that the leaf n is connected straight to the transformer, so that when the band on k passes downwards and upwards, the latter being the movement of importance, there is a momentary rush of full voltage current through n to the left-hand leaf m, which is sufficient to ensure the operation of the electro-magnet of the locomotive. As indicated in the drawing, a second controller is connected on another circuit from the transformer leading to the other running rail.

The Locomotive Mechanism

It is presumed that before anyone would attempt to design a body—by that is meant a dummy boiler, cab, etc.—for a different type of engine, he would need to make or have an exact outline of the mechanism which is to be contained within such body, and so in Fig. 2 is given an exact scale elevation showing the whole of the existing framing, collectors, wheels, motor and coil and mechanism of the reverser. This drawing, Fig. 2, is reproduced exactly full size. The dotted lines indicate the outline of the existing German die-cast boiler and cab roof.

It is unfortunate, perhaps, that the reverser occupies so much space, especially in the width of the engine. So great is this that it is quite impossible to let any part of the boiler come further back than the star wheel and the reverser must, in every case, be enclosed in the cab. Two or three designs can be given which would certainly have a pleasing appearance and in Fig. 4, a full-size elevation of the German engine is shown.

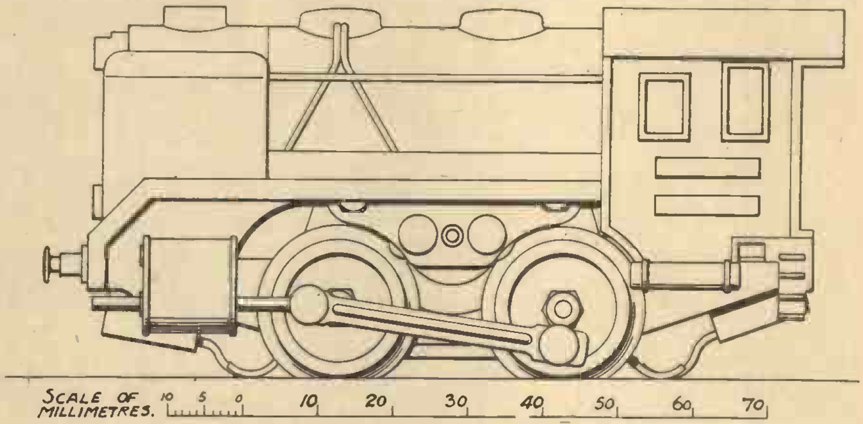


Fig. 4.—A side elevation of the locomotive drawn exactly full size.

(*To be continued*)

A New Electric Convector Heater

An attractive and efficient electric convector heater finished in oxidised copper has just been introduced on the market by the General Electric Company. The heater incorporates low-temperature rod-type elements of circular shape fitted inside a series of specially designed ducts. Such an arrangement gives maximum convection: the warm air is directed in an outward and upward direction, and an even distribution is ensured throughout the area the convector is designed to cover. The body of the heater, with the exception of the grille, will be found to remain cool at all times, and thus may be placed close to walls, etc., with perfect safety and with immunity for the walls against discolouration.

The heating elements and electrical connections are inaccessible when the convector heater is in use, but with the removal of four screws in the base these can be withdrawn for replacement or adjustment whenever necessary. The elements are arranged for two-heat control by a switch at the side of the convector. With a loading of 1,500 watts, the dimensions of the convector are: width 16½ in., depth 8¾ in., height 26½ in. The base is 18¼ in. wide by 10¾ in. deep, and the grille is 15 in. wide by 12 in. deep. The total weight is 37 lb. The convector is supplied complete with 6 ft. of special heat-resisting flex. Such a heater is ideal for use where an unobtrusive scource of heat is required. It is also an excellent auxiliary to tubular heaters in situations where wall space is too restricted to accommodate the necessary loading in the form of tubes.

Showing the convector heater uhich is attractively finished in oxidised copper.

ITEMS OF INTEREST

Turbo-alternator Facts

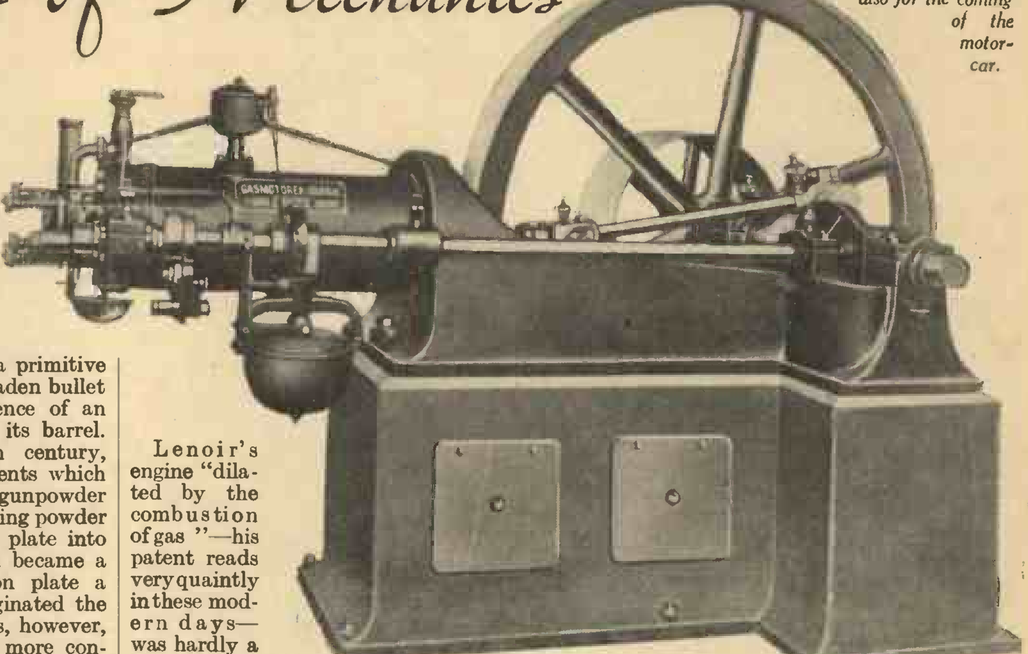
The electricity supply for more than half Manchester is derived from a turbo-alternator at Barton power station which delivers 41,000 Kilowatts. It recently set up a record by running continuously for 124 days, and was restarted after a rest of only 8 hours. The rotor weighs nearly 100 tons and revolves at a speed of 1,500 r.p.m., while the speed of the blade tips on the largest wheel of the turbine is 550 miles per hour!

The "Normandie."

A MODEL of the world's largest liner, and the present holder of the Atlantic Blue Riband has just been acquired by the Science Museum. The model, which is over ten feet in length, conveys an excellent impression of the vessel's unorthodox design, with its rounded and streamlined upper works.

Masters of Mechanics

Nicolas Otto and the Rise of the Gas Engine



The first four-stroke gas engine built by Dr. Otto in 1876. Not only did it revolutionise the gas-engine industry but it paved the way also for the coming of the motor-car.

THE earliest gas engine was a primitive form of gun which fired a leaden bullet under the propelling influence of an explosion of gunpowder within its barrel. Then, during the seventeenth century, came a series of crude experiments which were made with the explosion of gunpowder rammed into barrels. The exploding powder was made to throw up an iron plate into the air. Afterwards, the barrel became a cast-iron cylinder and the iron plate a piston. Thus, incidentally, originated the piston and the cylinder. It was, however, found that steam was a much more controllable agent for the purpose of moving the piston within the cylinder, and so the steam engine emerged and ultimately became practicable, whilst the operating principle of the gas engine remained unthought of for years.

During the latter end of the eighteenth century and at the beginning of the nineteenth, several attempts to construct a working gas engine were made. R. Street, in 1794, for instance, S. Brown, in 1823, and a few other inventors all endeavoured to bring out an engine which would operate by the power of exploding gas. All such attempts, however, failed signally, and their lack of success, was mainly due to a non-appreciation on the part of the inventors of the theoretical principles upon which a true gas engine must work.

Lenoir's Engine

The first successfully working gas engine was not given to the world until 1860. In that year a naturalised Frenchman, although a Belgian by birth, one Etienne Lenoir by name, and an inventor and engineer by profession, was connected with a Company in Paris called *Société des Moteurs Lenoir*, which had been formed in the previous year, and the object of which was to manufacture for sale, an entirely new type of gas engine which Lenoir himself had invented.

Lenoir's master patent was taken out on January 24th, 1860. It was for an engine "dilated by the combustion of gas." During the following month, the inventor obtained a similar patent in England, and forthwith he commenced the manufacture of his engines.

Now, although Lenoir's engines, and particularly his later ones, worked smoothly and silently, they were extremely wasteful of fuel. They took six or seven times the amount of fuel to produce a given horse-power that a modern engine would consume and, moreover, they were extremely hot running. Large quantities of cooling water were required for the radiator systems, and, owing to the internal heat, the piston assembly quickly gave way and even melted under working conditions.

Lenoir's engine "dilated by the combustion of gas"—his patent reads very quaintly in these modern days—was hardly a true gas engine, but was more of a steam engine. When the piston was about halfway through its stroke, the mixture of gas and air which it had sucked into the cylinder via the inlet valve was exploded electrically. A non-return valve was fitted to the inlet port of the cylinder, and this prevented the exploding charge from escaping backwards along the entrance conduit. The exploding gas, therefore, forced the piston along. The movement of the piston was conveyed to a flywheel by the usual crankshaft assembly. The momentum of the flywheel enabled the piston to make a return stroke within the cylinder, this stroke serving to expel the burnt gases from the engine via an exhaust valve. On the subsequent outward stroke of the piston, a fresh charge of mixture was drawn into the cylinder, and when, again, the piston had traversed half the cylinder's length, the mixture behind it was fired electrically, and so the cycle of operations proceeded.

An engineering curiosity—Dr. Otto's first "atmospheric" gas engine, built in 1867. Note the rackwork gearing of the piston.

Gas Version of the Steam Engine

Note carefully that Lenoir's engine did not compress the mixture and that, as previously mentioned, it was, in reality, a mere gas version of the steam engine, the exploding charge acting in a manner very analogous to a supply of steam suddenly injected into the cylinder.

Despite its many shortcomings, however, Lenoir's engine sold well, so great was the demand at that time for motive power. The first Lenoir engines were of two horse-powers—6 and 20. Within the space of three or four years, some four hundred of them were constructed at Lenoir's own works at Paris, whilst another hundred or so were manufactured by the Reading Iron Works in this country, which had a licence to work the Lenoir patents.

About this time, there rose up, again in France, one of the most curious geniuses which the modern world has ever seen. His name was Alphonse Beau de Rochas, and to the alertness and far-seeing perception of his mathematical and scientific mind is due not only the modern gas engine, but also the whole gamut of internal-combustion engines, great and small. Yet it is said that this Beau de Rochas, this somewhat mysterious French engineer, had no great liking for practical engineering, that he disliked experimentation and workshop practice, and that he was ever content with the formulation of strange projects on paper rather than with the practical achievement of their conception.

In 1862, just when Lenoir's engines were obtaining much popularity, Beau de Rochas announced in a pamphlet, four conditions which would direct the operation of a more efficient gas engine than had ever, up to that time, been constructed. He even made his formulations the subject of a patent, the validity of which, however, was contested later on by Lenoir.

The Four-stroke Engine

According to Beau de Rochas, gas engine efficiency depends upon the following conditions being obtained:

1. The greatest possible pressure of gas at the beginning of the explosion within the cylinder.
2. The greatest possible degree of expansion of the combusting gases.
3. The maximum velocity of gaseous expansion within the cylinder.
4. The largest possible cylinder volume with the least possible cooling surface.

Having enunciated these principles, Beau de Rochas then proceeded to state that a gas engine could only work efficiently when its cycle of operations embodied four separate strokes of the piston, i.e., suction of the mixture into the cylinder, compression stroke of the piston whereby the mixture is compressed in the cylinder head, ignition stroke (the real power stroke) of the piston and, finally, the exhaust stroke, by virtue of which the waste products of combustion are efficiently swept out of the cylinder.

Thus came into being the first—and, incidentally, an entirely complete—conception of what we now term the "four-stroke engine." This cycle of operations, upon which nearly every internal combustion works, is still termed, theoretically, the Beau de Rochas cycle. Beau de Rochas, however, never attempted to put his fundamental cycle of operations into working practice. That practical feat was left to the ingenuity of others.

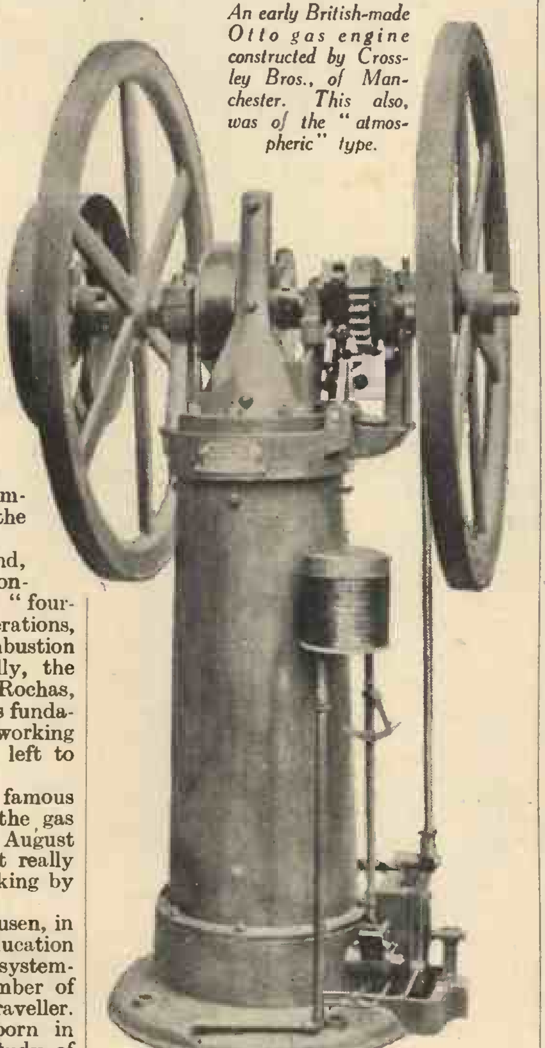
And now we come to the most famous name connected with the rise of the gas engine, to wit that of Dr. Nicolas August Otto, the man who made the first really commercially successful engine working by gas power.

Nicolas Otto was born at Holzhausen, in Germany, in 1832. His earlier education was meagre and he had little or no systematic scientific training. For a number of years he worked as a commercial traveller. Nevertheless, engineering was inborn in him and he began a spare-time study of gas engines when he was twenty-two years old. Lenoir's gas engine and its alleged success, urged Otto to further efforts in the construction of a working engine. He devised a gas engine, and had it made by a Cologne mechanic, but it was unsuccessful. Moreover, Otto was not a rich man and he found that experimental work in connection with engineering could be an exceedingly expensive pursuit. About the year 1863, Otto managed to interest in his experiments, a privy councillor of Cologne, named Langen. Herr Langen was struck with Otto's gas engine proposals, and he laid out money to bring about their practical achievement.

The Otto Engine

Eventually, after many trials and difficulties, Otto and his partner, Herr Langen, brought out a gas engine which differed radically from all previous engines of this nature. It operated strictly under the conditions which Beau de Rochas had laid down previously, its cycle of operations comprising the now well-known "four-stroke" cycle and also termed the "Otto cycle," although, in common fairness "Beau de Rochas" cycle should be the term used to denote this sequence of gas-engine operations.

In Otto's first working gas engine—the Otto "Atmospheric" engine—constructed in 1867—there was no compression of the gas. The piston was driven *upwards* within the cylinder by the force of the exploding charge and subsequently it descended under the influence of the external pressure of the atmosphere. In descending, the piston operated a rackwork gear which revolved a driving wheel, and thus the engine's power was provided. The atmospheric engine was excessively noisy, erratic, and violent in its running.



An early British-made Otto gas engine constructed by Crossley Bros., of Manchester. This also, was of the "atmospheric" type.

It was not until nine years later—in 1876—that the world's first successful gas engine was produced by Otto working in conjunction with Langen. It has been previously remarked that this engine operated under the strict conditions set forth by Beau de Rochas. It was an engine which worked upon strictly scientific and truly mechanical principles. Beau de Rochas' four-stroke principle was made practicable for the first time. Otto's engine sucked the gas mixture into the cylinder, compressed it, fired it, and ejected the burnt remains of the charge—all in a sequence of four strokes of the piston. At once, Otto halved and even more than halved the high fuel consumption of Lenoir's engines. The engine worked with reasonable silence—indeed, the inventor termed it his "Silent" engine—and its waste heat production was much less than that of the previous Lenoir engine. Quickly, therefore, Otto's "Silent" engine became a practicable engineering proposition. The demand for it grew and Otto found difficulty in obtaining the requisite capital necessary to establish a fresh extension of his factory. The relatively rich Langen, realizing the golden opportunity of the situation, opened his purse to its widest extent, and thereafter the firm of Otto and Langen leapt to fame as makers of silent, reliable, and successful gas engines.

The "Silent" Gas Engine

In England, the "Silent" gas engine was made by the Crossley Brothers, of Manchester, who were in close association with Dr. Otto through a great part of his period of experimentation. The Crossley engines, operating on the Otto principle, quickly became famous, and many of them constructed nearly half a century ago are still putting up a good performance in their various locations.

In 1886—less than ten years after Otto's first introduction of his "Silent" gas engine working on the four-stroke principle of Beau de Rochas, it was estimated that there were some 30,000 such engines in use in the world. Crossley's, of Manchester, had accounted for a goodly proportion of these engines, most of the remainder having been produced by Otto's own concern, the *Gas Motoren Fabrik*, of Germany, and by the *Compagnie Française des Moteurs à Gaz*, of Paris, which held the French patents.

In 1891—on the 26th of January, to be precise—Otto died. His decease took place at Cologne, and, curiously enough, little notice appeared to be taken of it at the time. In some strange way, Otto fell back into the obscurity from whence he had risen, and it was left for the famous Crossley Brothers to carry on his work.

Otto's Mechanic

When Otto found himself immersed in experimental work on the subject of the gas engine, he engaged a mechanic to assist him. Together they worked in a small shop at Deutz near Cologne, and it was largely due to the good workmanship and ingenuity of this mechanic that Otto's trial engines were a practical success.

Otto's original mechanic grew in status. Ultimately he became manager of the firm, and when he left it in 1882, he still retained a financial interest in it. But this mechanic of Otto's desired, as he said, to have greater time to pursue a "new hobby" and it was for that reason solely that he severed his working connection with Otto.

The "new hobby" which Otto's former mechanic wished to be free to follow up was nothing more nor less than the design and construction of a miniature engine working on Otto's principles but running at a higher speed and operating on petroleum and other liquid fuels instead of on gas.

And the name of Otto's mechanic was *Daimler*, a now very famous one in automobile engineering history, but the story of how he constructed the first motor-car will have to be reserved as fit subject-matter for a future article of this series.

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FURNITURE
CLOCKS AND WATCHES
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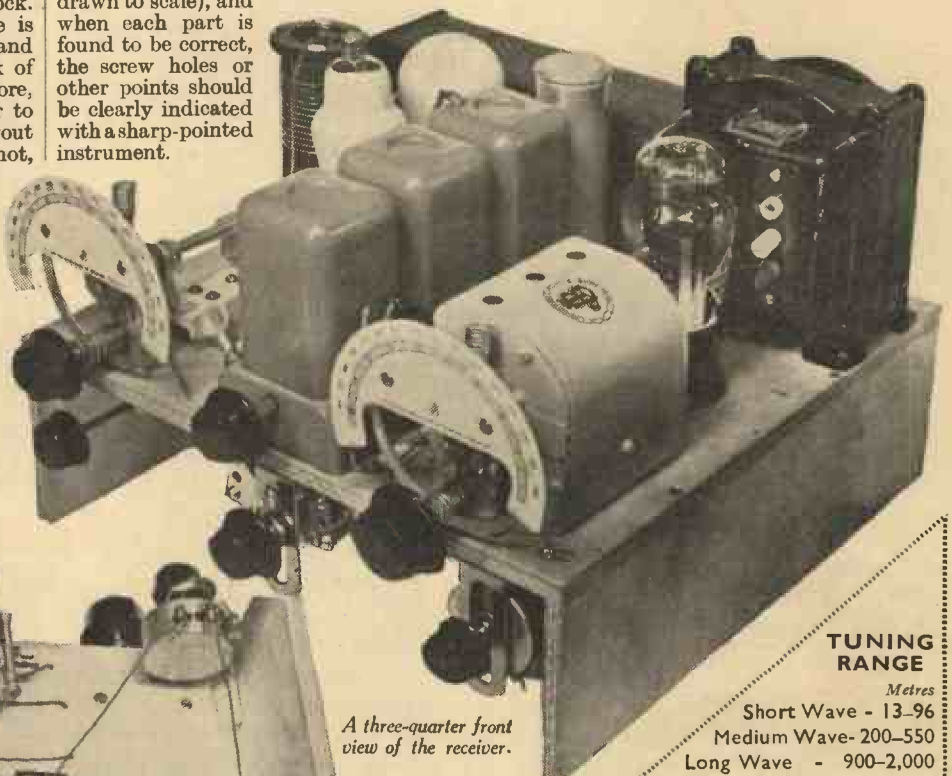
Every Question must be accompanied by the Coupon on page iii of Cover

THE P.M. A.C. MAINS ALL-WAVE THREE

An Efficient All-wave Three-Valve Mains Receiver with a Tuning Control for Each Waveband

WHEN dealing with receivers designed for use on the electric supply mains, it is to be expected that a little more care and thought must be expended in the construction. This is not only on account of the extra intricacy of the wiring, but it is very essential to guard against short circuits, or loose connections, which might lead not only to the destruction of one or more components, but might also lead to the user receiving a nasty shock. In all our mains apparatus great care is taken to so arrange the components and the wiring that there is very little risk of any such accident occurring, and, therefore, it is in the interests of the constructor to take care to duplicate not only the layout of the receiver but also the wiring. Do not, therefore, be tempted to improve upon our layout, or modify the position of any part because you think it will be better, as by so doing you may introduce some unforeseen trouble.

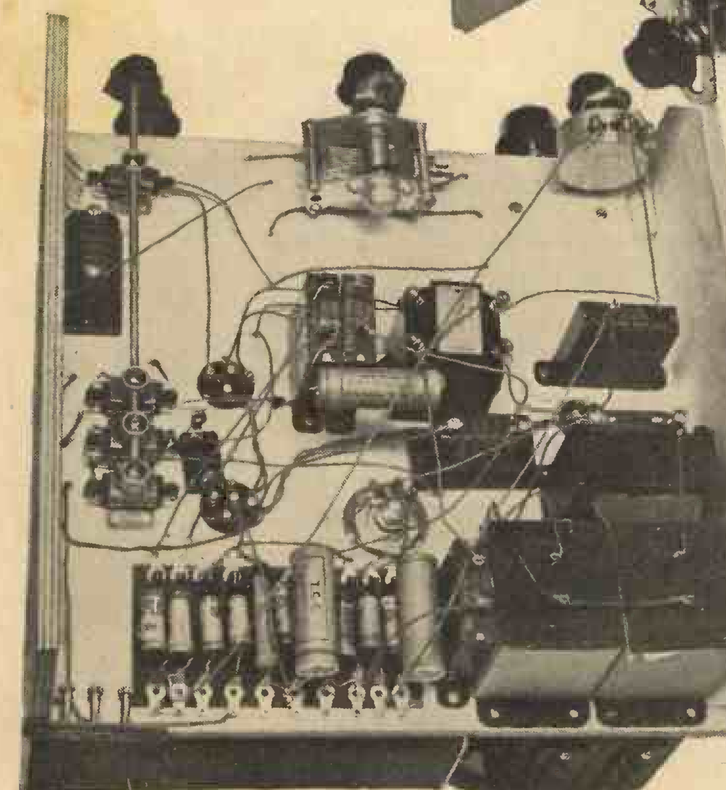
A reference to the illustrations and the wiring diagram will show that the receiver is very compact and there is little space to spare on the chassis. Therefore, before the construction is undertaken each part should be placed in its approximate position (as taken from the wiring diagram, which is drawn to scale), and when each part is found to be correct, the screw holes or other points should be clearly indicated with a sharp-pointed instrument.



A three-quarter front view of the receiver.

TUNING RANGE

	Metres
Short Wave	13–96
Medium Wave	200–550
Long Wave	900–2,000



This below-chassis view will be of assistance in wiring up. The resistances on the group board may be seen in the foreground.

The Design

In view of the fact that it is desirable to enclose a mains receiver in a cabinet, so that no live wires may be touched whilst it is "On," it was thought necessary to place the wave-change switch on the front of the receiver. To do this without introducing long leads we have employed the Bulgin switch which is operated through a rotary movement, and three of these are arranged in the most convenient position in the circuit, and a length of rod is passed through each and controlled from the front.

Certain readers dislike the straggly appearance which results from placing resistors in their exact position in the circuit, and in this receiver we have used a Bulgin resistance board so that all resistors may be placed in one spot in orderly array, and this both adds to the neatness of the finished receiver and simplifies wiring.

The Mains Section

In the mains supply section a metal rectifier has been used for the H.T. supply, and the mains transformer supplies, in addition to the H.T. voltages, the necessary heater supply for the three valves. A choke of ample rating is included for smoothing purposes, and the smoothing circuit is completed by an 8 mfd. electroly-

tic condenser. Electrolytics are also used for bias by-pass purposes, and thus, from all theoretical points of view, the circuit may be judged complete.

Starting Construction

Before starting the building of the receiver it is essential to get all the parts together, and this is to enable the exact position to be ascertained, although those who can transfer scale measurements may be able to reproduce the position from the scale wiring diagram on this page. The chassis must first be drilled for the electrolytics, and for this purpose a 1½ in. hole should be drilled through three thicknesses of the plywood from the underside of the chassis, and a ⅜ in. hole should then be drilled through the centre of this hole from the top of the chassis. This arrangement is adopted in preference to using a metal bracket for the condensers, and it permits the large lock-nut to be screwed tightly on to the thread of the condenser.

Three ⅞ in. holes must also be drilled to accommodate the valveholders, and a slot must be cut on the top of the chassis so that the L.S. pick-up strip may be attached without the metal parts coming into contact with the metallised surface of the chassis. When attaching the valveholders, this

LIST OF COMPONENTS FOR THE P.M. A.C. MAINS ALL-WAVE THREE

COILS

One set Three-gang, type WL-QRT (Wearite).
One Short-wave Coil, type SPC with type SPB Base (B.T.S.).

CONDENSERS (Variable)

One Three-gang, ·0005 mfd. Baby Condenser with S.M. Dial C1, C2 and C4 (J.B.)
One Single S.W., ·00016 mfd. type EJ with S.M. dial (C3) (Polar).
One Reaction ·0002 mfd. type QJ, C5 (Polar).

CONDENSERS (Fixed) — T.C.C.

Four ·5 mfd., type 65 (C6, C7, C8, C9)
One 2 mfd., type C5 (C14)
Three 25 mfd., 25-volt Electrolytics (C10, C11, C12)
One ·0001 mfd., type M (C13)
One ·01 mfd., type M (C18)
Two 4 mfd., type 84 (C15, C16)
One 8 mfd., type 802 Electrolytic (C17)

RESISTANCES — Amplion 1-watt type.

Two 50,000 ohms (R1, R2)
One 20,000 ohms (R3)
One 2,000 ohms (R4)
One 250 ohms (R5)
One ·5 megohm (R6)
One 750 ohms (R7)
One 25,000 ohms (R8)
One 5,000 ohms (R9)
One 350 ohms (R10)
One 10,000 ohms (R11)

CHOKES

Two H.F., type HF3 (Bulgin).
One 40H-60 m/A.L.F. (Premier).

VOLUME CONTROL

One 5,000-ohm wire-wound Potentiometer (R12), (B.T.S.).

TRANSFORMERS

One L.F., type DP21 (Varley).
One Mains Transformer, type W31 (Heayberd).

SWITCHES

One QMB on/off, type S80 (Bulgin).
Four change-over, type S81 (S1, 2, 3, 4), (Bulgin).

RECTIFIER

One Style H.T.8. (Westinghouse).

CHASSIS

Metaplex, 12 in. by 12 in. with 3½-in. runners (Peto-Scott).

VALVES

One ACVP, and one ACHL (Hivac), and one PT41 (Cossor).

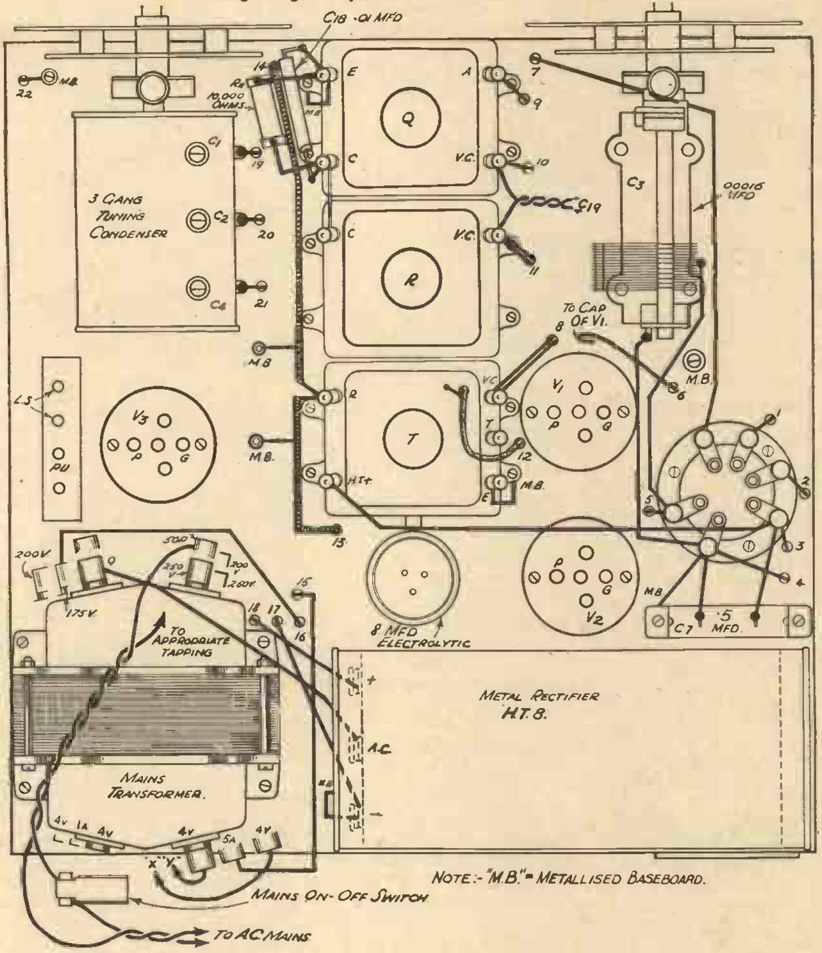
VALVEHOLDERS

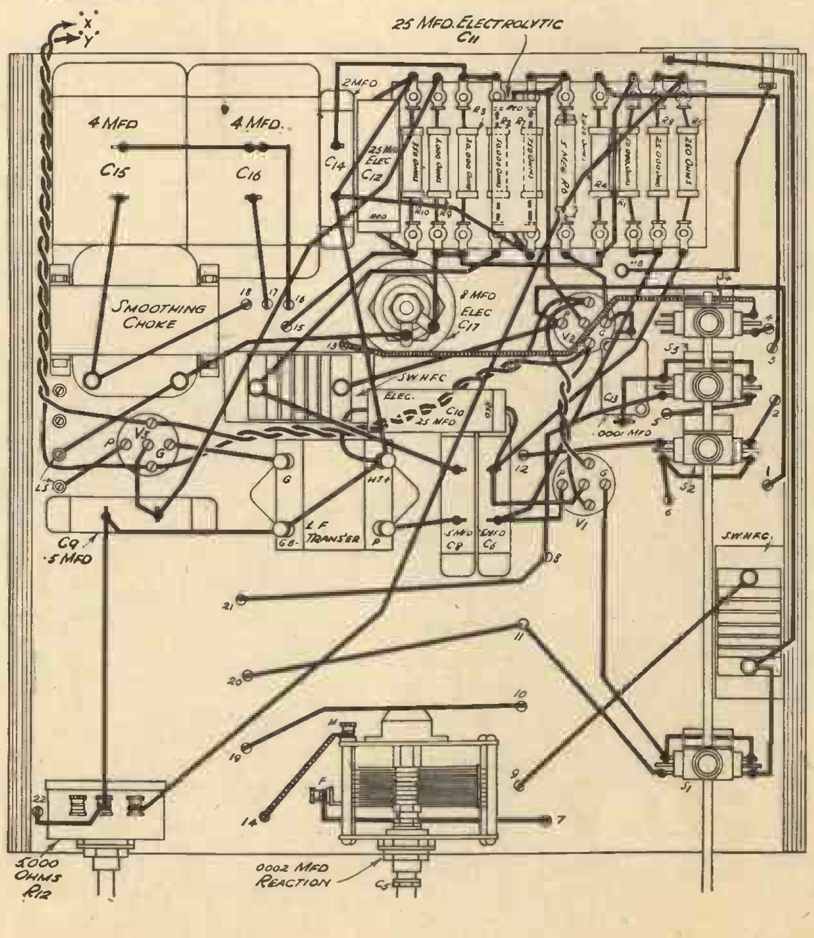
Three five-pin chassis type Airspring (Clix).

ACCESSORIES

Four Component Brackets (Peto-Scott).
One Ten-way Group Board (Bulgin).
One 9 in. by ³⁄₁₆ in. shaft (Bulgin).
Two Terminal Strips, L.S.—P.U., A., E. (Clix).
One Stentorian Senior Loudspeaker (W.B.).
One Cabinet (Peto-Scott).

Wiring Diagram of the P.M. A.C. Mains Three.





point must also receive attention, and in case of doubt it is worth while to scrape away the metal coating for a space slightly larger than the top of the valveholder. This point is mentioned as we have several times had receivers here which readers had failed to get in working order, and had found that the valveholder sockets were in contact with the top of the chassis.

Mounting the Parts

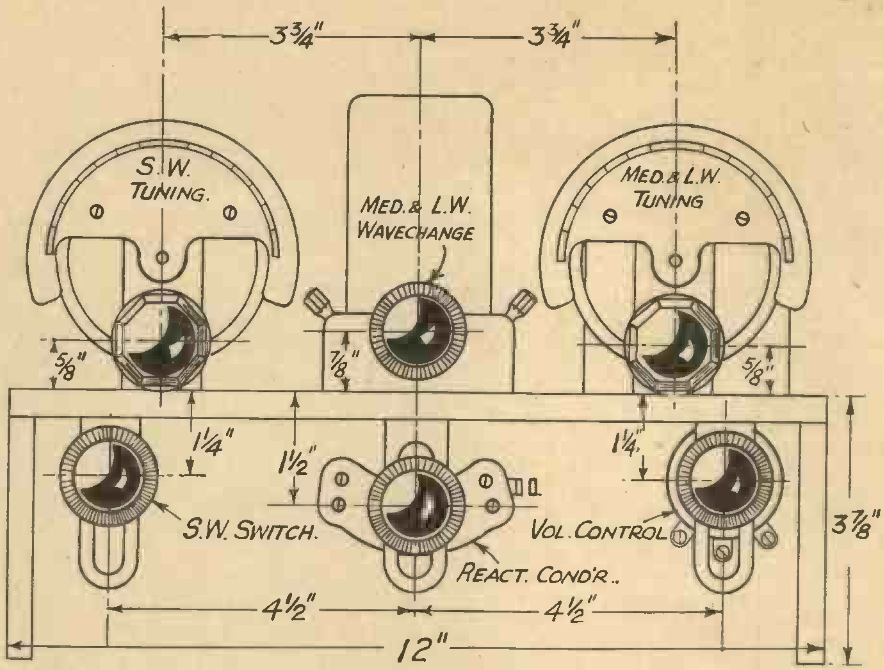
When all holes are drilled, the parts should be screwed down, mounting those on the underside of the chassis first, so that the receiver will rest flat on the bench or table. Before screwing the ganged switches in position the rod should be passed through them and each switch should be locked by means of the small grub-screw on the top of the moving knob. If this is not done you may find it impossible to push the rod through all the switches when they are attached.

Construction will be simplified if all the resistances are attached to the resistance board before it is screwed in position. When attaching the electrolytic condenser, make quite certain that the metallised surface of the chassis is intact round the fixing hole and lock the nut very tightly, as it is essential that the case of the condenser be joined to earth. If preferred, a short bare wire may be placed under the condenser before the nut is locked and this may be joined to the nearest earth point. This should not, however, be necessary if the above method of mounting is employed.

Note that the short-wave tuning condenser is raised slightly above the chassis surface so that the slow-motion drive may be balanced with the dial on the opposite side of the chassis. A piece of wood will serve for the purpose, or small lengths of ebonite tube may be cut as distance pieces. In view of the delicacy of this condenser, it is as well to leave this until all the remaining constructional work has been completed.

Wiring

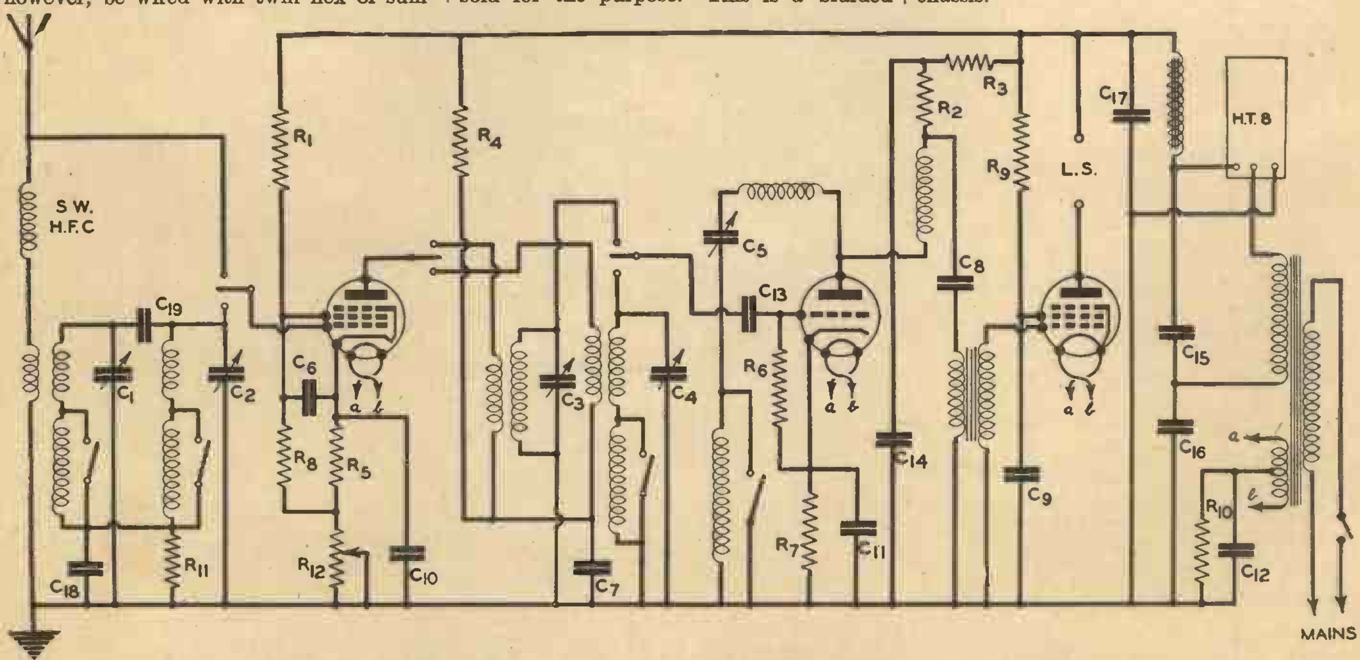
The wiring is not difficult, and if a definite system is adopted it should be found no more difficult than in the case of an ordinary battery receiver. The heater circuit must, however, be wired with twin flex of sufficient thickness to avoid voltage loss. Do not use the cheap flex which is obtainable at certain stores, as this may prove unsatisfactory. You need only a short piece, and it will pay to get a good heavy lead, preferably that known as 70/36, as this will carry up to 8 amps at 4 volts without appreciable loss. The remainder of the wiring may be carried out with ordinary connecting wire, soldering where possible and making quite certain that all joints are really sound.



Drilling dimensions for the cabinet front.

Earth Returns

There are only two other points which need emphasis on the constructional side. These concern the earth-return points which are carried out through the metallised coating of the chassis, and the screening of the reaction circuit. The latter is carried out by utilising the special screened cable sold for the purpose. This is a braided material inside which is a length of systoflex. The ordinary wire as used for wiring the receiver is passed through this systoflex and the screening cut back at the end and wrapped to prevent contact with the wire inside. When the latter is attached to the respective terminals at the ends, a short length of bare wire should be wrapped round the screening and connected to the nearest earth point. Notice carefully that the wire inside the screening lead must not be allowed to come into contact with the braiding or earth connection. The points marked M.B. are firmly attached to the metallised surface of the chassis, preferably by soldering the wire to a tag and attaching this to the chassis with a round-head screw. The points marked M.B. on the underside of the chassis must be connected to bolts the heads of which make good contact with the *upper* surface of the chassis.



The circuit diagram of the P.M. A.C. Mains All-wave Three. The reference numbers are repeated on the list of Components on page 361.

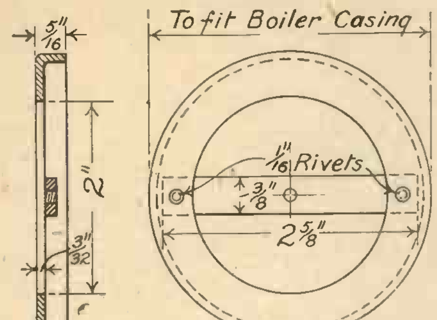


Fig. 18.—A section and front elevation of the boiler front.

Working Model Steam Engines

Details of the Boiler Frontplate, Smokebox Door and Saddle, and Spirit Lamp are Given in this Seventh Article of the Series

THE next part to take in hand is the boiler frontplate, shown in Fig. 18, and this can be made from a light brass casting, or a boiler-end stamping. It must be carefully filed to be a good fit inside the end of the outer boiler casing.

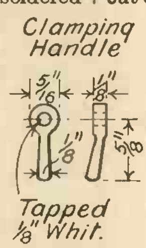
The flange need not be more than ¼ in. wide, and the central hole should be filed to 2 in. diameter. A piece of strip steel should now be cut to the dimensions given in Fig. 18, and this has to be riveted in position on the inside of the frontplate. The two holes to take the rivets should be countersunk on the outside of the casting, so that after riveting, the rivet heads can be filed flush. A central hole must be drilled and tapped out ⅛ in. Whit. to take the end of a steel screwed pin, which should be ⅝ in. long. This pin is for holding the smokebox door in position.

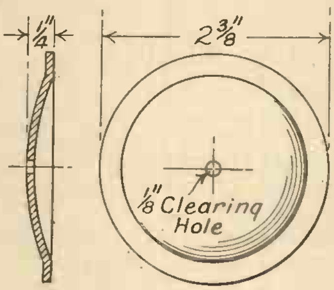
The boiler front can be fixed in position by means of four 3/32-in. screwed pins, screwed in through the outer casing into holes drilled in the flange of the plate. The holes for these pins should be drilled at equidistant spaces round the periphery of the boiler casing. For the smokebox door, a "dished" soft iron stamping can be used. The central hole should be drilled just large enough to allow the door to be slipped on to the screwed pin.

A small clamping handle can be fashioned out of a piece of ¼ in. × ⅛ in. mild steel, to the size indicated in Fig. 19, a hole being drilled and tapped ⅛ in. Whit. for screwing on to the projecting end of the screwed pin.

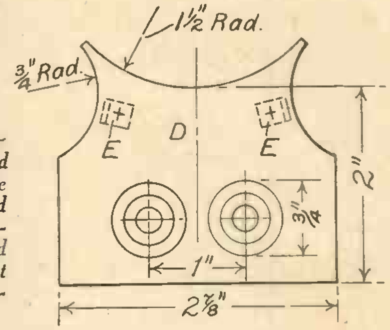
Steam and Exhaust Pipes

The steam pipe connections are clearly shown in Fig. 6 and 11 (December and February issues). A piece of brass tubing 14 in. long will be required, and from this cut off a piece 4 in. long and bend one end of this, as shown in Fig. 2, and solder it to the union fitting which is clamped in place by the union nut on the steam tap. Bend one end of the long piece of tubing, pass it through the outer boiler casing, between the water tubes, and push the other end through the hole made to receive it in the boiler backplate. Bend the projecting end of the tubing so that it joins up with the pipe from the steam tap, and then slip a short brass sleeve over the ends (as shown in Fig. 6) and solder the joints. To the other end of the tubing a union connecting piece is soldered, the other part of the union being soldered on to a short length of brass tubing which is screwed into the T-piece which connects up with the cylinder steam blocks.





Figs. 19 and 21.—(Left) A section and front view of the smokebox door, and details of the clamping handle and (right) The front plate of the smokebox saddle.



For the exhaust pipes, two 2½-in. lengths of brass tubing, 5/32 in. diameter, will be required, and one end of each should be threaded for a distance of ¼ in., the other ends being tapped round with a light hammer to contract the orifices slightly. After this is done bend the pipes to the shape shown in Fig. 11, and screw them in position in the steam blocks.

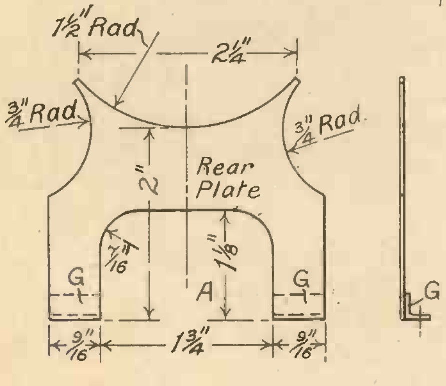
Smokebox Saddle

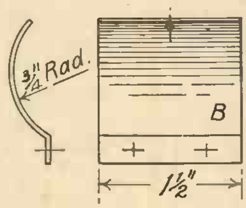
This can be built up from sheet brass 3/64 in. thick, the sides and front being made detachable so that access can be had to the cylinders. Mark out the shape of the rear plate to the dimensions given in Fig. 20, and after cutting out the plate with a sharp cold chisel, file down the rough edge carefully to the scribed outline. The part marked A has to be cut away to clear the cylinders. Two small brass angle pieces G can be soldered on to the plate in the position shown, to form feet for fixing the back of the saddle to the bedplate.

Now mark out the front plate D, using the rear one as a template, but do not mark out the part A, as this is not cut away from the front plate. After cutting out, lightly solder this plate to the other one and file down the rough edge till both plates coincide. Separate the plates and then proceed to cut out and file to shape two pieces B to the dimensions given, for forming the curved sides. After bending these to shape, cut out two more pieces C for the detachable side plates and drill a 7/16-in. hole in each to clear the nuts on the cylinder pivot pins, and also drill four 3/32-in. holes where indicated.

The two curved side plates can now be clamped in position against the rear plate, and the joints well soldered on the inside. Next clamp the front plate in position, and solder two angle pieces, ¼ in. wide, to the inside of the curved side pieces in the positions indicated at E, Figs. 21 and 22, so that the front faces of the angles touch the front plate.

Before removing the clamps, drill a 1/16-in. hole through each angle piece and front plate; the holes in the angle pieces being afterwards tapped to receive small fixing screws. Now place one of the side plates





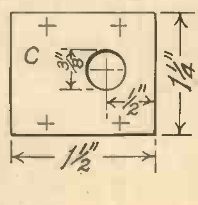


Fig. 20.—The various parts for forming the smokebox saddle.

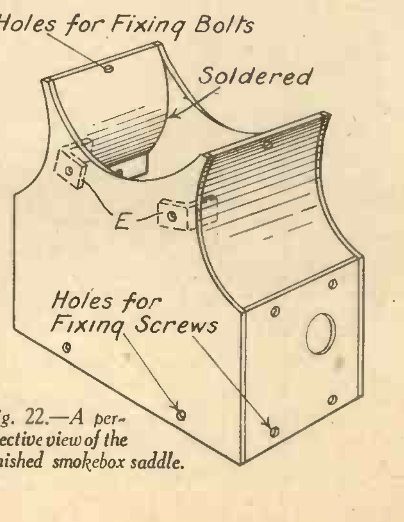


Fig. 22.—A perspective view of the finished smokebox saddle.

C in position, and mark the position of the two holes to be drilled near the bottom edge of the curved plate, B. Tap the holes to take $\frac{1}{16}$-in. Whit. screws, and repeat the operation on the other curved plate.

Two "dummy" cylinder covers can be screwed on to the front plate D as shown, to give a more realistic appearance to the saddle.

The parts forming the saddle can be assembled in position on the bedplate and the holes carefully drilled and tapped in the bottom parts of the steam blocks for taking the fixing screws for the side plates. Two holes will also have to be tapped out in the bedplate to receive the screws for fixing the angle pieces G in position. For fixing the lower part of the front plate a $1\frac{1}{2}$-in. length of $\frac{1}{4}$-in. angle brass can be soldered to the saddle, as indicated in Fig. 22. The boiler back plate is held in position on the bedplate by means of a brass angle piece as shown in Figs. 1 and 6.

In order to protect the sides of the firebox from the heat of the lamp, the firebox may be lined with sheet asbestos held in place by a piece of tinplate bent to shape and riveted to each side of the firebox by two or three rivets. The asbestos lining is indicated in Fig. 6.

Details of Spirit Lamp

The dimensions of the completed spirit lamp are given in Fig. 23. The reservoir can be made from tinplate, about No. 22 gauge, the bottom and sides being formed from one piece cut to the shape and dimensions given in Fig. 24. After drilling the holes for the supply pipes, bend the sides up on the dotted lines and well solder the corner joints on the inside.

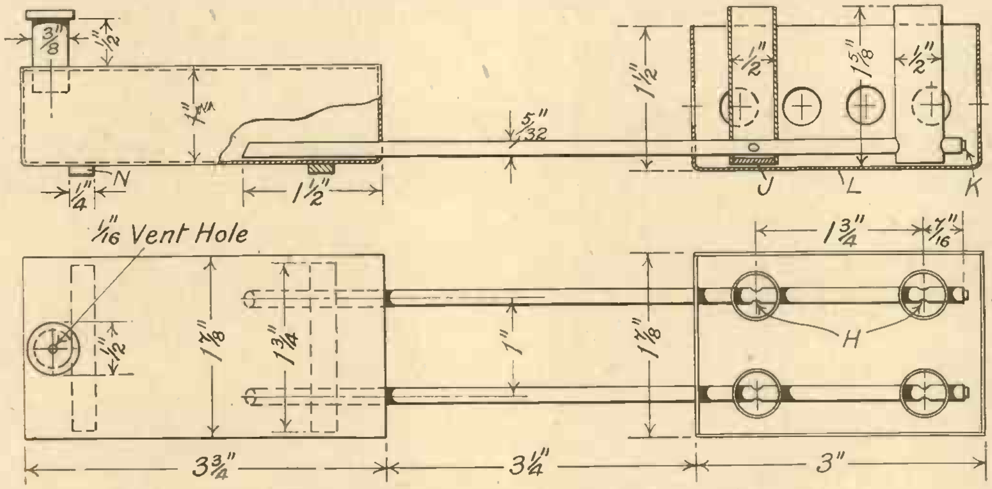


Fig. 23.—A part sectional elevation and plan of the spirit lamp.

bedplate between the steam blocks, and two holes drilled and tapped in it to take the fixing screws. The top part of the front plate is screwed to the two angle pieces E. Before finally fixing the front plate in position the steam pipe from the boiler must be coupled to the union piece between the cylinders.

Fixing the Boiler in Position

On referring to Figs. 1 and 6 (December issue), it will be seen that the bottom of the firebox has a flange at the sides and front, which is screwed down to the bedplate. This flange is composed of three lengths of $\frac{1}{2}$ in. brass angle, which can be riveted to the firebox casing with $\frac{1}{16}$-in. copper wire rivets, after having the holes drilled to take the small screws for fixing the angles down on the bedplate. The holes in the latter can be carefully marked out after the boiler casing is bolted to the smokebox saddle. For this purpose two $\frac{1}{8}$-in. bolts can be used, which pass through holes drilled near the top edges of the curved side plates of the

Top Plate

The top plate of the reservoir can also be made of tinplate, and should be a push-fit in the top of the reservoir. A $\frac{3}{8}$-in. hole must be drilled near one edge of the plate to take the filling tube, consisting of a $\frac{3}{4}$-in. length of light brass tubing, which is soldered in position, leaving $\frac{1}{8}$ in. projecting above the top of the reservoir, as shown in Fig. 23. Do not solder the top plate in position till after the supply pipes are fixed in place.

For the wick tubes a piece of $\frac{1}{2}$ in. diameter light brass tubing about 7 in. long will be required. Cut off four pieces $1\frac{11}{16}$ in. long and file the ends square till each tube is exactly $1\frac{5}{8}$ in. long. Two $\frac{5}{32}$-in. holes must now be drilled through each tube for the supply pipe to pass through, and the centres of these holes should be $\frac{3}{16}$ in. from the bottom of the tubes. Each supply pipe consists of a $7\frac{1}{4}$ in. length of $\frac{5}{32}$ in. diameter brass tubing and on both sides of each tube small nicks H must be made with a small round file.

The wick tubes can now be slipped in position and soldered to the supply pipes, after which four discs can be cut out of a piece of sheet brass and filed till they just fit in the bottom ends of the wick tubes. Solder these discs in position, as at J, and then plug the ends of each supply pipe with a short piece of brass wire K soldered in.

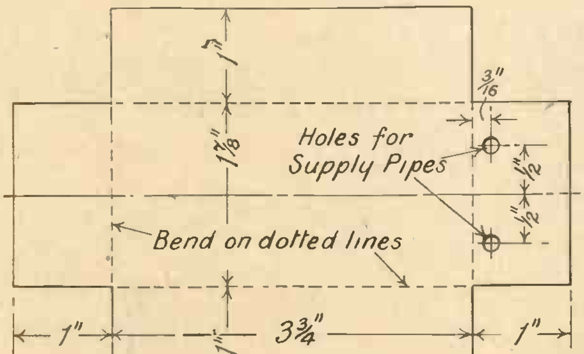
Drip Tray

Before soldering the ends of the supply pipes in the reservoir the drip tray L must be made. For this a piece of tinplate about 6 in. × 4 in. will be required, on which the developed shape of the tray can be marked out as shown in Fig. 25. After drilling the air inlet holes and those for the supply pipes, the front and the two sides of the tray can be bent up on the dotted lines and the joints soldered on the inside. Now push the supply pipes through the holes in the front of the tray till the wick tubes are in the position shown in Fig. 23. See that the supply pipes are quite parallel, and then solder them to the tray where they pass through the front plate.

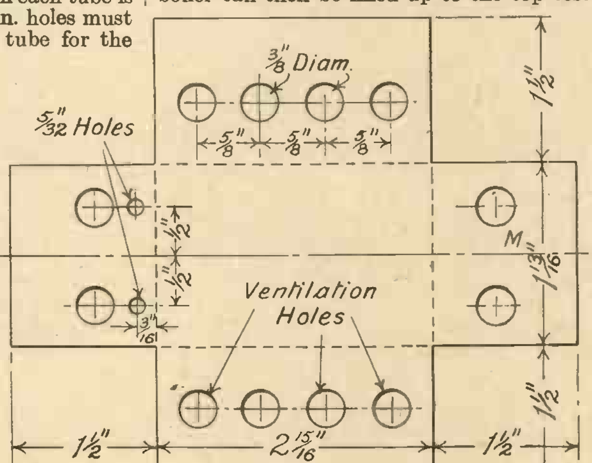
The back plate M of the tray can now be bent up and soldered in position to the side plates. Having done this push the ends of the supply pipes through the holes in the rear plate of the reservoir, and when the latter and the front of the tray are the correct distance apart the ends of the supply pipes can be soldered to the bottom of the reservoir. The top plate of the reservoir should now be soldered in place, after which a small cap can be turned out of a piece of brass to fit in the top of the filling tube. Drill a $\frac{1}{16}$-in. vent hole through the centre of the cap, as indicated in Fig. 23. This completes the spirit lamp with exception of the two packing strips N, which can be soldered to the bottom of the reservoir in the position shown.

Testing Under Steam

A little fine lubricating oil should be applied to all the working parts of the engine, and the flywheel given a number of turns to run the oil well into the bearings. The boiler can then be filled up to the top test



Figs. 24 & 25.—(Left) The tinplate blank for forming the bottom and sides of the lamp reservoir and (right) The shape of the metal plate for making the drip tray for the spirit lamp.



cock with hot water from a kettle, using a small tin funnel placed in the hole where the safety valve screws in. The top test cock should be kept open during this operation, while the bottom one should, of course, be shut off. When the water reaches the level of the top test cock, turn it off and screw down the safety valve, after adjusting the spring so that the valve can be raised comfortably by pressing the spring up with the finger.

The lamp reservoir can then be about half filled with methylated spirit and the wicks lighted. These should be of asbestos yarn. After three or four minutes have elapsed open the steam valve slightly to allow a little steam to enter the cylinders to warm them up, and give the flywheel a few turns with the hand to eject the small amount of water which will have formed in the cylinders. Now open the steam valve a little more, and if the cylinders and steam blocks have been adjusted correctly, the engine should begin to run at a good speed. Slightly open the bottom test cock occasionally to try the level of the water, which should never be allowed to get below this level whilst the lamp is alight beneath the boiler, otherwise there would be a risk of running the solder.

Finally, the finished model can be left unpainted, the boiler casing and other parts being rubbed over occasionally.

A Designograph

By V. E. Johnson, M.A.

A DESIGNOGRAPH is an instrument of precision, capable of automatically constructing any number of designs, which are mathematically correct. These designs can be made exquisitely beautiful, chiefly by an appropriate and harmonious blending of correct colours. Such an instrument, if correctly designed, does not become monotonous.

The designs made by this machine—no matter how constructed—are the result of the compounding of two or more separate motions, but, if more than two are employed, the results are too involved. Two of the simplest and best movements to combine, are a straight line and circle, and it is with these two that we are concerned in this article, i.e., a movement backwards and forwards in a straight line and round and round in a circle. In other words, cause a pen or pencil to move to and fro across, or partly across, a circular uniformly revolving disc covered with a sheet of paper. Such a movement will produce an extremely good design, provided the relative speeds are correctly adjusted.

The Result of Varying the Speeds

Suppose the recording disc (that on which the design is made) to be revolving quickly, the tracing pen will travel comparatively slowly across the recording disc, resulting in a spiral, which does not lend itself to a good design. Therefore, it is not advisable to rotate the recording disc quickly, in fact, the rotational speed should always be less than that of the designing wheel.

If we reverse the above procedure, an excellent design will be produced, with an interlacing and shading of colour which is quite unique.

One great advantage that a tracing formed by a stylographic pen has over one actuated by a pendulum or combination of pendulums, is that in the case of the former, the movement can be arrested at any moment and continued with a change of colour, which is impossible in the case of a pendulum.

Varying the Design

The most marked variations in design are produced in the following manner:

1. Variations in the *relative* speed of the moving parts.
2. Altering the position of the peg in the holder on the designing wheel, and changing the position of the wheel itself (by altering the holder only, you simply alter the size of the design, without altering its character).
3. The use of different coloured inks, a design in, say, red and green, having quite a different appearance to the same design in blue and orange.
4. By a skilful manipulation of different designs on the same piece of paper. When completed, the whole appearing as one design.

Reproducing the Same Design

There is, of course, no difficulty in immediately reproducing any design before the various parts have been moved, but having secured a design of some particularly interesting and beautiful character, it is an additional attraction to be able to reproduce it on some future occasion. Referring to the sketch of the designograph, it will be seen that the slot in the baseboard has a graduated ruler on *both* sides of it. Supposing we call the one on the left side A, and the other B, then $2\frac{1}{8}$ in. $A \times 3\frac{5}{16}$ in. B fixes the position of the movable block.

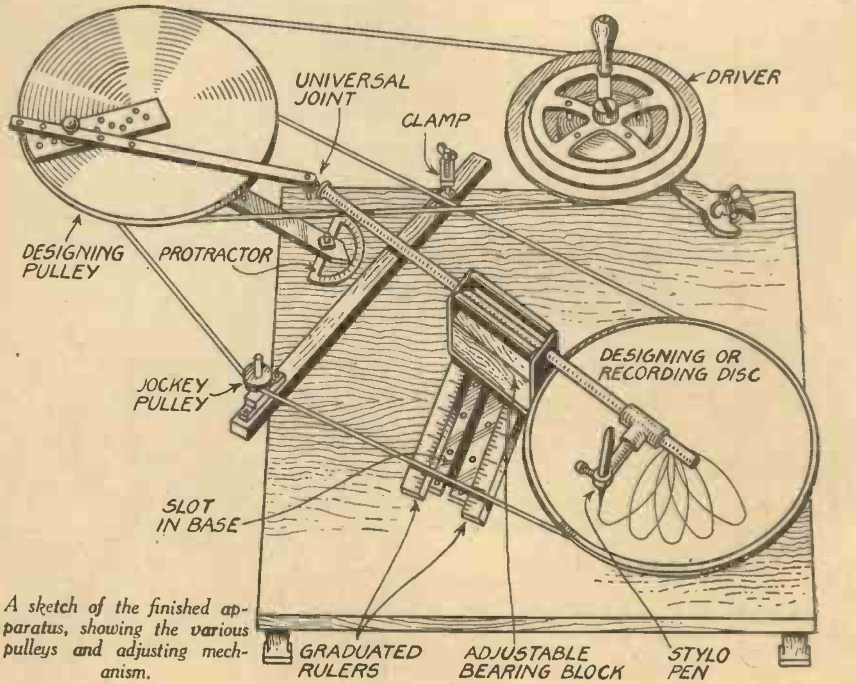
The position of the penholder, with respect to the end of the controlling rod, is easily measured, R meaning right side, and L left. The position of the designing wheel is fixed by the pointer on the protractor. There only remains to determine the position of the cords or belts. As an example, number the different pulleys on the various wheels, 1, 2, 3 in descending order of magnitude, remembering that D, the driver, has two sizes, DW, the designing wheel, three, and RD, the recording disc, one only. Thus $D1X$ to $RD2$, and $DW3$ to RD will give you the necessary information, X meaning that the straps are crossed. This same principle can be applied to any other type of designograph.

The Construction

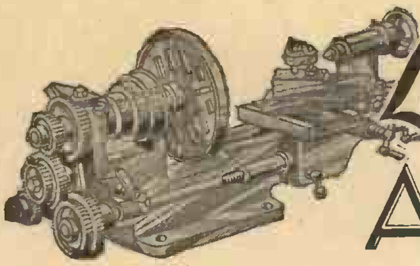
The baseboard of the designograph measures 19 in. × 21 in. × 1 in., the four legs are 3 in. high, and the slot in the baseboard is $7\frac{1}{2}$ in. long × $\frac{1}{4}$ in. wide. The diameter of the recording disc is $10\frac{3}{4}$ in. and this disc contains five pulleys measuring 10 in., 9in., 6 in., 5 in., and $2\frac{1}{4}$ in. respectively. The designing pulley is 10 in. in diameter, and is fitted with seven pulleys measuring $9\frac{1}{2}$ in., $8\frac{1}{2}$ in., $7\frac{1}{4}$ in., $6\frac{1}{4}$ in., 4 in., 3 in., and 2 in. respectively, and the driving wheel is 9 in. in diameter and has two pulleys measuring 8 in. and $5\frac{1}{4}$ in. The brass sliding rod is $17\frac{1}{2}$ in. long and $\frac{7}{16}$ in. in diameter, and the flat connecting rod is 12 in. × $\frac{3}{8}$ in. × $\frac{1}{8}$ in. The length of the swivelling arm on which the designing pulley turns is 8 in., and the driving arm is $6\frac{1}{2}$ in. in length.

The Pen

An ordinary stylographic pen was used for the model illustrated, but for those who require great accuracy, glass pens should be used. These can be obtained from any scientific instrument makers, and require frequent cleaning, a good paper, and non-clogging ink. Ordinary pens can be used if desired, provided an extremely fine nib is used. The most satisfactory colours to commence with are scarlet, blue, green, violet, and a deep orange. A separate pen and filler must be used for each colour, and a fairly stiff paper for the designs.



A sketch of the finished apparatus, showing the various pulleys and adjusting mechanism.



Lathe Work FOR AMATEURS

GRINDING OPERATIONS

By W. H. Deller

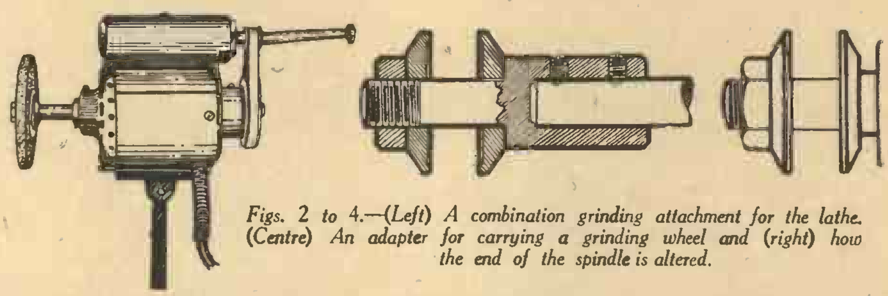
WHILE a centre lathe is primarily intended to be a machine for performing operations that are strictly regarded as turning, its general design is such that it may be easily adapted for use in other directions outside of this sphere.

The operation that is most akin to turning, is cylindrical grinding, and as a general rule, all turned work that is subsequently hardened should be finally ground. Other forms of grinding such as cutter and surface, can also be conveniently carried out on the lathe.

Frequently, the lack of facilities for carrying out such operations is the cause of a finished job falling short of perfection. Therefore it is proposed to deal with the adaption of the lathe for grinding processes.

Extra Equipment Necessary

The extra equipment necessary to complete the conversion is really very little, and as to the question of outlay, the reader who is so disposed, may make the attachments for a fraction more than the bare cost of the material involved. Briefly, what is required is a driven spindle carrying a grinding wheel mounted on the tool platform in place of the usual turning tool. As may be imagined, a motor-driven unit specially made for the purpose, provides by far the simplest solution to the problem. Such electrically-driven self-contained "tool-post" grinders are to be had in great variety. These may be suitable for external or internal work, or a combination appropriate for both classes. The power of the motors fitted are usually of the order of 1/8-h.p., and therefore may be plugged into the lighting circuit. A small internal grinding attachment of this description is seen fitted to the lathe in Fig. 1. The wheel spindle is removable by unscrewing the knurled collar on the necked portion of the casing, so that other spindles of different diameter or length may be substituted as required. A diagram of a combination attachment is shown in Fig. 2. Here the external wheel is driven at armature speed, and the internal spindle driven with an endless belt by a pulley at the opposite end of the armature spindle. The means provided for mounting in the tool post is so arranged, that the attachment is simply clamped in position with the spindle required nearest to the nose of the lathe. When the internal spindle is not in use, the belt should be slipped off so that the full power of the motor may be utilised to drive the large grinding wheel.



Figs. 2 to 4.—(Left) A combination grinding attachment for the lathe. (Centre) An adapter for carrying a grinding wheel and (right) how the end of the spindle is altered.

Converting an Existing Motor

An existing motor in the region of a 1/4-h.p. suitable for the mains current available, may be converted for use as a grinder providing that the armature is mounted on substantial bearings. If the motor is a modern one, it will be fitted with ball bearings which is an advantage, but precautions should be taken to exclude the entry of grinding dust, as far as possible, into the bearings and inside of the motor.

The question of mounting the motor must first be considered, and probably the simplest way of so doing will be by fixing the motor to a baseplate. On account of bringing the armature spindle down to centre height, it may be necessary to remove the top slide of the "compound," and mount the baseplate directly on to the cross slide in substitution. While this will provide a rigid fixing and enable good work to be produced between the centres, it will not permit of taper grinding being carried out on work held in the chuck. As, however, most jobs may be tackled, this objection is not a serious one.

Having decided on the method of fixing the motor, the next step is to adapt the spindle to carry a grinding wheel. This can be done by making an adapter as shown in Fig. 3, or where the diameter and length of spindle will permit, by altering the end as shown in Fig. 4. The first example affords the best method as the motor may still be used for other purposes. In making the adapter, it should first be roughed out and the hole bored to neatly fit the spindle. After fitting the grub screw or screws, the part is finished by turning on a true peg held by the screws. This should ensure that the extension runs perfectly true when in position. The internal grinding attachment may be fitted at the front of the baseplate (so that it can be detached when not being used), and driven by a belt from a pulley fitted in place of the grinding wheel, or with a friction wheel in direct contact with a pulley so fitted.

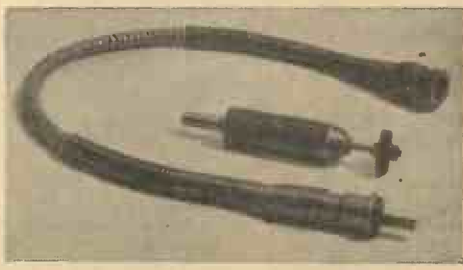


Fig. 5.—Details of a flexible shaft unit.

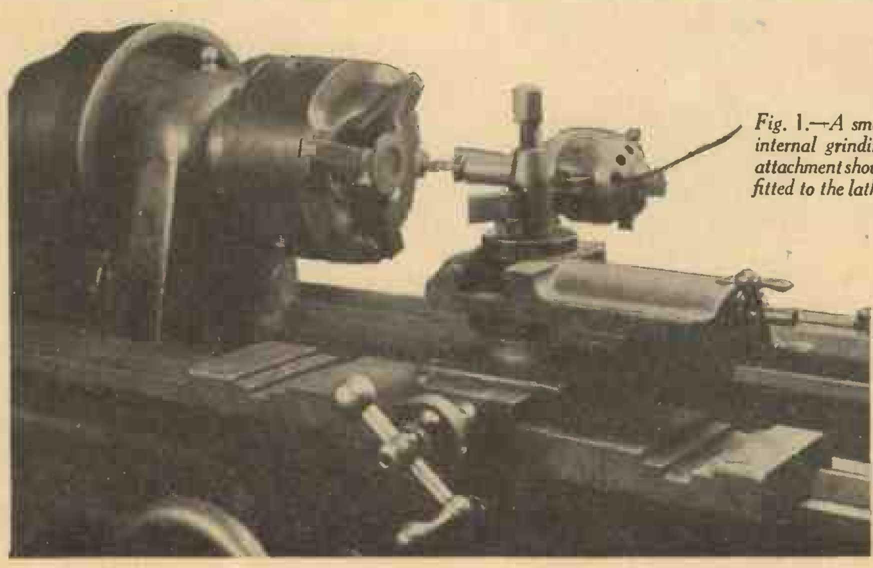


Fig. 1.—A small internal grinding attachment shown fitted to the lathe.

Flexible Shaft Drive

Where the lathe is a small one, the dimensions of even the smallest motor giving sufficient power will be too great to permit mounting in the manner stated, and in such cases, an alternative method must needs be adopted. A flexible-shaft drive affords perhaps a simple solution as the actual grinding head can be got down to quite small proportions.

Where such a drive is contemplated, the actual flexible-shaft unit should, on account of the high speeds involved for internal grinding, be one that is fitted with ball races. A shaft unit of this description is illustrated in Fig. 5. The head shown separately is in this instance provided with a collett for gripping the shanks of small arbors carrying the appropriate wheels. It is better to avoid purchasing a head that is permanently fitted with a drill type of chuck, as this is not nearly good enough.

The head may, of course, be made on the lines of those shown later, in which case the shaft only needs to be considered, and there is no reason why, for light work, an old speedometer driving shaft and casing should not be pressed into service for the purpose (see Fig. 6). Where, however, one of the commercial types of flexible shaft units is to be used, it will be necessary to provide some means of holding the head portion in the tool holder. Alternative methods of so doing, and which will meet the requirements of most types of tool posts, are shown in Fig. 7. No actual dimensions can be given as these will depend upon the diameter of the grinding head, height from tool platform to centre, etc. Other details are made clear in the sketches.

Fig. 6.—For light work, an old speedometer driving shaft may be used.

The flexible shaft may be motor-driven direct or via countershaft to give a range of speeds above that of the motor, and if fitted in this manner, will form a valuable addition to the workshop equipment as its uses, apart from grinding, are numerous.

Fig. 7.—Alternative methods of holding the head portion of the flexible shaft in the tool holder.

Belt Driving from Countershaft

Although a more or less self-contained electrically-driven grinding head provides the most simple means of converting or adapting the lathe for grinding, the job can be accomplished by belt driving from a drum countershaft situated above the lathe as shown diagramatically in Fig. 8.

The driving drum should extend to more than the maximum distance that the lathe will take between the centres, taking care to arrange it in such a position that the down belt will not be unduly tightened or slackened when the cross slide is moved. Where the drum cannot be mounted in relation to a line through the lathe centres shown in Fig. 9, then a jockey pulley will need fitting to compensate belt tension; but this is a complication that is usually avoidable.

Belt-driven Grinding Heads

The reader who is desirous of doing a little grinding on the lathe, and intends making the head himself, will naturally wish to achieve his aim with the minimum of trouble. A ball-bearing head, which will produce creditable work of small proportions, may, with very little trouble, be contrived from a front hub of a bicycle. Very little actual work, if any, is needed in the way of alterations. A round belt will transmit all the power that is required so that a vee pulley is all that is wanted to take the drive. The flanges may be reduced in diameter to below the spoke holes for the sake of appearance, but this is not really necessary.

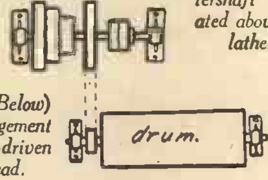
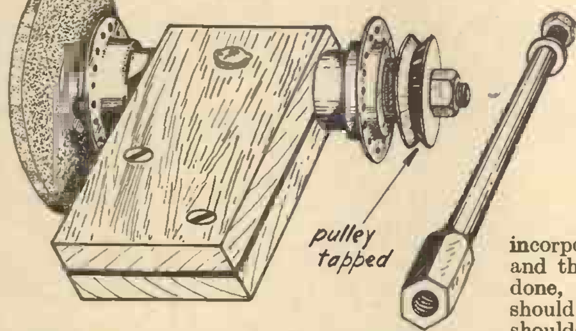


Fig. 8.—(Centre) Belt driving a grinding head from a countershaft situated above the lathe.

Fig. 10.—(Below) General arrangement of a belt-driven grinding head.



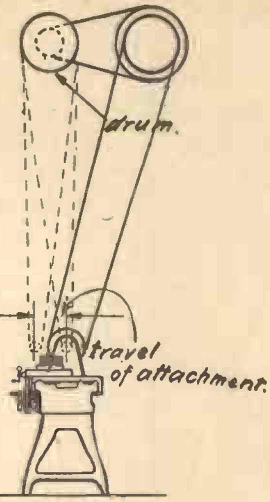


Fig. 9.—A jockey pulley fitted to compensate belt tension.

A general arrangement of the head and method of mounting is shown in Fig. 10 together with an adapter and shaft for internal work.

Belt-driven External-Internal Attachment

A suitable design for making a belt-driven combination attachment is shown in Fig. 11. The external spindle is driven from a drum situated above the lathe in the manner previously explained. The pattern making involved is of the most simple nature, one pattern being required for the bracket and one for the friction pulley. As shown, the main spindle runs on ball bearings which can be on the lines indicated, or the design modified to incorporate standard combined journal and thrust ball-races. Where this is done, the inner rings of the races should be made to butt against shoulders turned on the spindle at either end, and screwed caps fitted to effect adjustment to the outer rings. If the centre of the caps are bored to clear the shaft and a groove provided in each one to contain a felt ring, a good dust-proof bearing will result.

The spindle may, of course, be mounted on plain bearings, but to do this properly, the bearings require to be adjustable and also an adjustable thrust-plate is an absolute necessity, so that all things considered, the method shown or that suggested, forms the easiest way to go about the job. To bring the internal attachment into use, the grinding wheel is removed and the aluminium pulley substituted. The bracket is then swung round to bring this pulley nearest to the tailstock. It should be noted that the round body of the internal attachment is slightly eccentric in relationship to the spindle. This enables the body to be rotated, an thus bring the friction wheel to bear against the face of the pulley with the right degree of pressure before finally clamping into position. No dimensions are given on the drawings, as the attachment will have to be made to individual requirements.

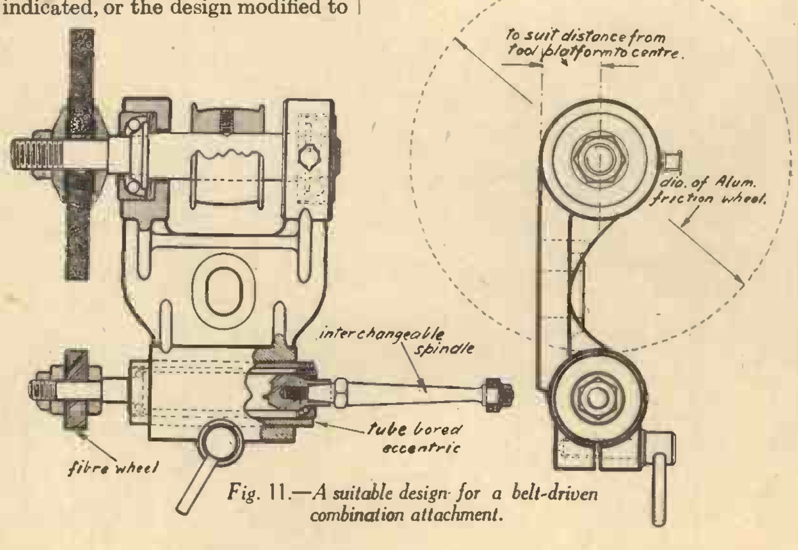


Fig. 11.—A suitable design for a belt-driven combination attachment.

GROUND ORGANISATION

The Efficient Operation of a ... of Disaster to a Minimum.

The London air-port, Croydon, floodlit at night.

THE fact that British air-lines now operate during all kinds of weather, with a reliability of just on 100 per cent., is mainly due to the skill of experienced pilots, to the dependability of multi-engined air-liners, and to the wonderful organisaton which has been created in wireless, meteorology, and ground lighting. It is with the ground organisation of air transport that we propose to deal.

Take, for example, the equipment at a modern aerodrome such as the London air-port, Croydon.

Here one finds a spacious booking-hall and waiting-room for passengers, together with an adjoining hotel with restaurant and other accommodation. Departments are provided for dealing with mails and freight; also a Customs staff such as one would find at sea-ports. Air-liners pick up and set down their passengers at special arrival and departure platforms, while for taking-off and landing, they have a large and unobstructed aerodrome surface.

Big sheds, adjacent to the main buildings, provide housing for the air-liners not in flight. There are fully-equipped workshops for the overhaul and maintenance of aircraft and engines; while the flying personnel have their own pilots' room, where they assemble prior to, or after the completion of, their scheduled flights along the main air routes.

The Control Tower

The "brain" of the air-port is to be found in the control tower dominating the main buildings. Here is the traffic officer on duty; also the operators in charge of the wireless installation; while another important department is that of the meteorologists, who are constantly obtaining and distributing data as to weather conditions, along the airways between London and the Continent. This weather organisation not only receives frequent reports from a large number of ground stations, but pilotless balloons are sent up to secure information as to wind-strength and direction; while reports are also available from the upper-air "soundings" made by aeroplanes sent up daily by the Air Ministry.

All such observations are plotted on weather maps, which the pilots of air-liners consult before they start their flights. At the same time, wireless messages are flashing constantly between the main air-ports of Europe, describing the conditions from hour to hour as to wind, cloud, and visibility.

Not only do such messages pass from station to station, but they are also transmitted from the ground to air-liners in flight, thus keeping pilots in touch with any weather changes that may be in progress ahead of them along the routes they are following. In this way, should fog settle suddenly on an aerodrome for which he is steering, a pilot in flight can be warned of the fact by wireless, and advised to alter his course so as to alight at some alternative air-station where visibility is better.

Avoiding Risk of Collision

In times of bad visibility, the officer at Croydon can bring into play a system enabling him to exercise a special control by wireless over aircraft approaching or leaving the air-station, thus lessening any risk of collision. And in this connection it should be mentioned that air-liners out-going and in-coming on the Continental routes, follow different courses, thus separating the main traffic lines.

Vital to the efficient operation of a modern airway is its system of wireless signalling, on the ground and in the air. Whenever flying conditions render such a course desirable, air-liner pilots can obtain wireless direction and position bearings from main air-stations. Such wireless guidance enables them to fly for long distances without seeing anything of landmarks below, and yet to maintain a perfectly accurate course; while wireless "homing" devices are now provided in aircraft which enable them, by picking up the signals sent out by transmitting stations, to steer directly towards such stations. The modern pilot is also aided in bad weather by such devices as turn-indicators, "automatic pilots," and artificial horizons—these enabling him to keep his machine on an even keel and steer an accurate course,

A control officer plotting the position of an Imperial Airways liner on his map in the control tower at the air-port of London, Croydon.

OF THE MODERN AIRWAY

Modern Aerodrome is Largely Dependent on the Precautions Taken to Reduce the Risk Below is Described the many Ingenious Devices and Apparatus used in this Endeavour

when flying in such conditions as mist or fog rob him of any normal visual landmarks or horizon by which to correct the movements of his machine.

A night view of the new cone-type boundary light at Croydon Aerodrome.

Short-range Beams

The latest developments of airway wireless take the form of short-range beams, directed upward from an air-station, which guide an airman when he is coming in to land in fog. With these beams are incorporated special vertical rays that indicate to a pilot his varying height above the ground as he flies in down the main beam. Further developments with short-wave warning beams, may take the form of an apparatus fitted in an air-liner to warn the captain of the proximity of another machine when mist or fog reduce ordinary visibility.

Ever since civil aviation began, just over sixteen years ago, experts on marine lighting have been developing special ground lights and beacons for the guidance of aerial traffic. The brilliant red of the neon light, with its fog-piercing power, is used in a giant beacon at Croydon which pilots can see when they are still many miles distant. The aerodrome is also surrounded at night by red boundary-lights, while a special form of flood-light, throwing a low beam across the landing-ground, is capable of producing over a wide area an illumination almost equal to that of daylight.

Another special device, in which much ingenuity has been displayed, takes the form of an automatic device to tell an airman the direction and strength of the wind as he comes gliding down to land at a main or intermediate aerodrome. This takes the form of a large, illuminated, arrow-like structure which swings always head to wind, and along the top of which, coloured lights can be mounted to indicate the strength of the wind.

Guiding Beacons

One of the problems in airway lighting has been the need to establish on hills or mountains, and at other remote points, powerful unattended guiding beacons which will function with a minimum of attention or overhaul. This has led to the employment, in automatic beacons, of a sun-valve or light-sensitive device which automatically sets a light going as soon as darkness begins to fall, and which extinguishes the light when daylight comes on the following morning. These automatic beacons, each flashing its distinctive signal, have now been brought to a high state of efficiency. Working automatically from gas-storage chambers, they will continue to light themselves up and put themselves out for a considerable period of time; and the mechanism is so ingenious that a beacon will, if necessary, automatically change its own gas mantles. Apart, in fact, from an occasional visit from an engineer to re-charge the gas cylinders, and give the machinery an overhaul, one of these air-lighthouses will look after itself for long periods without anyone having to go anywhere near it. Automatic electric beacons are also employed, operated by a small gas-engine plant which will run for long periods without attention.

The aerodrome beacon at Croydon is one of the most powerful in the world, and, on an average clear night, is visible over 60 miles away. It is of the red neon type, consisting of a number of neon tubes arranged in the form of a truncated cone on a metal framework. The beacon flashes a morse signal indicating the name of the aerodrome. The light source, although capable of being seen many miles away, is of low intrinsic brightness over a wide area, and does not dazzle pilots.

An Amplified Air-mail Scheme

The use of all such methods of airway lighting, both at air-stations and intermediate points, is now assuming a still greater significance in view of the decision to bring into operation, in 1937, an amplified air-mail scheme by which first-class letter mails, without any aerial surcharge, will be air-borne in bulk over the chief Empire routes. Under this new plan a fleet of larger and more powerful air-liners, already in construction for Imperial Airways, will operate by night as well as day, passengers being provided with sleeping-berths in addition to day saloons. All this will, of course, entail a considerable amplification not only of the flying equipment but also of wireless, meteorological, lighting services, and chains of guiding beacons stretching along thousands of miles of routes.

Showing the bridge of the Imperial Airways Liner "Scylla."

Woodworking for Beginners

Continued from Page 316 of Last Month's Issue

Mortoise (*continued*)

After being marked out, the mortise chisel which should have a blade exactly equal in width to the width of the mortise. The best way is to cut about half-way through the wood from one side, and then turn it over and cut across the grain at the ends of the mortise. The wood can then be turned back and the hole completed from the first side. An alternative method, which is rather better for the beginner, is to work half-way through the wood from each side. In any case it is of especial importance that the chisel should be held perfectly upright whilst cutting, and the wood should be placed on a solid piece of timber or on a bench hook.

There are two ways of cutting out the mortise, and both have their uses under different circumstances. The first, which is a great time saver, is to bore a few holes through the wood inside the lines marked out for the joint; after that the chiselling process is very much easier. Another way is to start in the centre of the joint; make a chisel cut by giving the tool a moderately heavy blow with a mallet, and then work backwards and forwards to each end of the joint. Cuts should be made every ¼ in. or so, when the waste wood can easily be removed. (See Fig. 23.)

Mortise Chisel.—See Chisels.

Mortise Gauge.—Also called a double marking gauge. This tool is similar to the ordinary marking gauge, but has two spurs which enable it to mark a pair of parallel lines which are also parallel to the edge or side of the wood. (See Fig. 18.) As the name implies, this tool is employed for marking out mortises. (See Gauges.)

Moulds.—There are various types of moulds, most of which can be made with a moulding plane of the kind briefly described under Planes. The most commonly used moulds are ogree, ovolo, scotia and bead; some of these are illustrated in Fig. 21 (shown last month).

Nail Punch.—Also called pin punch. This is similar in construction to a centre punch, but has a flat end instead of a point. Its purpose is for driving the heads of nails down below the surface of the wood. To prevent it slipping off the nail head, it should be held with the tip of the third finger close to the end; the finger then presses against the surface of the wood. (See Fig. 20, shown last month.)

Nailing.—This apparently very simple process demands a certain amount of care if good results are to be secured, especially when doing delicate work or dealing with thin wood. Nails should never be placed near the end of a piece of wood, or else splitting is almost sure to be caused. In every case it is advisable to make a hole through the piece of wood to be attached, to receive the nail; this avoids splitting and helps to keep the nail perfectly upright. (See Fig. 22, shown last month.)

A point which often puzzles the amateur wood-worker is what length nails should he use. A very good rule to follow is to use nails which are from two and a half to three times as long as the wood is thick.

Nails.—In various types, such as wire nails, floor brads, cut nails, oval nails, wire points, panel pins, escutcheon pins, etc. (See Fig. 19, shown last month.)

Northern Pine.—A useful soft-wood grown in the northern parts of Europe; it is commonly grown in Scotland, and for that reason often gets the name of Scotch pine. Another common name for the wood is yellow deal, whilst in the north of England it is generally called red deal. The wood is widely used for joinery purposes, since it is fairly free from knots, is easily worked, and takes a good finish when stained or varnished. It withstands exposure very well, and is thus widely used for roofing, doors, windows, and other building purposes. It is strong and durable.

The sapwood has a blueish tint and should always be avoided in purchasing, since it is not so durable nor easily worked; it is also absorbent and cannot be so easily varnished.

Notch.—A rectangular sinking made by sawing and chiselling. Notches are marked out by first measuring the length, squaring lines round the wood, and then gauging the depth. To cut out, the ends are first sawn down just to the gauge line, and if the notch is more than an inch or so long it is advisable to make other saw cuts at intervals to prevent splitting later.

Oilstones.—Used for sharpening edge tools such as chisels, plane irons, spokeshaves, etc. There are several kinds of oilstones, among which might be mentioned, Arkansas, Charnley Forest, Carborundum, and Turkey. All except Carborundum are "natural" stones quarried in different parts of the world; Carborundum is, however, a stone made by artificial processes.

Arkansas stone is white in colour, fine-grained, and of fairly even quality. It is useful for tools which require a very keen edge, but is too slow cutting for other purposes.

Charnley Forest stone is greenish-grey and cuts very slowly. It puts a very

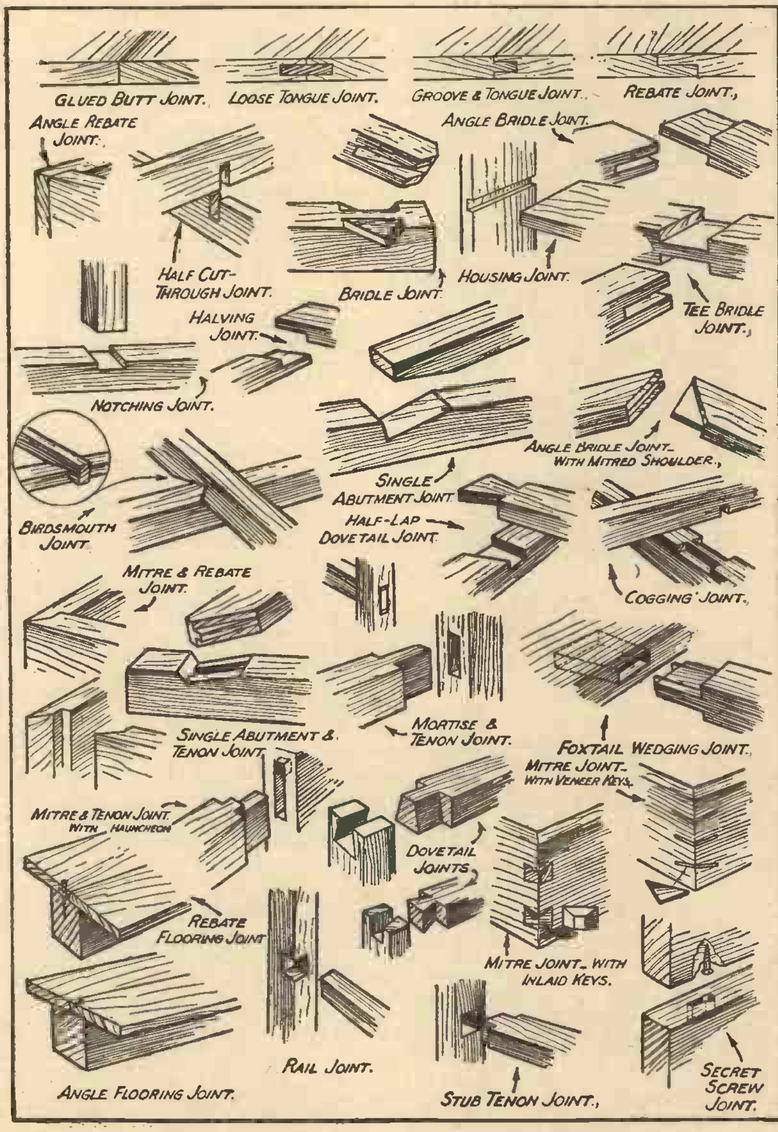


Fig. 23.—Various joints used in joinery and carpentry.

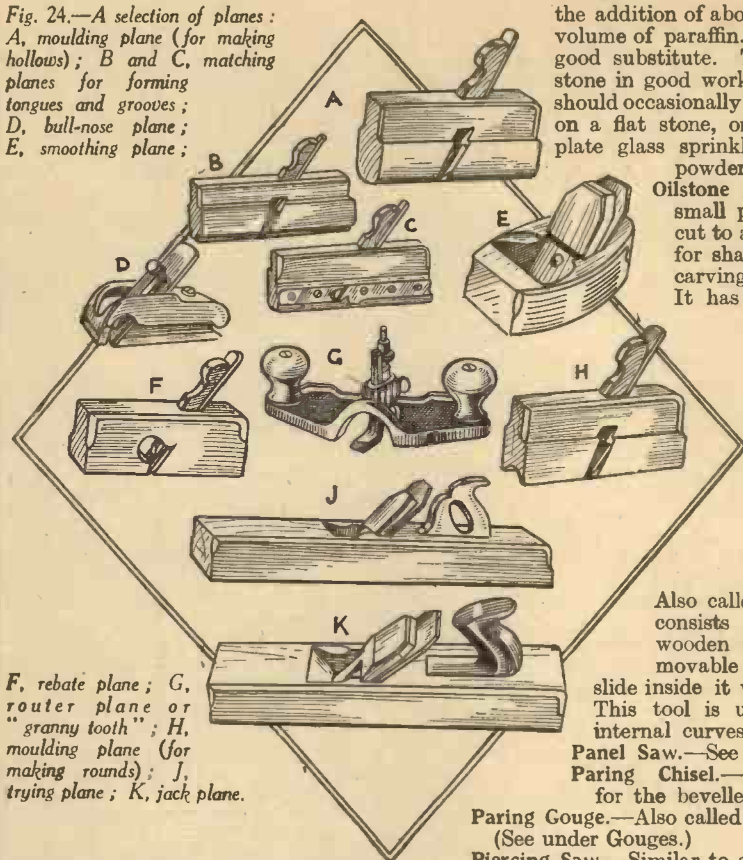


Fig. 24.—A selection of planes: A, moulding plane (for making hollows); B and C, matching planes for forming tongues and grooves; D, bull-nose plane; E, smoothing plane; F, rebate plane; G, router plane or "granny tooth"; H, moulding plane (for making rounds); J, trying plane; K, jack plane.

fine edge on tools, and is thus useful as a finishing stone where tools are being used for delicate work.

Carborundum can be obtained in a variety of grades and is very quick cutting. It is not sufficiently fine to produce a very keen edge, and wears away rather quickly. When using this kind of stone it is advisable to finish off the work on a leather strop to remove "wire edges."

Turkey stone varies immensely in different samples. Good samples are very fine grained and produce an excellent edge such as is required for a razor. It is greenish coloured, and the powder samples often show a streak of red or brown.

Fig. 25.—This sketch shows how pincers can be used without damaging the surface of the wood; a small wooden block is placed under them near to the head of the nail to be withdrawn.

In using an oilstone it is important that the proper kind of oil should be employed. The best is generally considered to be neat's-foot, and this is often improved by the addition of about one-tenth by volume of paraffin. Olive oil is a good substitute. To keep an oilstone in good working condition it should occasionally be rubbed down on a flat stone, or on a sheet of plate glass sprinkled with emery powder or sand.

Oilstone Slip.—This is a small piece of oilstone cut to a shape suitable for sharpening gouges, carving tools, bits, etc. It has two flat sides and two half-round edges; of the latter one is of smaller radius than the other. Slips are obtainable in various sizes.

Pad Saw.—Also called keyhole saw; consists of a turned wooden handle with removable blades which slide inside it when necessary. This tool is used for sawing internal curves and holes.

Panel Saw.—See Saws.

Paring Chisel.—Another name for the bevelled-edge chisel.

Paring Gouge.—Also called scribing gouge. (See under Gouges.)

Piercing Saw.—Similar to a small fret saw but fitted with a wider and stronger blade. It is generally used in metal working, but is also useful for making internal curves in thick wood or in stout ply-wood. Also called a coping saw.

Pincers.—The commonly known tool for extracting nails. It should always be employed as a lever and not merely for gripping nails so that they can be pulled out. (See Fig. 25.)

Planes.—Of various types, such as smoothing planes (short planes with beech-wood stock) used for cleaning off joints and dirty marks; jack planes, longer planes having beech stock from 10 to 14 in. long, and used for removing the initial roughness from wood and for trueing up comparatively short lengths; trying planes, similar to jack planes but with longer stock, used for trueing long pieces of timber; rebating planes, narrow planes, in which the mouth is open at one side so that the tool can be used in angles (or rebates); matching planes for making tongues, and moulding planes for forming moulds, beads, etc., on the edges of wood. In using planes of all types, weight must always be placed on the front at the beginning of the stroke, and gradually transferred to the back as the stroke proceeds. In other words, an attempt must be made to produce a "hollow" edge on the wood; this cannot actually be done due to the straightness of the sole.

When making a mould all round a rectangular piece of wood, it is best to deal with the ends first, so that any splitting at the corners will be removed when the edges are dealt with.

Reamer.—A kind of drill used for enlarging holes. It is tapered so that the end can easily be inserted in the existing holes. The type of reamer generally used for wood has a crescent-shaped cross section, so that it actually cuts instead of merely rubbing the material away.

(To be continued)

Money Making IDEAS

Advice by our Patents Expert

IMPROVING A ROLLER BLIND

"I WOULD greatly appreciate your opinion on the following idea of mine. As it is usual for the cord of a blind to slip round the spindle of the roller and jam the blind, I think this idea would alleviate this problem.

"A toothed wheel, fixed to the roller, is moved by another toothed wheel having a greater number of teeth. The spindle of the second wheel takes the cord, one winding for pulling up, the other winding for pulling down. The length of these windings will be small (about 3 in. or 4 in. each) depending on the ratio of the teeth. There would be no cord hanging from the centre of the blind, the cord in this case being at the side of the window. The whole idea could very easily be fitted to existing rollers as well as being fitted to new ones." (J. M., Fife).

THE improved roller blind is thought to be novel from personal knowledge, and so far as can be ascertained from the description would appear to form fit subject matter for protection by patent. A sketch and further particulars of the proposed arrangement should be furnished before a definite opinion can be given on the merits of the invention.

AN IMPROVED TAP VALVE

"CAN you advise me on the merits or otherwise of the invention described in the accompanying specification. I think this specification, together with the photographs enclosed, will make the idea perfectly clear." (J. P., Blackheath.)

THE improved valve of the screw-down type is ingenious and should be satisfactory in use. It is thought to be novel from personal knowledge and, if novel, should be a commercial success if properly marketed. The inventor, having obtained provisional protection for his invention, is advised to approach valve makers, and if the invention is not novel he will probably be soon advised of the fact. As the inventor is probably aware, the Patent Office do not make a search for novelty until after the complete specification has been filed, and it is presumed that no independent search for novelty has been made.

The following firms might be interested in the invention: F. H. Evans & Co., 138 Plashet Road, Upton Park, E.13; Kemp & Wright, Stratford Brass and Engineering Works, Junction Road, Stratford, E.15; The Winstone Engineering Co., 309–311 City Road, London, E.C.1; Frank Love, Ltd., XL House, Great Guildford Street, Southwark, S.E.1.

It is also presumed that the inventor has not had professional assistance in the drafting of his patent application, and should he require such assistance the Editor will be pleased to put him in touch with a reliable patent agent.

A DECARBONISING TOOL

"I ENCLOSE drawings of a device for facilitating the work of decarbonising a motor-car engine. Can you inform me as to its novelty, and if it is fit matter for taking out a patent." (E. D., Bucks.)

THE proposed tool for decarbonising internal-combustion engines is apparently an improved tool for grinding-in valves of such engines. As there has been a great number of patents obtained for such tools, it would be advisable to search through prior patent specifications relating to the subject matter before spending money in protecting the invention. If novel, it would appear to contain sufficient subject matter for a patent, but it is extremely doubtful if it would be possible to make a commercial success of the invention, because any patent which might be obtained at this date would necessarily be very restricted in its scope, and so might be readily overcome without infringing.

A NOVELTY FOR SMOKERS

"PLEASE give me your opinion regarding the enclosed idea. The advantages of such a combination, I am sure, would prove a great boon to all smokers of cigarettes, particularly lady smokers, who always desire compactness. The 'idea' could be modified to suit reguirements." (G. C., nr. Blackburn.)

THE combined cigarette carton and book match carton may have advantages with a certain class of smoker, but even if novel, it is not considered that the mere sticking together of two cartons involves invention sufficient to support a patent. Owing to the difficulty in obtaining any adequate protection for the idea, it is not thought to have any commercial value, and a further drawback, which is probably insurmountable, is the difficulty in transporting matches which under carriage arrangements are classed as explosives.

AN AGRICULTURAL MACHINE

"IS there a machine already on the market for pulling and topping root crops? If not, where could I apply to take out a patent for this device? I should also like the names and addresses of firms who specialise in the manufacture of this type of machine." (T. F., Dublin.)

IT is thought that there are machines on the market for lifting root crops, as there have been a number of patents for such machines which a search amongst prior patent specifications would disclose. It may be possible to obtain a patent for the improved machine, if novel, but since no particulars are given it is not possible to give further advice. Applications for British patents are made at the Patent Office in London.

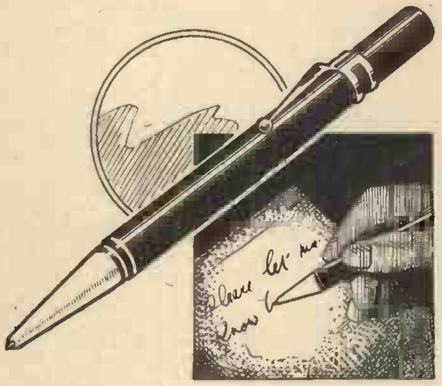
The International Harvester Company of Great Britain, Ltd., 259 City Road, London, E.C.1, would probably be interested in the invention.

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, and enclose 1d. stamp for the reply.

A Luminous Pencil

WE have dealt in these pages from time to time with various types of pen and pencil which have incorporated some novelty in their design. The latest addition in this respect is the luminous pencil shown below. It is self-propelling and repelling, and enables one to write in the dark. This is made possible by a bulb lighting up the head of the pencil, and thus throwing a light on to the paper upon which one desires to write. The current for the light is obtained from a small dry battery concealed in the handle of the pencil. This luminous novelty costs 8*s.* 6*d.*, and refill batteries cost 4*d.* each. [179.]



A luminous pencil which throws sufficient light on to a sheet of paper, etc., to enable one to write in the dark.

An Electrically-Operated Door Lock

A DEVICE has recently been placed on the market whereby an ordinary lock as fixed to front doors, etc., can be opened at will from a distance by means of an electric push button.

It consists of an ordinary "Yale" type door lock, to which is attached a special electric unit, which, when the push button is pressed, withdraws the catch of the lock. If desired, a spiral spring can be fitted to the door, so that when the catch is released, the door will swing open a few inches indicating to the person outside that he may enter. As soon as the person pushes the door open, the special resetting cam resets the lock ready for closing again. The fitting of the electric unit does not interfere in any way with the ordinary action of the lock, which may be operated as usual if required, by means of either key or by turning the knob inside. The wiring required is very simple, and the push button which operates the lock may be mounted at any convenient place in the house. Two or more buttons may be mounted in any position required, any one of which will operate the lock. The "Yale" type lock, electric unit and resetting cam, complete cost £3 10*s.* [180.]

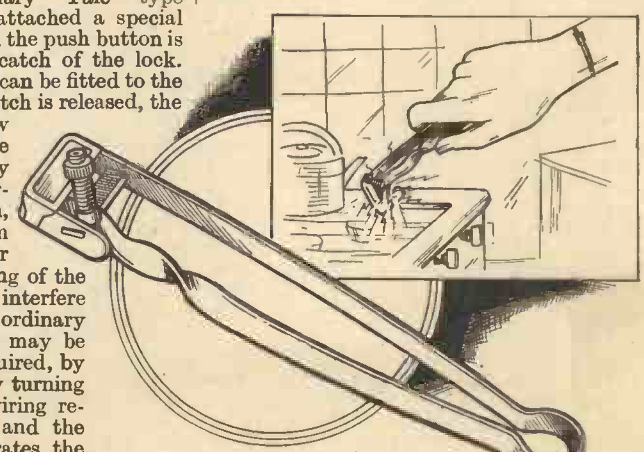
A wireless novelty in which an A.C. D.C. receiver is housed in a globe of the world.

A Globe Wireless Set

A NOVEL type of wireless receiver is that shown in the illustration on this page. It consists of a globe of the world containing an all-electric A.C. or D.C. minature wireless set. It is simple to operate and gives extremely good reception. It costs £7 7*s.* [181.]

An Ingenious Gas Lighter

WE show on this page a serviceable flint-operated gas lighter which is of simple construction, and is entirely fool-

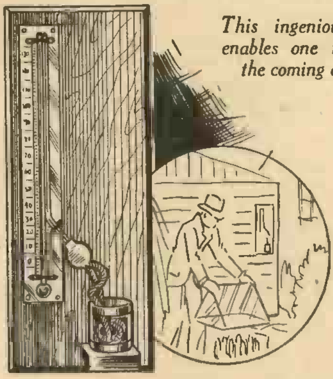


A serviceable flint-operated gas lighter, which is entirely foolproof.

proof. It is made of finest British steel, and is operated by pressing on the twisted side to which the flint is attached. It is guaranteed for one year and costs only 2*s*. 6*d*. A packet containing three spare flints is obtainable for 4*d*. [182.]

A Frost Predictor

THE sketch herewith shows a device for foretelling at a glance the coming of frost without the aid of tables. Frost is indicated when the wet-bulb column falls below the dry column, at sundown. The mercury tubes are fitted on a metal scale

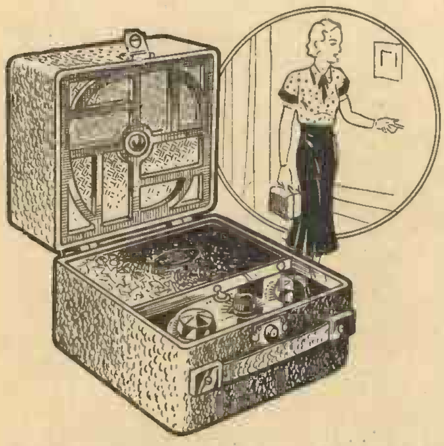


This ingenious device enables one to foretell the coming of frost.

mounted on an oak back. This frost indicator should prove indispensable to gardeners, as it enables them to take suitable precautions to prevent the frost reaching their plants. It costs £1 10*s*. [183.]

A Compact Portable Receiver

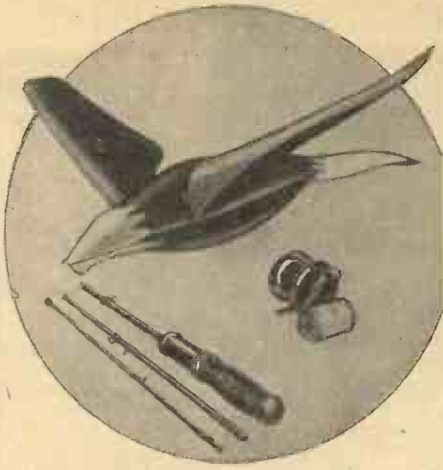
WIRELESS enthusiasts will no doubt be interested in the midget portable wireless receiver shown on this page, which measures 6 in. × 4½ in. by 1⅛ in., and weighs less than 2 lb. It is considered to be one of the smallest self-contained 2-valve portable receivers ever produced, and is designed to work between the medium wavebands. It has a range of 50 to 100 miles, and is supplied with a single Ericsson telephone. The price of the receiver is £4 10*s*. [184.]



A midget portable wireless receiver which covers the medium wavebands and has a range of between 50 and 100 miles.

The Mistry Bird

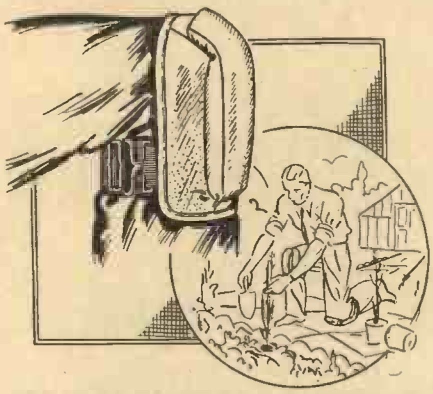
THE mechanical bird shown on this page is a new and fascinating sport. You play the bird in the air by means of a steel rod and line, which is shown dismantled in the illustration. The wings revolve as the bird soars into the air, allowing it to rise to about 300 ft. The price complete with rod and line is 25*s*. [185.]



A mechanical bird which, when swept in the air with the rod and line shown, will rise to a height of 300 ft.

Knee Pads for Gardening

FOR really getting down to the job, these pads will be found ideal for the gardener. Strongly made of waterproof rubber-lined twill, padded with thick sponge rubber and reinforced with solid rubber facings on the outside, they are quickly



Solid rubber knee pads which enable one to kneel on hard and stony paths without experiencing any discomfiture.

fitted and very comfortable in use. They enable one to kneel in luxury, on even the stoniest of stone paths and disperse with the worry of carrying a mat from place to place. They are obtainable for 4*s*. post free. [186.]

BOOK RECEIVED

"Everybody's Book of Aeroplanes." By R. Barnard Way. Price 1s. 6d. Published by Percival Marshall & Co., Ltd., 66 Farringdon Street, London, E.C.4.

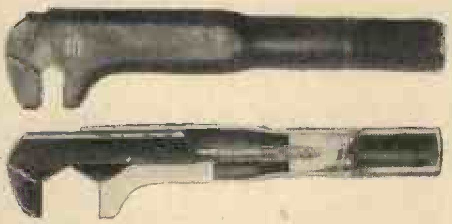
THIS attractively illustrated book describes in detail, the principles of construction and flight, and how to identify notable machines of the day. The opening chapters deal with the early pioneers of flying, and the book goes on to describe why an aeroplane flies and how it is made. There is also a chapter on gliders and sailplanes. Although a fair number of foreign planes are described, the book gives most attention to British aeroplanes.

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.

The "Master Grip" Pipe Wrench

THE pipe wrench shown below is not a modification of an existing design, nor a combination of existing designs, but is an entirely new product with tremendous advantages over similar tools which are at present on the market. Carefully balanced, it has not a one-sided frame or loose head; its patent jaws ensure maximum grip and easy release. Adjustment is in the correct place for one-handed operation, and the selective adjustment enables the tool to be used as a very large adjustable spanner for back nuts, etc. The head and the shank are of ·45 carbon manganese steel, having tensile strength of 40/50 tons per sq. in. The pipe wrench has a capacity of ⅛ in. to 2½ in., and costs 16*s*. [150.]

The "Master Grip" pipe wrench which is fitted with interchangeable jaws It is designed to give instant grip and release without slip.



A spanner with a ball-bearing adjustment. The body, which is of hydraulically drawn steel, is in one piece and virtually unbreakable. It is extended up behind the adjustable jaw, giving maximum support against spring.

A Spanner with Ball-bearing Adjustment

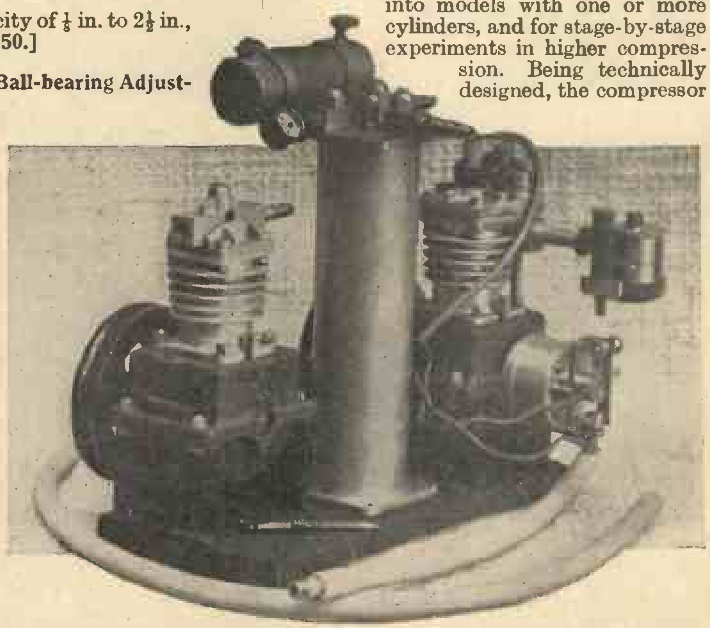
THE adjustable spanner shown in the illustrations on this page, one of which is a section through the tool, should prove extremely useful to the home mechanic. The adjustment mechanism, which is at the end of the handle, is ball-bearing, which is fully protected from dirt and grit; thus friction is practically eliminated and the spanner is enabled to obtain a vice-like grip. The jaws are so arranged that they will take four sides of a hexagon nut, and the inside of the lower jaw is serrated to allow the spanner to grip, even if it is not tightened up. Designed for a variety of purposes, this tool will act as a small pipe wrench, vice or clamp, and can be used to remove split-pins, etc.; in fact, it does the work of a number of tools. The knurled handle, while free to rotate, remains attached to the body when the movable member is completely unscrewed and withdrawn. By reason of the presence of the ball-bearings, the releasing action is smooth and easy. It is obtainable at the following prices: 3½ in., 3*s*. 6*d*. standard, 5*s*. chromium; 6 in., 5*s*. 6*d*. standard, 7*s*. 6*d*. chromium; 9 in., 8*s*. 6*d*. standard, 10*s*. 6*d*. chromium; or complete in a wallet 18*s*. 6*d*. standard, 24*s*. chromium. [151.]

Grinding of Curves

AT the coming Leipzig Spring Fair, March 1st–9th, 1936, there will be shown a handy implement, fitted with a flexible shaft and a 1-h.p. motor. The grinding device is fitted to the hand-lever by a crossed crank. An indiarubber disc transfers the grinding force, so that the machine will adapt itself to any curvature. The disc does 3,000 r.p.m. The work done is guaranteed to be clean and as desired. The special advantage of the device is that by the clever way in which the joints have been arranged, and by the correct transmission of power, it will always respond to the slightest pressure of the hand. The working is elastic and free of vibrations.

A Small Compressor Plant

QUITE a number of readers will no doubt be interested in this efficient little compressor plant. It has a bore and stroke of 1·25 in., and all the bearings and piston are entirely self-lubricating and fire resisting. The simplicity of the design makes it eminently suitable for building into models with one or more cylinders, and for stage-by-stage experiments in higher compression. Being technically designed, the compressor



This compressor plant is suitable for direct coupling to an engine or motor. It is designed for a pressure of 100 lb. per sq. in. and for speeds up to about 1,250 r.p.m.

An electric hair dryer which is absolutely shock proof and silent in operation.

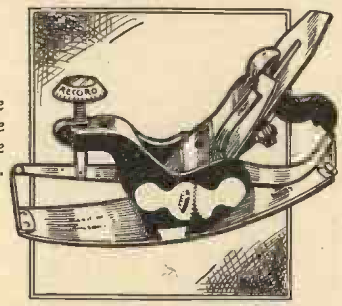
can also be used for all commercial purposes, laboratories, and for experimental instructional work in technical schools and colleges. [152.]

A Streamline Hair Dryer

ABSOLUTELY shock proof and silent in operation, this electrically-driven hair dryer should appeal to all those readers who find drying their hair with a towel an extremely tedious task. It has a low power consumption, and is easy to handle. The mechanism is fitted into an unbreakable mottled enamel-finished case. The air inlet is at the back of the dryer, thereby rendering it impossible for hair to be drawn into the machine. It works from A.C. or D.C. supplies and costs 21*s*. [153.]

The "Record" Circular Plane

THE circular plane shown below will be found an extremely useful tool for the workshop. The steel face of the plane is anchored to the plane body in the centre, and adjusted by means of a screw controlling the two levers. It is fitted with toothed segment plates, which are graduated to provide for setting to correct radii. The plane is 10 in. long, has a $1\frac{3}{4}$-in. cutter and weighs $3\frac{1}{2}$ lb. It costs 26*s*. [155.]



A new type of plane for the handyman.

BOOK RECEIVED

"Railway Modelling in Miniature." By Edward Beal. Price 3s. 6d. 133 pages. 270 illustrations. Published by Percival Marshall & Co., Ltd.

NO model-railway enthusiast should be without this new publication which deals in the main with the small HO and 00 gauges. There are 133 pages devoted to all aspects of this interesting hobby, and the subjects covered will enable everyone to build the most comprehensive lay-out and to carry out all railway engineering practice in perfect detail.

The chapters deal with the merits of the small gauges, Track Work and Lay-out Design, Modelling Railway Buildings, Building and Equipment Designs, Rolling Stock and Motive Power, and conclude with some interesting and valuable details on scenic work.

The work is profusely illustrated in line and tone, and there is no difficulty in adapting many of the illustrations to gauge 0. The majority of the working drawings are complete with a scale for use in either the 00 or H0 gauges, and it is only necessary to double the H0 measurements in order to construct the item for use in gauge 0.

NEW INVENTIONS

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

IN a column, for which I propose to write notes upon striking new inventions, it is appropriate that I should begin with a novel device relating to loose-leaf note-books. This comprises a back provided with a magnet, and the edge of each leaf is adapted to be retained by magnetic attraction. The inventor contends that this device is eminently convenient, as each leaf can be inserted or removed without disturbing its neighbours, and he claims that it is an improvement upon the ring system, in which the holding of the leaves depends upon two or three weak holes. The principle of this invention is applicable also to card folios and files.

Light on the Subject

SPEAKING of note-books, it is fitting to add that a tiny electric light bulb is now affixed to a loose-leaf note-book. This will facilitate the writing and reading of notes in the dark. A policeman on the highway at night, will find this device helpful.

Safety Thirst

THE turning over of a cup by a youngster is a frequent accident even in the best-regulated nurseries, which upsets both the drinking vessel and the nurse. To obviate this inconvenience, there has been devised an infant's safety cup, which renders the contents practically unspillable. The device consists of a resilient cap fitted over the top of the vessel, having at the edge an opening, at which point the child drinks. But should he knock over the cup, a flap prevents the liquid from escaping.

Flat Iron with Legs

THE industrious housewife will hail with delight an appliance which will reduce the annoyance of washing day. The object of this invention is to guard against the sad experience of placing a too hot iron upon material and burning it. There has recently been devised a flat iron furnished with legs, upon which it can stand when not being employed for ironing. The legs are brought into use by a slight pressure of the finger or thumb.

Overhead Garage Door

FROM the fertile brain of an American has emanated the idea of a garage door which opens outwardly and upwardly until it attains a horizontal position. Whether it formed part of the original design of the inventor, I cannot say, but such an arrangement will at least afford an extension of the roof.

Advertising on Rails

A RECENTLY accepted British patent application is for means to utilise the hand rails of escalators as a medium for advertisements, or for imparting information to passengers. For this purpose, the devisor proposes the use of a rubber, cellulose or other water-proof solution coated on its face with a clear varnish or lacquer, as a protection against dirt and defacement. This can be removed from the hand rail by a suitable solvent. If desired, the rail may be constructed hollow and a means of illumination placed within it.

DYNAMO.

PRACTICAL MECHANICS Replies to Queries and 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.

SILVERING A MIRROR

"I WISH to silver two pieces of glass each 18 sq. in., one piece in black silver and the other in copper silver. Could you tell me what chemicals to use, and the best method of performing the task?" (W. R., Liverpool.)

THERE are several methods of silvering glass, and each method has its own advantages. The formalin method of silvering is about the best for most purposes.

To work this method, take 20 or 25 grains of silver nitrate and dissolve it in about an ounce of *distilled* water. This represents the stock solution. It should be kept in the dark.

To make the silvering bath, take approximately 2 drachms of the above stock solution, and add liquid ammonia solution to it *drop by drop* until the white precipitate which first forms JUST dissolves. At this stage, add to the solution 2 oz. of *distilled* water.

In a separate vessel place 70 to 80 drops of commercial formalin solution (approximately 40 per cent. strength). Then pour into this vessel the silver solution to which the ammonia has been added, and finally pour the mixed solutions into a clean glass or porcelain vessel in order to ensure thorough mixing. The solution is now immediately poured over the glass to be silvered. A silver mirror is deposited almost immediately, after which the solution should be poured away, the mirror well rinsed in clean cold water, allowed to dry slowly and then varnished on the back.

Success in silvering is dependent upon the correct mixing of the solutions, and also upon the cleanliness of the glass surface. The glass to be silvered should, first of all, be washed with soap and water. It should then be rubbed down with a paste made of whiting and water, and finally it should be washed over with weak nitric acid, this treatment being followed by a thorough washing with *distilled* water in order to ensure the perfect cleanliness of the glass surface. The vessels used for the preparation of the silvering solution must also be perfectly clean. It would be advisable, moreover, for you to make a few preliminary trials at the silvering of small pieces of glass before you attempt the silvering of 18-sq. in. glasses.

By your terms "black" and "copper" silver, we believe that you imply the character of the backing which is usually placed on commercially silvered mirrors. These are usually electrolytically deposited layers of silver or copper, which are placed over the mirror layer of silver in order to protect the latter. They can be formed by placing the mirror in a silver or copper plating bath.

EXPERIMENTING WITH CARBON DIOXIDE

"AN interesting article in 'Practical Mechanics' has prompted me to perform an experiment for which I need the following data:

"1. At what temperature does solid carbon dioxide evaporate at atmospheric pressure?

"2. What would have to be the pressure upon it so that it would remain solid at 15° C.?

"3. What is the density of solid carbon dioxide?" (R. T., Sussex.)

SOLID carbon dioxide evaporates at all temperatures above −78° C. under atmospheric pressure, its evaporation being slow. If, by this particular query, you wish to know the lowest temperature which can be produced by the evaporation of solid carbon dioxide, this is −110° C., this temperature being produced by the evaporation of a solution of solid carbon dioxide in ether under atmospheric pressure. Evaporated alone, solid carbon dioxide will lower the temperature of its surroundings to about −60 to −70° C.

At 15° C. carbon dioxide would not remain solid. Under pressure it would be converted into liquid carbon dioxide, which would require, at this temperature, a pressure of approximately 52 atmospheres to retain it in that state.

The density of solid carbon dioxide varies according to the physical condition in which it is prepared and, with the pure material, it has not been accurately determined. Write to Imperial Chemical Industries, Millbank, London, S.W.1, who will give you any density-determination figures which may have been made upon their solid carbon-dioxide product "Drikold."

OIL FROM PEPPERMINT LEAVES

"COULD you please tell me how to extract the essential oil out of peppermint leaves, etc.?" (H. L., nr. Huddersfield.)

TO obtain peppermint oil, collect the fresh leaves of the plant just before the flowers begin to open. Allow the leaves to dry in the air for three or four days, turning them over frequently. They are then placed in a still and heated up with water. Water and peppermint oil distil over, the latter being separated from the water and then redistilled. About 10 lb. of the pure oil are normally obtained from one ton of the leaves and flower tops.

Advisory Leaflet No. 98 of the Ministry of Agriculture and Fisheries deals with the subject of *Peppermint, Its Cultivation and Distillation*. It can be obtained, price 1½d. post paid, from H.M. Stationery Office, Adastral House, Kingsway, London, W.C.2.

Turn to Cover III for interesting information about advertisers' latest catalogues.

REPLIES in BRIEF

E. A. M. (Oxhey).—It is not clear whether you require a 5 amp or a ·5 amp resistance. For the former you will require $\frac{3}{8}$ lb. of 20-gauge Eureka wire, and for the latter $\frac{1}{2}$ oz. of 36-gauge Eureka wire. The former is suitable for operation on 180 volts at 5 amps, resistance being 36 ohms. In the latter case it would be 360.

R. B. (Littleborough).—It would be difficult to state exactly, without examining the apparatus, what caused the burner to fracture. It is most probable that the new voltage is too high, and hence the tube may be heating up faster than normal, or you may have been overloading the tube and heating the sealed-in wires. The trouble at the moment is caused by the crack, since there must be a vacuum in the tube, and it seems that this has failed. You will get a spark on starting, but this will flash out as the distance is too great. Your only plan is to return the bulb to the maker and see if it can be repaired.

A. J. C. (Co. Dublin).—The telephone would be quite suitable in the circumstances you name. Insulated wire must be used.

(P. S. Cornwall).—American whitewood may be used in place of Balsa.

No Name (Oldham).—When a rocket such as you suggest gets into space, internal pressure would tend to increase the volume. Your query is not clear.

W. J. B. (Manchester).—We hope to publish the article you require in an early issue.

R. J. B. (Hertford).—The circuit details are patented and you would therefore not be able to use it. Further information is probably obtainable from The Electronic Musical Development Co., 52 Bunhill Row, London, E.C.1.

T. M. (Waterford).—It is against our rules to publish addresses. If you will let us have a stamped addressed envelope, we shall be glad to send you the address of the manufacturers.

H. R. (Manchester).—We have several times described how to make shocking coils from electrical bells. The idea is as old as the proverbial hills. Devices such as you require, made from electrical bells, are described in *Simple Electrical Apparatus*, obtainable at 1*s*. from any bookstall, or by post 1*s*. 2*d*. from Geo. Newnes, Ltd., 8-11 Southampton Street, Strand, W.C. Many thanks for your suggestion.

S. D. (Navan).—You omitted to enclose a coupon or stamped addressed envelope. We recommend you to study the small handbook on the subject published by Messrs. Percival Marshall & Co., Ltd., 13 Fisher Street, London, W.C.1.

C. D. (Penge).—So called silver paper is usually aluminium, but it could be an alloy of tin, also pure tin and lead. Methods of making toy bombs were described in a past issue, a copy of which can be sent to you for $7\frac{1}{2}d$. We do not recommend making them in glass bulbs. The only papers which deal with the advertisements you require are the daily papers. Your coupon was out of date; you should be able to obtain the February number.

No Name (Scunthorpe).—You did not append your name, nor enclose a stamped addressed envelope. We do not publish addresses. Let us have your name and we shall be glad to trace the information you require.

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Advertiser	Page No.	Information Required

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TOOLS

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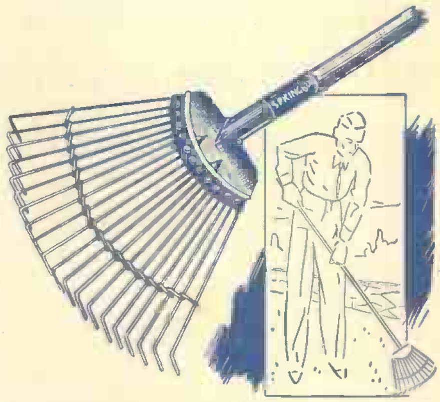

This device, known as a rake-brush, is suitable for weeding lawns and sweeping up dead leaves. It should prove an efficient tool for the gardener.

tool is a great ally in the better-lawns campaign. The flexible spring steel teeth clinging closely to the ground, conform to the irregularities of the surface, and remove moss without disturbing the roots of the grass. For collecting up dead leaves and rubbish, this feather-weight tool will be found to be just the thing. Made in 40 in., 20 in., and 10 in. spans, they are supplied complete with handle for 15*s*., 5*s*. 6*d*., and 5*s*. respectively. They are sent carriage paid. [187.]

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PRACTICAL MECHANICS, MARCH, 1936

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