WONDERS OF THE "QUEEN MARY"

NEWNES

PRACTICAL MECHANICS

MAY

6D.

OUR £20 CAR—

Completing the Chassis

This useful Book is published at **2/6**

TO-DAY IT IS FREE TO YOU

THE HUMAN MACHINE

(Secrets of Success)

It teaches you—How to Memorise . . . Self-Confidence . . . How to Develop Personality . . . How to Think . . . But you cannot earn money by thinking how to think. You must *do something. You must study your job.*

Send for Free Particulars of the Course that interests you and at the same time ask for a free copy of the Human Machine.

NOW IS YOUR CHANCE TO GET INTO A SKILLED KEY POSITION

IF SO, YOU MAY BE THE ARTIST THAT COMMERCE IS WAITING FOR.

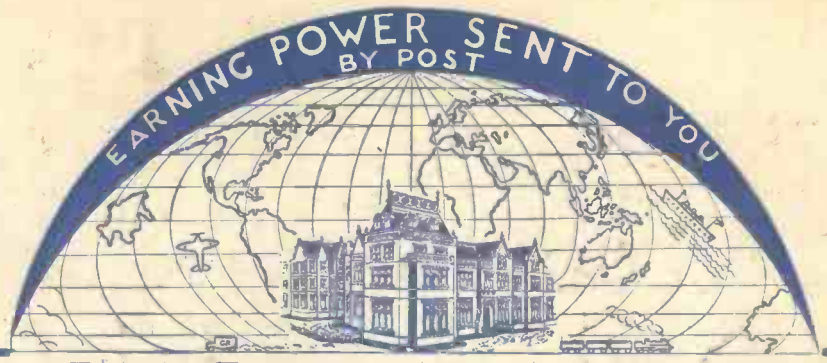
Just try it for yourself, trace or draw the outline and then put in the features.

Jim Duck

There are hundreds of openings in connection with Humorous Papers, Advertisement Drawing, Posters, Calendars, Catalogues, Textile Designs, Book Illustrations, etc.

60 per cent. of Commercial Art Work is done by "Free Lance Artists" who do their work at home and sell it to the highest bidders. Many Commercial Artists draw "retaining fees" from various sources, others prefer to work full-time employment or partnership arrangement. We teach you not only how to draw what is wanted, but how to make buyers want what you draw. Many of our students who originally took up Commercial Art as a hobby have since turned it into a full-time paying profession with studio and staff of assistant artists; there is no limit to the possibilities. Let us send full particulars for a **FREE TRIAL** and details of our course for your inspection. You will be under no obligation whatever.

Jim Duck **Art Dept. 76.**



STUDY AT HOME IN YOUR SPARE TIME

OPEN LETTER TO PARENTS

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

J. H. Bennett

YOU CAN HAVE A COLLEGE TRAINING IN ALMOST ANY CAREER FOR A FEW SHILLINGS MONTHLY

- Accountancy Examinations
- Advertising and Sales Management
- A.M.I. Fire E. Exam.
- Applied Mechanics
- Army Certificates
- Auctioneers and Estate Agents
- Aviation Engineering
- Banking
- Boilers
- Book-keeping, Accountancy and Modern Business Methods
- B.Sc. (Eng.)
- B.Sc. (Estate Management)
- Building, Architecture and Clerk of Works
- Cambridge Senior School Certificate
- Civil Engineering
- Civil Service
- All Commercial Subjects
- Commercial Art
- Concrete and Structural Engineering
- Draughtsmanship. All branches
- Engineering. All branches, subjects and examinations
- General Education
- G.P.O. Engineering Dept.
- Heating and Ventilating
- Industrial Chemistry
- Insurance
- Mathematics
- Matriculation
- Metallurgy
- Mining, all subjects
- Mining, Electrical Engineering
- Motor Engineering
- Motor Trade
- Municipal and County Engineers
- Naval Architecture
- Pattern Making
- Police, Special Course
- Preceptors, College of
- Pumps and Pumping Machinery
- Radio Service Engineering
- Radio Communication
- Road-Making and Maintenance
- Salesmanship
- Sanitation
- Secretarial Exams.
- Shipbuilding
- Shorthand (Pitman's)
- Structural Engineering
- Surveying
- Teachers of Handicrafts
- Telephony and Telegraphy
- Transport Inst. Exams.
- Weights and Measures Inspector
- Welding
- Wireless Telegraphy and Telephony
- Works Managers

If you do not see your own requirements above, write to us on any subject.

HOW TO STUDY

In your spare time when it suits YOU. You fix your own time, you do not GO to your studies—the postman brings THEM TO YOU. There is nothing that a class-room teacher can show on a blackboard that we cannot show on a white paper. The lesson on a blackboard will be cleaned off, but our lessons are PERMANENT. A class-room teacher cannot give you a private word of encouragement, but a Correspondence Tutor can do so whenever your work deserves it. On the other hand he can, where necessary, point out your mistakes PRIVATELY.

TO STUDENTS LIVING ABROAD

or on the high seas, a good supply of lessons is given, so that they may be done in their order, and despatched to us for examination and correction. They are then sent back with more work, and in this way a *continuous stream of work* is always in transit from the Student to us and from us to the Student, therefore distance makes no difference.

IT IS THE PERSONAL TOUCH WHICH COUNTS IN POSTAL TUITION

EVERY DEPARTMENT IS A COMPLETE COLLEGE EVERY STUDENT IS A CLASS TO HIMSELF

Dept. 76, THE BENNETT COLLEGE, SHEFFIELD.

Practical Mechanics

VOL. III. No. 32
MAY
1936

Edited by F. J. CAMM

SUBSCRIPTION RATES:
Inland and Abroad, 7s. 6d. per annum
Canada - - 7s. per annum

Editorial and Advertisement Offices: "Practical Mechanics," George Newnes Ltd., 8-11 Southampton Street, Strand, W.C.2.
Registered at the G.P.O. for transmission by Canadian Magazine Post.

Notes, News, and Views

A New European Car

IN the latest type of European car, the motor is housed at the rear, between the wheels it drives, whilst the steering wheels are placed at each end of the machine, giving considerable leverage for rapid manœuving. Thus there is one wheel in front, followed by two wheels on an axle, and a fourth wheel at the rear of the car.

"Seeing" the Invisible

WE learn that an artificial eye, which extends the range of human vision into the dark areas of "ultra-violet" and "infra-red," is now available for scientific use, and will undoubtedly be turned to many purposes of everyday life during the next few years.

A Private Aerodrome

IT is stated that a private aerodrome for the King is to be built in Windsor Great Park in the near future.

Semi-Streamlined Buses

OVER 220 new semi-streamlined buses are being put on to the Paris streets.

Fireproof Houses

THE latest development in fireproof houses is a flooring made of very light hollow steel beams, made by welding together steel plates.

A "Portable" Sailplane

A RUSSIAN inventor has invented a sailplane that can be folded and packed into a suitcase. Made of rubberised fabric, it inflates to a body 20 ft. long with a wing spreading 12 ft. either side. It is a glider, and will travel with the wind and float on water.

A Proposed Dirigible Design

A VEHICLE driven by a propeller drawing air through a lengthwise tube was recently demonstrated at the Kansas City airport, by T. M. Finley, who has attempted to interest the United States Government in his new design for constructing dirigibles. The vehicle weighs 5,000 lb. and the body is mounted on a V8 truck chassis. A speed of 47 m.p.h. has been attained, and the air speed through the tube has reached, so it is stated, a speed of 105 m.p.h.

Safe Parachute Jumps

TO accustom them to the sensation of falling through space, would-be aviators and parachute jumpers practise descents from a 130-ft. tower in New Jersey, America. The parachute is hauled to the top and then, with guide wires to keep it on its course, floats slowly down with the learner.

Something New in Wireless

C. ALEXTUINAS, a wireless expert, has just completed a pair of "transceiver" units weighing only 3 lb. Each unit is capable of transmitting a voice a distance of 2 miles at a frequency of 60 megacycles. The receiver and transmitter can be carried on a shoulder strap, and the power supply is self-contained.

Most Modern Tank in the World

A MODERN tank has been introduced into the Swedish army which is considered to be the most modern tank in the world. It can cover rough ground on chains or ride on the usual wheels, and the change-over operation is made with a switch and takes only 18 seconds. The speed on the chain ribbon is 25–30 m.p.h. and on the wheels 50 m.p.h.

A Streamlined Steam Engine

A NEW German streamlined steam engine, built by Henschel Wegmann, recently made its first trial run at Hamburg. It can attain a speed of 110 m.p.h., and can be driven both ways.

An All-metal Monoplane

AN ultra-high-speed two-seater medium bomber was recently tested out at Fairey's private aerodrome, near Hayes. It is an all-metal streamlined aeroplane fitted with a 12-cylinder Rolls-Royce "Merlin" engine, and although its speed is a "hush-hush" matter, it is thought that the speed is 300 m.p.h. at least.

A New Baby Car

MR. T. MURRAY JAMIESON, a Londoner, has designed a new baby racing car, which, shaped like a bullet, is capable of 120 m.p.h. It is little more than two-thirds the weight of a standard saloon.

Into the Stratosphere

CAPT. Z. BURZYNSKI, the winner of last year's balloon race for the Gordon Bennett Cup, proposes to attempt to reach the stratosphere in the balloon "Polonia."

Piccard's Next Attempt

PROF. PICCARD is also to make another ascent into the stratosphere towards the end of the summer. He hopes to ascend to a height of 30,000 metres.

A New American Airship

PLANS for constructing an American "twin" to the German airship "Hindenburg" are being considered in America.

Adrift in the Arctic

A SPECIAL wooden ship of 1,000 tons displacement and with 400-h.p. oil-burning engine, is being designed at the Arctic Institute in Leningrad, for drifting in Polar waters. It is expected to drift for four years during which scientific experiments will be carried out.

Experimental Atlantic Flights

THE De Havilland Aircraft Company are constructing a new fast air liner (D.H. 91) for experimental Atlantic flights.

A Speed Limit for Aeroplanes

WITH wings designed as at present, aeroplanes will be limited to a top speed of 575 m.p.h., according to a demonstration given in New York by a director of research of the National Advisory Committee for Aeronautics.

A Giant Reservoir

A GIANT reservoir, which will take seven years to construct and cost more than £2,120,000, is to be built for Tokio.

A Bosporus Tunnel

THE idea of building a tunnel under the Bosporus, linking Turkey in Europe with Turkey in Asia, is being considered.

A New Type of Lorry

A LORRY which has five pairs of wheels, so sprung that the chassis remains horizontal when climbing over obstacles, was exhibited at the Geneva Motor Show.

Five Miles Up

WE learn that two young Russian scientists—Romanov and Khvostnikov—recently reached an altitude of nearly five miles in their stratosphere balloon.

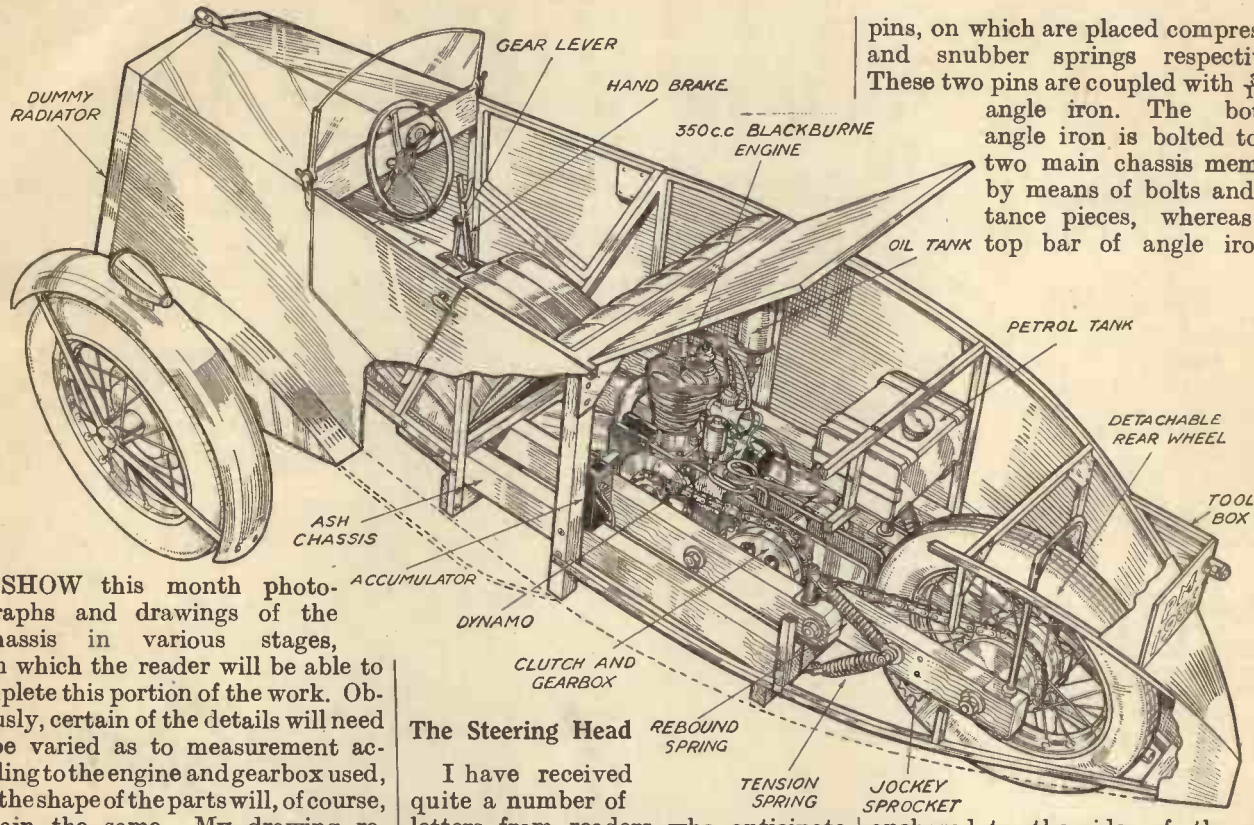
Gold in the Alps

DR. LUKAS WAAGEN, chief of the Austrian Geological Institute, has said that the Austrian Alps contain 25,600,000 tons of gold ore, from which it would be possible to extract gold worth £60,000,000.

OUR £20 CAR—3

In this Article, the Completion of the Engine and Gearbox Mounting, Steering, and Suspension is Dealt with.

By F. J. Camm



I SHOW this month photographs and drawings of the chassis in various stages, from which the reader will be able to complete this portion of the work. Obviously, certain of the details will need to be varied as to measurement according to the engine and gearbox used, but the shape of the parts will, of course, remain the same. My drawing relates to the 350 c.c. Blackburne engine and the Albion gearbox. In order to save readers trouble, the address of the former is Burney & Blackburne, Ltd., Atlas Works, Bookham, Surrey, and the latter, The Albion Eng. Co., Ltd., Upper Highgate Street, Birmingham, 12. The hubs for the two front wheels are obtainable from The British Hub Company, Ltd., Weaman Street, Birmingham, 4. When writing to them, mention the name of this journal so that they will be able to identify the parts in question.

The Steering Head

I have received quite a number of letters from readers who anticipate that they will have difficulty with the steering head. Accordingly, I have made arrangements with manufacturers for these to be supplied complete and ready for use and for a nominal sum; I have also made arrangements for my car to be on exhibition in some of the leading London stores, so that readers may inspect it and check their construction against mine.

This month I deal in detail with the steering. It will be noticed that the steering heads have top and bottom pins, on which are placed compression and snubber springs respectively. These two pins are coupled with $\frac{3}{16}$-in. angle iron. The bottom angle iron is bolted to the two main chassis members by means of bolts and distance pieces, whereas the top bar of angle iron is anchored to the sides of the main members, by means of pieces of tubing flattened at each end and bolted in position. Each end will, of course, need to be flattened and bent to the required angle, so that the parts fit snugly. They act as tie rods and resist the rocking motion which might result when the brakes are applied.

The Engine Plates

The two transverse cross-members in front of and behind the engine and gearbox are secured by means

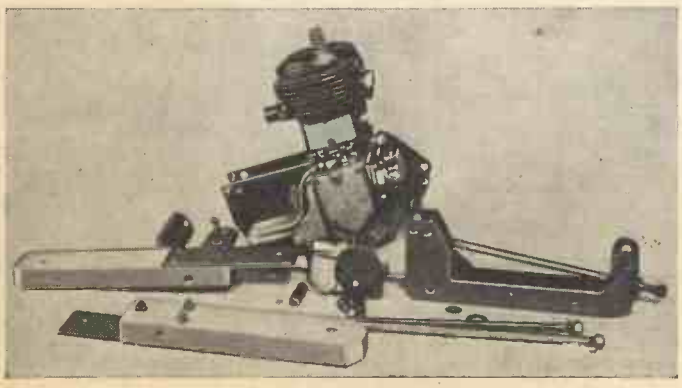


Fig. 1.—The engine, with the rear forks, engine plates, screwed anchoring rods.

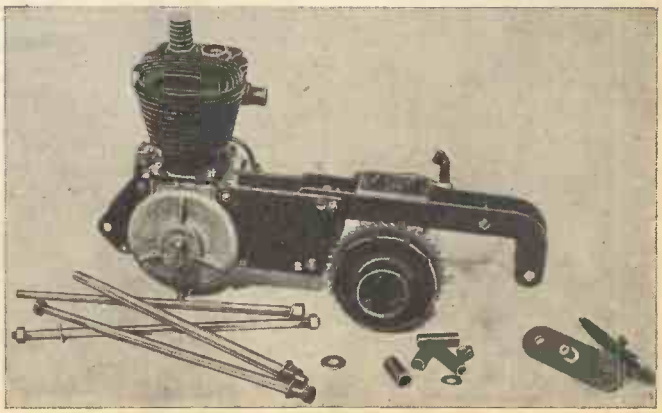


Fig. 2.—The engine plates fitted.

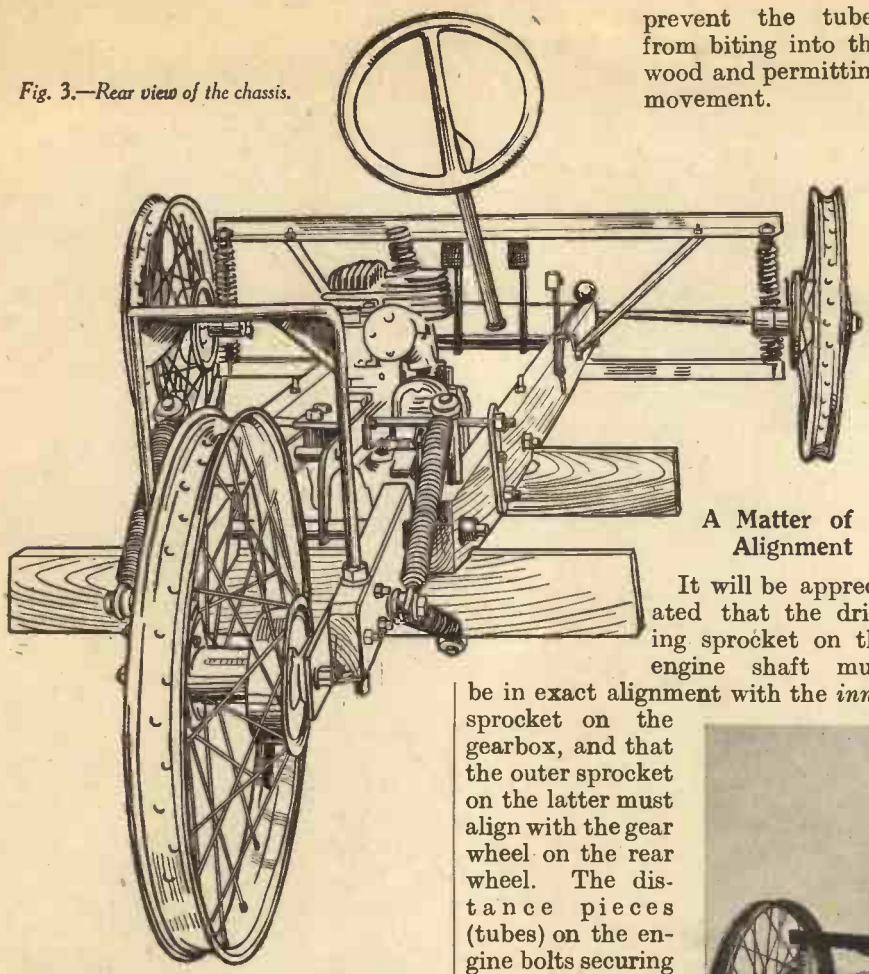


Fig. 3.—Rear view of the chassis.

of rods screwed at each end. Drawings for these various bolts are given, as well as for the engine plates. These are made from $\frac{3}{16}$-in. mild steel, and the photographs show their location. It will be seen that one long transverse rod passes through the front engine plate, and others behind the engine and behind the gearbox. The engine and gearbox sprockets are aligned and located by means of pieces of steel tubing which pass over the bolts, washers also being placed at each end, where they abut with the main wooden chassis members. The washers will prevent the tubes from biting into the wood and permitting movement.

A Matter of Alignment

It will be appreciated that the driving sprocket on the engine shaft must be in exact alignment with the *inner* sprocket on the gearbox, and that the outer sprocket on the latter must align with the gear wheel on the rear wheel. The distance pieces (tubes) on the engine bolts securing the engine to the chassis should be cut so that this alignment is secured. I stress this point because if the alignment is out, the chains will run off. The gearbox, it will be seen, has two short studs in the top of it, and these pass through a piece of $\frac{3}{16}$-in. mild steel with long holes (to permit of front chain adjustment as with a motor-cycle) and which bridges the two gearbox plates. By locking the nuts after the chain tension has been adjusted (the chain should be allowed to sag for at least $\frac{1}{2}$ in.), this plate will also secure the gearbox.

Long Bolts, Distance Pieces, etc.

Notice the position of the long bolts, distance pieces, and washers which secure the rear suspension, and observe also that two plates pass outside the body at the point where the rear engine plate meets the gearbox cradle plate. This is a somewhat lengthy description of what is in reality a straightforward piece of metal working. If you have not the dies and screwing tackle, I can let you have the address of an advertiser who will be able to supply you with the parts already cut to shape and length.

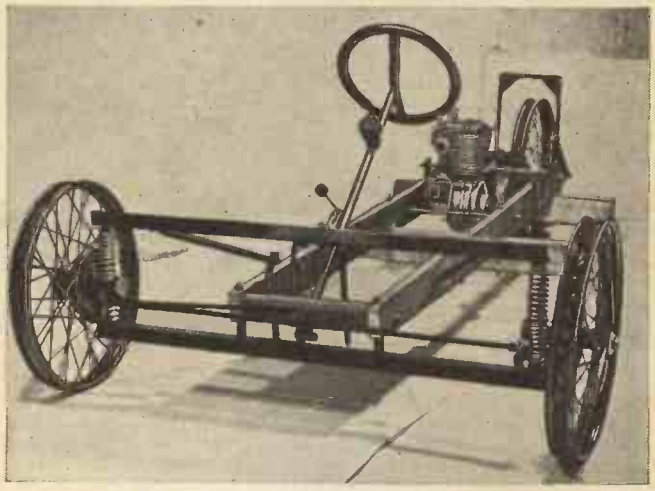


Fig. 4.—Front view with steering system fitted.

Last month I gave one method of anchoring the rear wheels to the rear forks. This month I give an alternative arrangement consisting of a flat

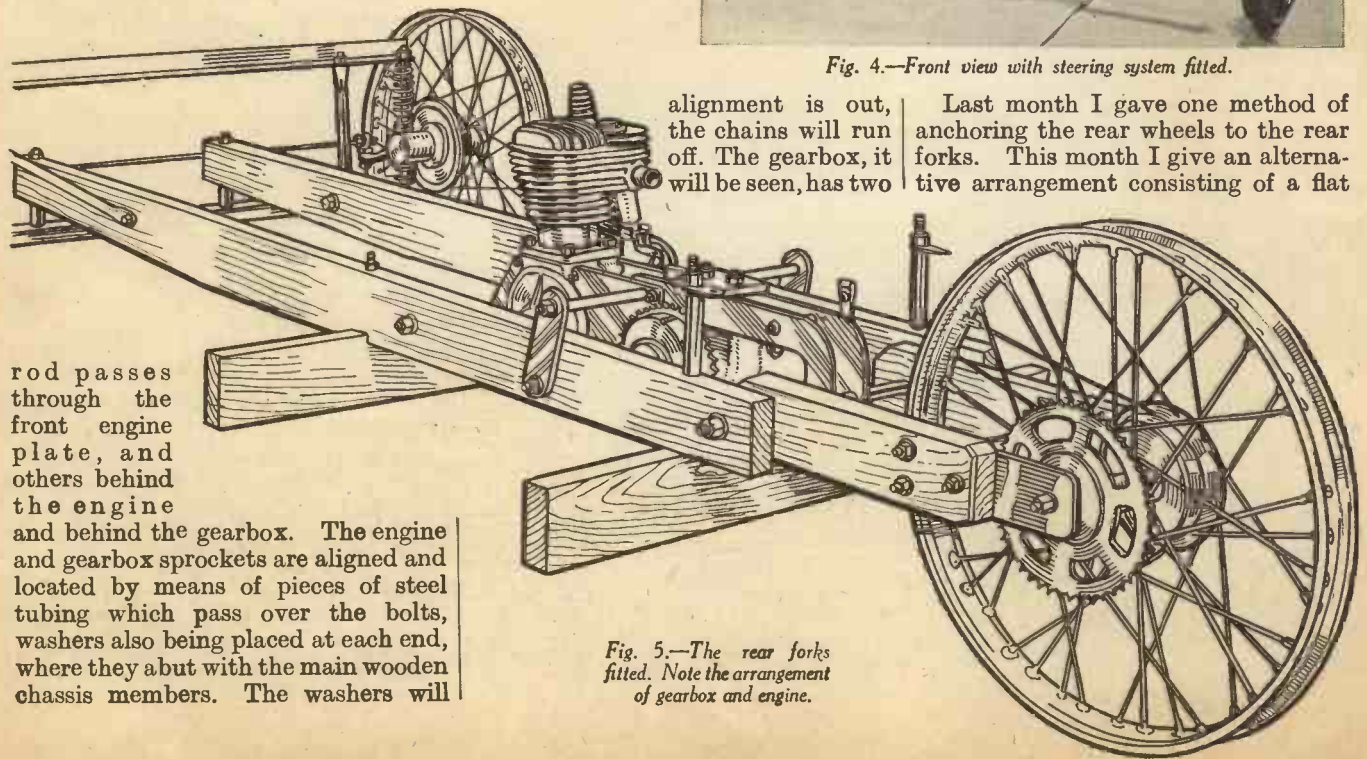


Fig. 5.—The rear forks fitted. Note the arrangement of gearbox and engine.

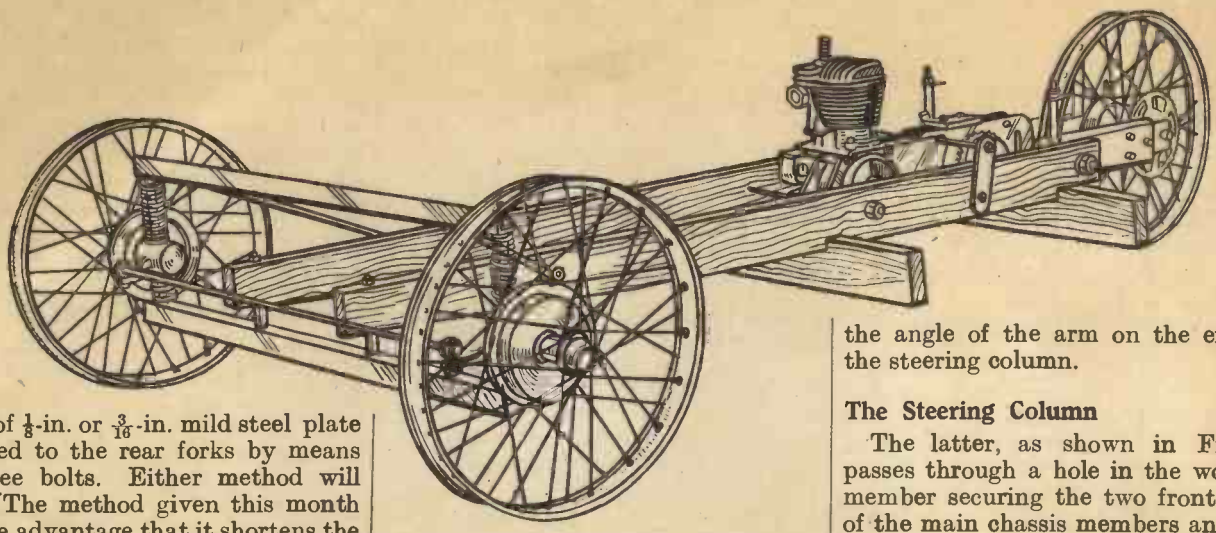


Fig. 6.—The chassis partly assembled.

piece of $\frac{1}{8}$-in. or $\frac{3}{16}$-in. mild steel plate clamped to the rear forks by means of three bolts. Either method will suit. The method given this month has the advantage that it shortens the amount of wood required. I show in one of the photographs the rear suspension attached. It will be appreciated that metal ears will be required for the forward end of the spring to attach them to the spring anchorages and that at the rear suitable spacing tubes and washers will be necessary to enable the springs to take up varying angular positions as the suspension comes into play.

The Tracking Rod

Reverting now to the steering system and front axle, it will be observed that the two arms on the steering head are coupled by means of a track rod, each screwed end of which passes through an eye attached to each arm. A drawing is given of these eyes. Steering is effected, as clearly shown in one of the diagrams, by means of a coupling rod, which by push-and-pull motion imparted by the movement of the steering wheel, turns the wheels to each lock. This coupling rod has, of course, turned-down ends which are either screwed and nutted or drilled for a washer and split pin. The turned-down ends will also need to be set to the requisite angle, that is to say, one end passes vertically through the steering arm on the steering head, and the other will need to be bent to coincide with the angle of the arm on the end of the steering column.

The Steering Column

The latter, as shown in Fig. 7, passes through a hole in the wooden member securing the two front ends of the main chassis members and has a locking collar secured by a tapered hinge. The driver's end of the steering column will eventually be secured to the dash by means of the bracket provided, and will have a similar locking collar to prevent end movement of the steering column. The push-pull steering rod can be attached to either the near-side or the off-side steering arm.

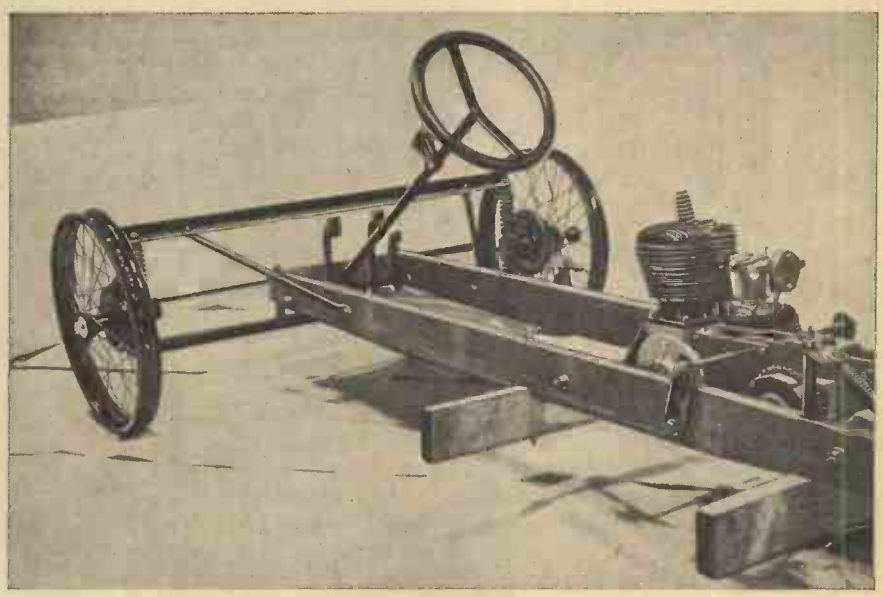


Fig. 7.—The steering, axle and tie rods and controls are clearly shown here

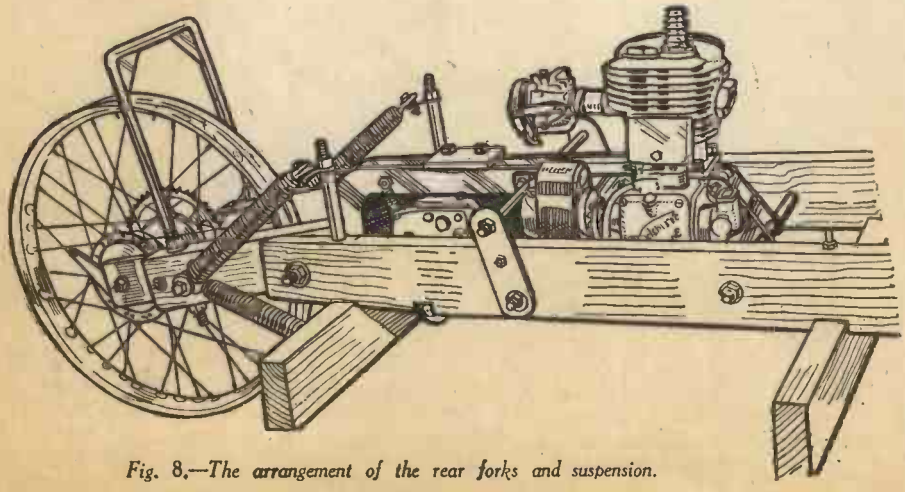


Fig. 8.—The arrangement of the rear forks and suspension.

The track rod should have a sufficient length of screwed portion at each end to enable the wheels to be toed in, that is to say, the distance between the wheels at the forward end should be about $\frac{3}{16}$ in. less than the distance between them at the rear. By means of the nuts on each side of the eye, this distance can be adjusted to a nicety.

The Brake Pedals

The three brake pedals are made from plate or can be purchased. They are secured to a rod passing through the two main members and are spaced by means of pieces of tube passed over

Fig. 9.—The first stage in assembling the front axle.

surface of the steel and copy the sizes from the diagrams and lightly centre-punch round the outline. Then drill a series of holes, breaking into one another outside this outline and file up to shape. Notice that you require two of each different shape of plates. When drilling them, each pair should be clamped together so that the holes coincide. Drill a small clearing hole before putting the correct size of drill through, this makes for a more accurate hole and relieves the task of drilling.

Ready-made Fittings

As I mentioned before, however, I can let readers have the name and address of manufacturers who will supply the various fittings ready made.

The total cost of £20, which I set as the limit, is on the high side, and will permit a certain amount of work being placed out, although actually there is nothing which is beyond the skill of an amateur. I have arranged everything for simple construction without sacrificing strength or efficiency, and have had in mind, of course, the amateur as distinct from the professional. The latter will, no doubt, adopt brazing, welding, and

the rod. A detail of the method of fixing is given.

The length of the steering column, which may be of 1-in. steel tube 20-gauge thickness, will depend upon your height. Before cutting it off to length, sit in the chassis and estimate the length. The steering wheel may be purchased from Messrs. Bluemels, Ltd., Wolston, near Coventry, and should be at least 12 in. in diameter. Although I have arranged for central mounting of the steering wheel, there is no objection to mounting it to one side. This arrangement of the steering is simple, eliminates the need for elaborate fitting, and perfectly satisfactory.

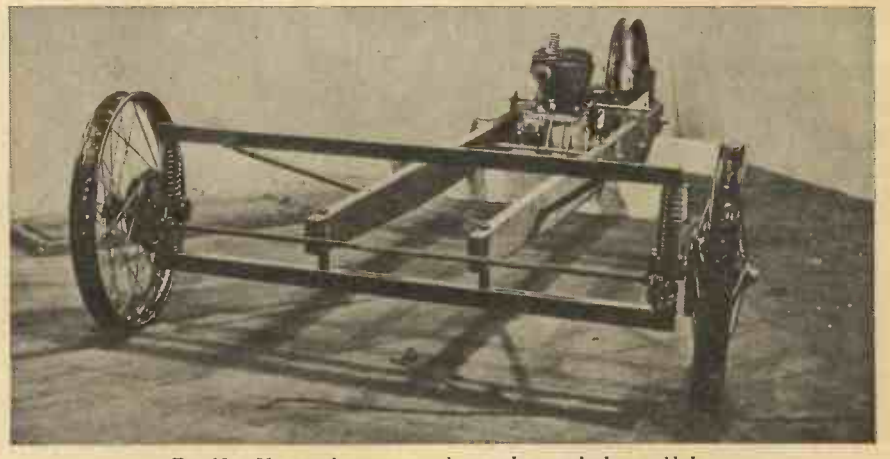


Fig. 10.—View with engine, gearbox, and rear wheel assembled.

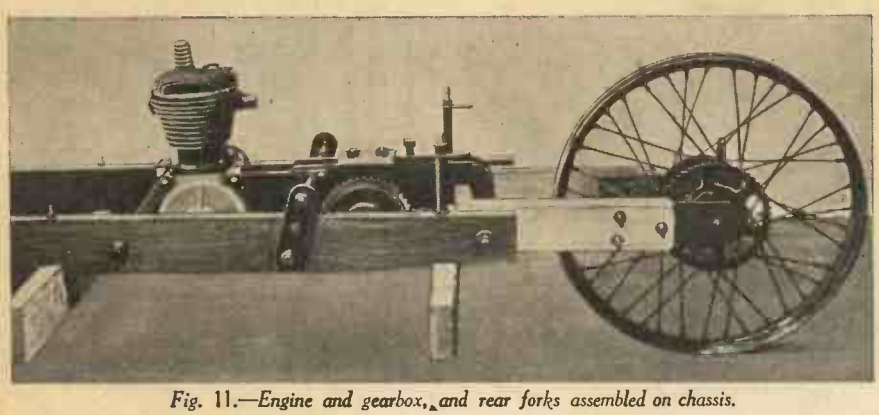


Fig. 11.—Engine and gearbox, and rear forks assembled on chassis.

In one of the illustrations I show the long U-bolt which connects the rear forks and keeps them in alignment. When this is attached and the rear spindle locked, the rear unit becomes a rigid structure.

Engine and Number Plates

Those bolts which secure the engine and gearbox rear suspension and rear forks should for preference be fixed with castellated nuts, and be drilled for split pins. This effectively prevents the nuts from working loose and hence obviates risks of lack of chain alignment.

A word about making the engine and other plates: chalk over the

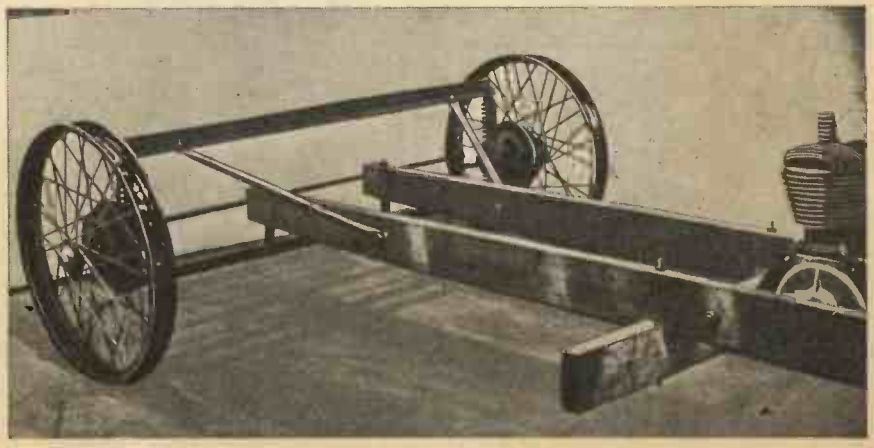


Fig. 12.—The tie rods securing upper member of front axle to the main chassis members.

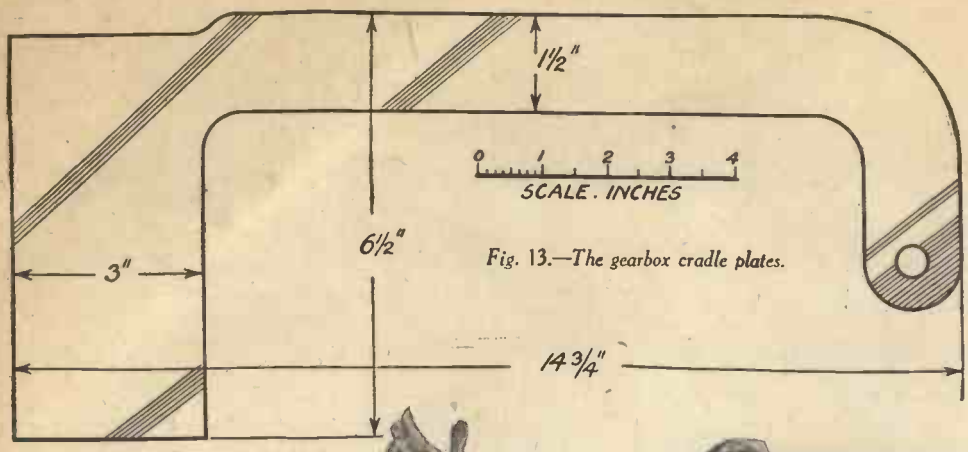


Fig. 13.—*The gearbox cradle plates.*

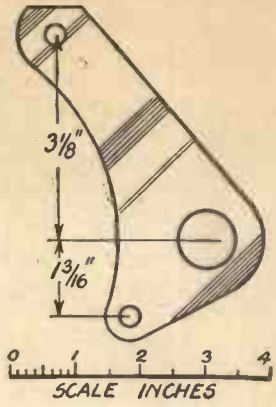


Fig. 14.—*Front engine plates.*

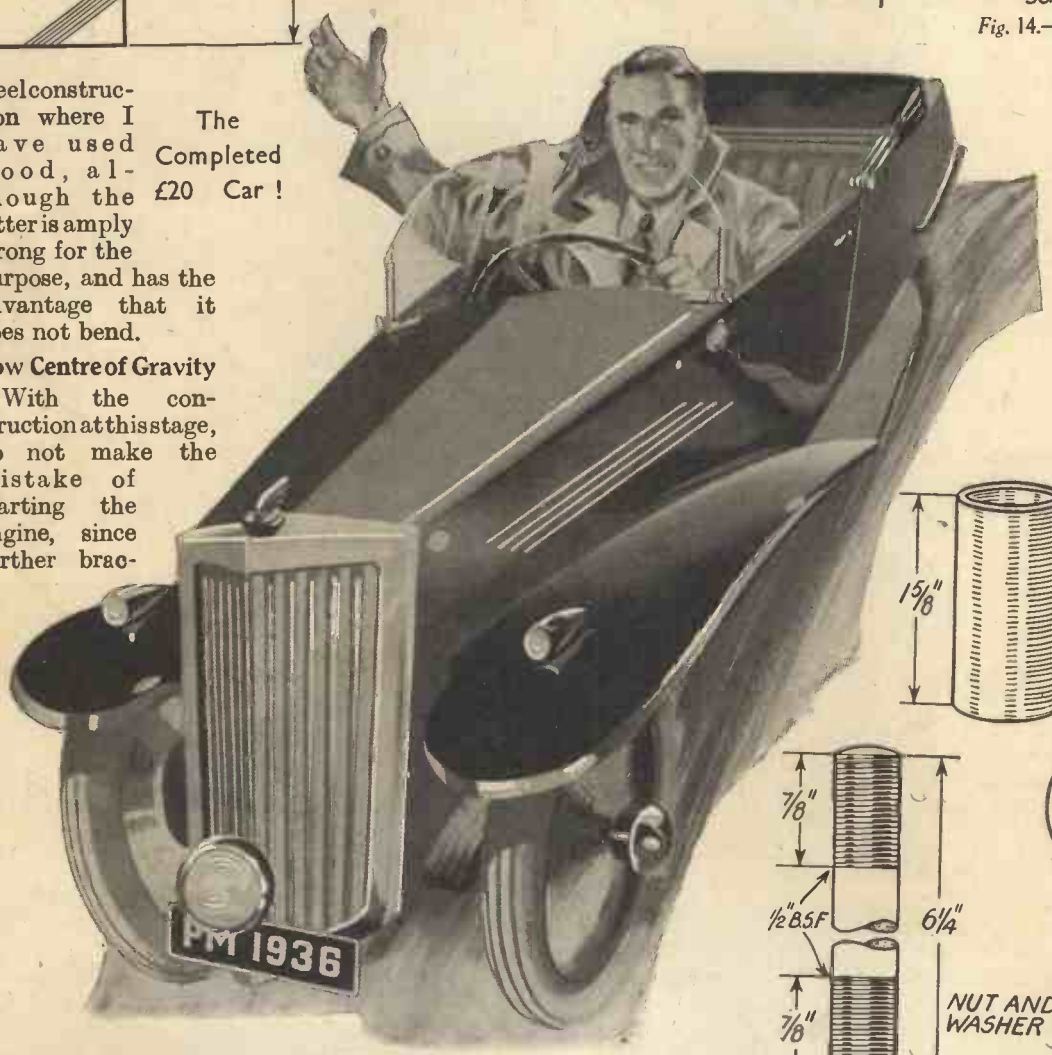
steel construction where I have used wood, although the latter is amply strong for the purpose, and has the advantage that it does not bend.

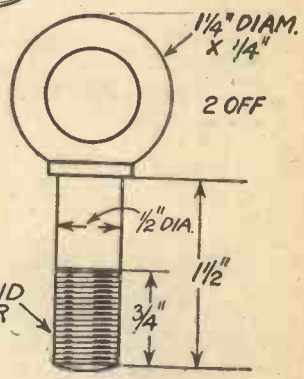
The Completed £20 Car !

Low Centre of Gravity

With the construction at this stage, do not make the mistake of starting the engine, since further bracing of the chassis is necessary to secure rigidity. Notice that the forward end of the chassis is covered underneath to provide pedal room and to keep the centre of gravity low.

Give all of the wooden parts a coat of lead colour or dead black and do not forget to smear all bolts with oil and to





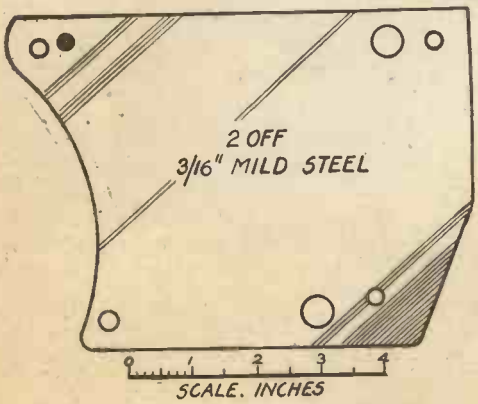


Fig. 15.—*Rear engine plates.*

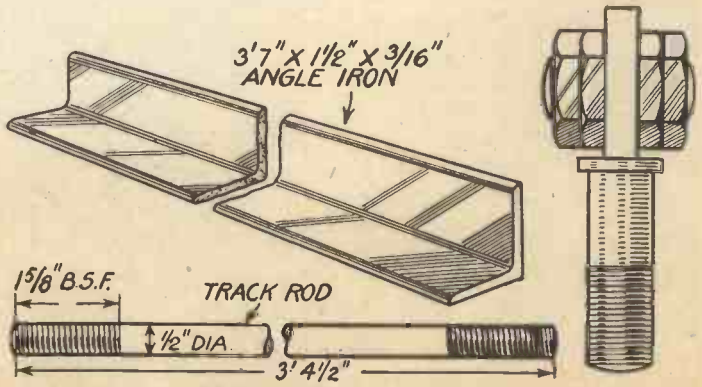


Fig. 16.—*The axle angle irons, track rod, bottom axle bolt and bush, and track-rod eyes and method of locking track rod in eyes.*

place a little graphite grease in all of the holes drilled in the wood. This will prevent rusting. The holes in the wooden part should be drilled of $\frac{1}{64}$-in. larger diameter than the bolts and rods, otherwise the cling of the wood may tend to grip them and prevent them passing through.

Chassis Members

Use bits of the Forstner type, and drill the chassis members whilst they are clamped together to ensure all of the holes being in absolute alignment. It is a good plan to mark out the chassis members on the floor with chalk, marking the position of all the holes which are clearly shown in the diagrams and photographs, and then to transfer these to the two main chassis members. This will make for easy assembly and quick erection.

Use engineers' bolts with accurately cut threads; these may cost a little more, but they are well worth it.

Braking System

I shall not deal with the braking or system of control, but shall devote special drawings and descriptions of these in the next issue. It is sufficient to say that the normal type of accelerator pedal with the usual throttle stop is fitted, that the foot brake operates the rear wheel brake, and the hand brake operates the two front-wheel brakes. It is not necessary, contrary to what I stated in the first issue, that the brakes should be coupled. The gear lever consists of the lever and gate as fitted to the tank of a motor-cycle and is mounted on the side of the chassis, as shown in one of the illustrations.

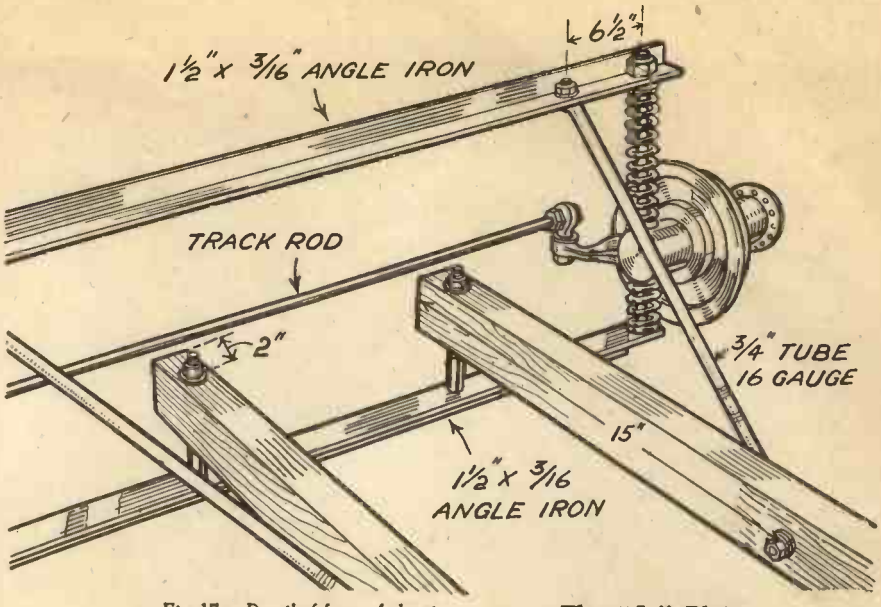


Fig. 17.—Detail of front of chassis.

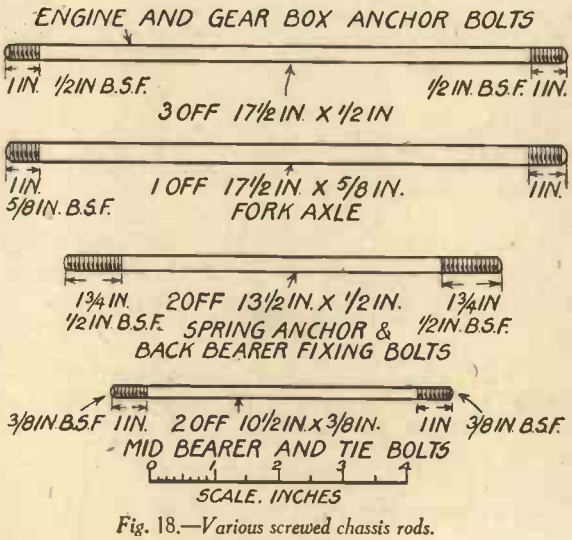


Fig. 18.—Various screwed chassis rods.

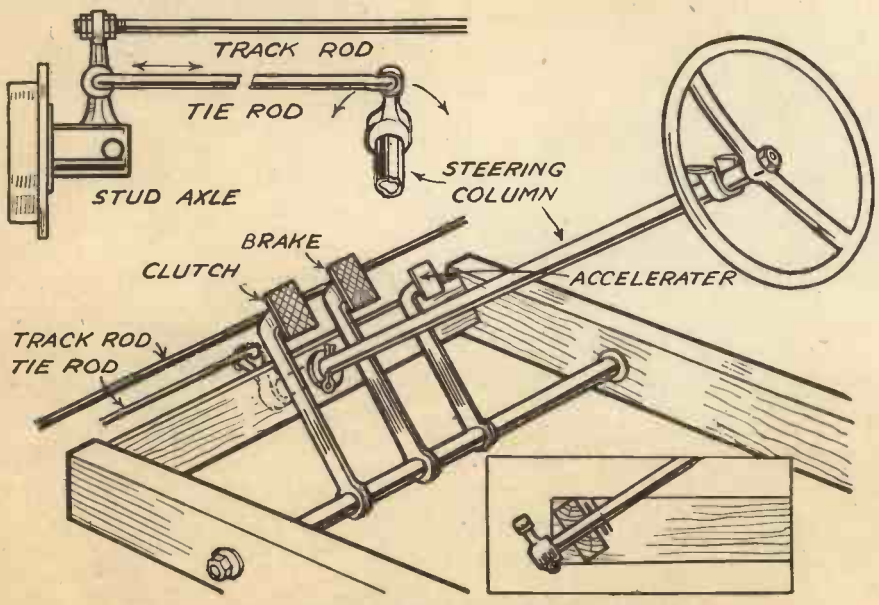


Fig. 19.—Arrangement of steering and controls.

The "L" Plate.

One or two readers have pointed out to me that as the official designation of a three-wheeler is that it is a motor-cycle, it is unnecessary for a beginner to be accompanied by a skilled driver when the former is learning to drive, although he must, of course, fit the "L" plate if he did not hold a motor-cycle driving licence prior to April 1934. This is so, and I gladly draw attention to it.

Several other readers wonder how they are to apply for registration. This must be done through the offices of the nearest County Council, and it must be registered as a car of your own make under the heading "Make of Car." You must give all details of the colour, where the car is garaged, and so on. Numbers will then be assigned to you which must be painted on according to the official regulations.

I shall give a drawing next month showing how to lay out the number plates.

The Driving Licence

If you are not old enough to apply for a licence to drive any motor vehicle, apply for a licence to drive a motor-cycle, providing you are of the age which entitles you to that. This will legally entitle you to drive a motor-cycle or a three-wheeler. It must be remembered that it will be necessary under the Road Traffic Act to take out a third party insurance policy, which may be effected through any insurance company.

Recording EARTHQUAKES

Fig. 1.—A view of a street in Quetta after the earthquake in May last year when over 30,000 persons were killed.

Various Causes below the Surface result in Heavy Stresses being placed on the Outer Crust of the Earth, thus causing what is Known as an Earthquake Shock

By G. R. M. GARRATT, M.A.

IT will perhaps be a surprise to many readers to learn that more than four hundred earthquakes have actually occurred within the British Isles during the past fifty years. Yet such is the case, and although many of them have been very small ones, quite a number have been felt over a wide area. More than three-quarters of the total number have occurred in Scotland, mostly at Menstrie near Stirling, and at Inverness, but widely different localities have been shaken at times. Such towns as Stafford, Derby, Swansea, Hereford, Carmarthen, Doncaster, and Colchester have all experienced quite severe shocks but fortunately, so far as I am aware, not one single life has been lost as the direct result of a British earthquake since the year 1580, when severe shocks were felt in London and an apprentice was killed by a stone falling from the roof of Christ Church in the City. London was shaken again on several occasions in the year 1750, and a number of houses were destroyed, fortunately without loss of life.

The Seismograph

Such earthquakes as we experience in England are very moderate affairs compared with the disastrous and destructive shocks which are felt elsewhere—India, Italy, Japan, and among the islands of the Pacific—and when they occur near thickly populated areas, there is sometimes terrific loss of life. Only last May, 30,000 people lost their lives in Quetta, the whole city was destroyed, and more than £6,000,000 will be required to rebuild it.

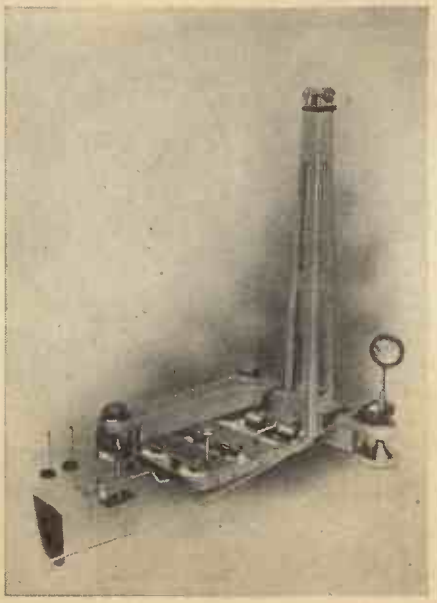


Fig. 2.—A close-up view of the pendulum and column. The pendulum itself is supported by two thin steel wires from a point near the top of the column.

The study of earthquakes by means of delicate instruments known as Seismographs has taught us more than any other method about the interior construction of the earth. It has shown, for example, that the earth is solid to a depth of about 2,000 miles, and that below this depth it is liquid.

To experience a really bad earthquake is a terrifying ordeal. Generally, there is heard a low rumbling sound for a few seconds, though the note is so low as to be inaudible to many ears. Then a terrific jolt is felt, followed by a violent rocking motion. Sometimes a brief pause occurs, and then the rocking motion is renewed even more violently before quiet conditions are once more restored after a lapse of perhaps a minute.

The Main Focus of the Shock

An earthquake is generally due to a "fault" below the surface. Various causes result in tremendous stresses being applied to the rocks and strata which form the outer crust of the earth, and sometimes these stresses beeome so great that a sudden break or slipping occurs. The quantity of matter which may thus be suddenly displaced is immense, and may amount to several cubic miles. The energy which is thus released is incalculable. Much of it is converted into wave motions which travel for thousands of miles through the earth.

The actual fault does not generally take

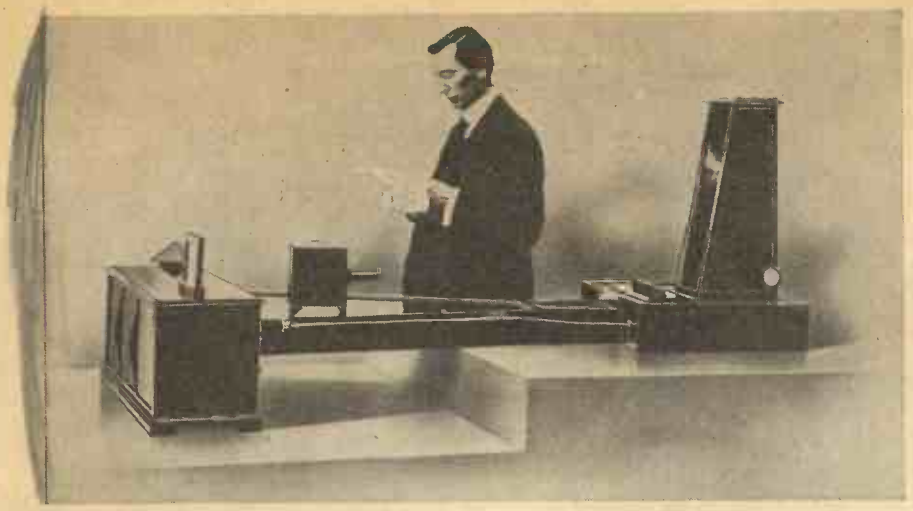


Fig. 3.—A Milne-Shaw seismograph. This is one of the most common forms of seismograph used for recording very distant earthquakes.

place on the surface, but may be at a considerable depth, although the shock is obviously most severely felt at the "epicentre" or surface lying immediately above the main focus of the shock.

An earthquake shock gives rise to three distinct types of wave, which travel outwards in all directions from the focus, and it is by virtue of the fact that these waves travel at different speeds that we can estimate the distance of a shock from the records of a seismograph. The first type of wave, known as the P or primary wave, is a longitudinal motion, corresponding with a push-and-pull in all directions from the focus. This wave travels at a speed varying from 4½ to 8½ miles per second, depending on its depth. The second type of wave, which is known as the S or secondary wave, is a transverse or side-to-side motion. It can only be transmitted through solids and travels with a velocity between 2½ and 5 miles per second according to the depth.

A Surface Wave

The third type of wave is known as the long, or surface wave and, as its name implies, it travels only over the surface of the earth—at a constant speed of 2·4 miles per second. Although the surface wave travels by the longest route, it is always the strongest as indicated by the records of a seismograph. Sometimes it is only the surface waves which are recorded at all after a distant earthquake when the primary and secondary waves are so weak as to disappear altogether before reaching the recording station.

Considering the Quetta earthquake of last May, let us follow the path of the waves as they travel outwards until they are received by a seismograph in London—such as may be seen at the Science Museum, South Kensington. The primary waves travel the fastest, and exactly eleven minutes and seven seconds after the commencement of the shock, the first of these waves will disturb the delicate pointer of the seismograph, which will continue to oscillate as further primary waves are received.

At the moment when the first primary wave is reaching London, the first of the secondary waves is barely half-way on its journey and will actually be at a depth of about one thousand miles beneath the surface of Eastern Turkey. The first secondary wave will reach London just twenty minutes and twenty-six seconds after the first shock, or nine minutes nineteen seconds after the arrival of the first primary wave.

Primary and Secondary Waves

The secondary waves are generally of greater amplitude than the primaries, but although it is usually fairly easy to distinguish between the primary and secondary waves on the record, it is not always easy to pick out the *exact* instant at which the first secondary is received, and if one wants to ascertain the distance of the site of the shock, it is important that the first secondary wave should be accurately identified.

The pointer of the seismograph will continue to record the oscillations of the succeeding primary and secondary waves until, almost thirty-four minutes after the first shock, the pointer will commence to make wider and longer swings, showing that the surface waves have begun to arrive. The surface, or long waves, as they are generally termed, are always the most powerful, but it is often difficult to detect the moment when the first ones arrive. In a small earthquake occurring at a considerable distance, it is often only these long waves which are received and it is then neither possible to estimate the distance of the shock nor to learn anything very definite about it.

One of the most remarkable discoveries was made as the result of investigations of the records of earthquakes at distances of more than 8,000 miles. The primary and secondary waves from an earthquake at such a distance, penetrate through the earth to a depth of about 2,300 miles on their way to the observing station, and it was noticed that a secondary wave is never received from a shock more than 8,000 miles away. It was this fact which gave the first definite proof that the inner core of the earth was a liquid because the transverse secondary waves cannot be transmitted through a liquid.

Different Types of Seismograph

Having seen how the waves travel from India to London, let us examine the instrument upon which they are recorded. There are many different types of seismographs, but the fundamental principle is the same in all, and they differ only in mechanical arrangement and detail. The essential feature is that some part of the mechanism shall remain motionless while the ground and the rest of the instrument are disturbed by the seismic waves. Then, by connecting a magnifying lever between the stationary point and some part which is moved by the earth waves, it is possible to obtain a magnified record of the ground movements. The great difficulty in the construction of a seismograph is to arrive at an arrangement which produces a satisfactory stationary point.

Almost all seismographs adopt the principle of the pendulum, and the simplest possible form of seismograph consists of a simple pendulum with a pencil fixed to the heavy bob at the bottom. We may imagine that a sheet of paper is so fixed beneath the pendulum that the pencil draws a pattern on the paper when the earth is moved by the waves of an earthquake. Unfortunately, such a simple instrument is not sufficiently sensitive because the earth movements due to a distant earthquake are extremely minute. Also, the waves generally have a long "period"—that is to say that the time interval from the crest of one wave to the next is usually of the order of several seconds, and if the pendulum bob is to remain virtually motionless, it is obvious that the pendulum itself must have a swing period greatly in excess of the longest period we want to record. If the period of the pendulum is short compared with the period of the earthquake waves, the bob has time to follow the movement of the support, and no motion is recorded on the paper. Unfortunately, a simple pendulum having a period of only ten seconds must be nearly 80 ft. long—a somewhat unwieldy object. We therefore use another device for giving the pendulum a long period—by making it swing about a nearly vertical pivot to which

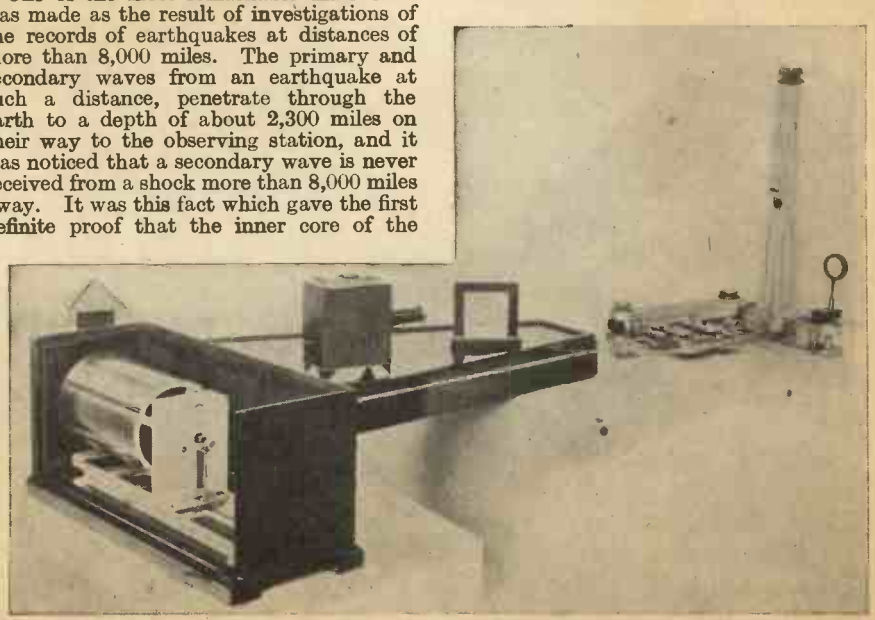


Fig. 4.—The seismograph, with covers removed. The pendulum may be seen supported by the pillar on the right, while the recording apparatus is shown in the foreground.

it is hinged, rather like a farmyard gate. The support must not be exactly vertical, otherwise the instrument would remain at rest in any position, but with a small inclination we can make the period as long as we like and periods of about ten seconds can conveniently be obtained with "booms" only 8 in. long.

The Milne-Shaw Type

The Milne-Shaw type of seismograph is the most common in general use. The supporting frame of the pendulum consists of a vertical iron pillar which is cast in one piece with a triangular bedplate supported on three levelling screws which rest on a block of stone or concrete embedded in the ground. The pendulum boom is a light rod of aluminium about 16 in. in length and at the inner end it is fitted with a steel knife edge which presses against an agate cup fixed to the supporting pillar.

The mass, or bob, of the pendulum consists of two weights, each having a mass of about half a pound. These are fixed to the boom and just beyond the weights is a thin steel wire which supports the boom from a point at the top of the pillar. Sometimes a double supporting wire is used, ending in a thread of unspun silk at the top.

We have now got a sensitive horizontal pendulum, and by levelling the instrument to bring the supporting points nearly vertical we can make the period as long as we please. Unfortunately, there is another difficulty which must be overcome. If we make the period very long the pendulum will have little tendency to settle in any definite position and its zero position will tend to change. As a compromise, therefore, the period must be limited to about twenty seconds, but such a short period inevitably means that the motion of the earthquake wave imparts a certain motion to the pendulum itself and it is necessary to introduce a device to damp the resulting oscillations of the pendulum so that it rapidly returns to its zero position. The damping of the pendulum may be accomplished in a variety of ways: either by attaching to the pendulum a small vane which dips in a vessel of oil, or by fitting a copper sector to the pendulum in such a manner that the copper sector passes through a powerful magnetic field. It is the latter system which is used in the Milne-Shaw instrument. When the pendulum swings, the magnetic field induces currents in the copper sector which react with the magnetic field in such a way as to oppose the motion of the pendulum and so "damp out" the oscillations.

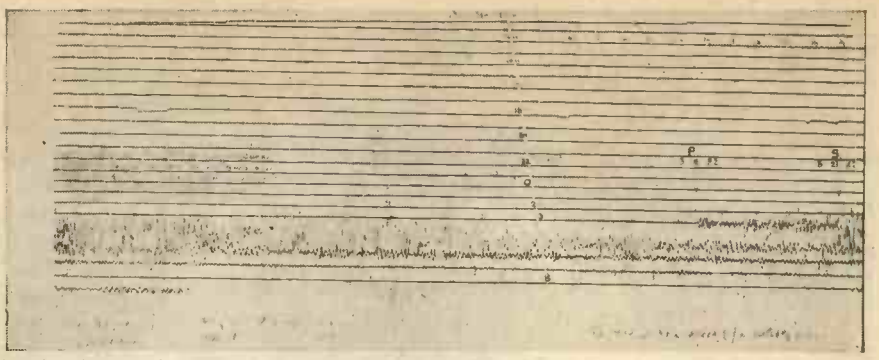


Fig. 6.—A record of the Tokio earthquake of September 1st, 1923. This was a very large shock, and although the times of the P and S waves can be picked out as shown on the right, the first of the long waves is indistinguishable.

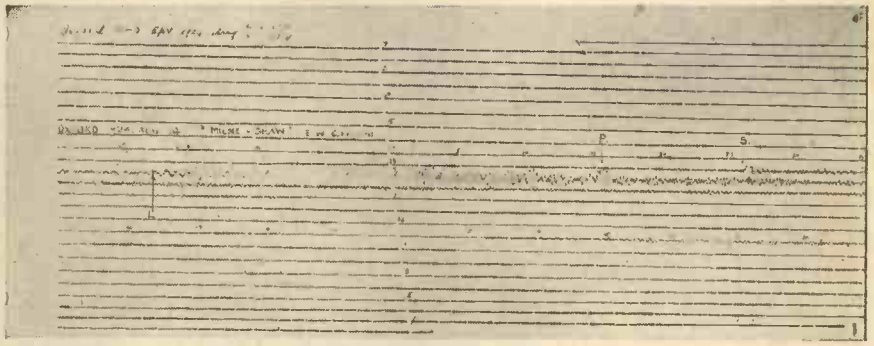


Fig. 7.—This is a record of a smaller Japanese shock in which the beginning of both the primary and secondary waves is very well marked. The time interval between the P and S waves gives the distance of the shock. The first of the long waves is not so well marked, but as shown by the "L" on the left.

Damping Effects

If there were no damping, and the pendulum was once set swinging, it would go on oscillating for ever, and the resulting record would be entirely false. There is an optimum degree of damping in practice because if there is too much damping the displacement disappears too slowly and the usual arrangement is to make each successive swing about one-twentieth of the one before.

The movement between the ground is generally far too small to be recorded directly and some magnifying system is essential. Some seismographs with long and heavy pendulums are arranged to give a mechanical magnification by means of pivoted levers. These cause friction, however, and a light and delicate instrument of the Milne-Shaw type obtains the required magnification by means of a beam of light reflected from a small mirror which rotates on an iridium pivot in an agate setting and which is coupled to the free end of the pendulum. This gives a magnification of about three hundred times.

The beam of light first passes through a vertical cylindrical lens and then, after reflection by the mirror, through a horizontal lens which focuses the light into a fine point which falls on a narrow slit only three-thousandths of an inch wide. The slit is in contact with the surface of a roll of bromide paper which is moved by a clockwork motor. The bromide paper requires development like an ordinary photographic print before the record becomes visible, but the definition is so fine that waves with a period of only two or three seconds are clearly defined on the paper, which only moves at the rate of 1 in. in three minutes.

Such an instrument as has been described, is only capable of recording the motion of the ground in one direction. That is to say, if the boom is pointing in an E–W direction, the instrument can only record the N–S component of the earth's motion, and if a complete record is required in order to determine the direction of the shock, it is essential that two similar instruments should be used, one with its pendulum at right angles to the other so that the two components can be compared and the resultant direction obtained.

(*Continued on page* 490)

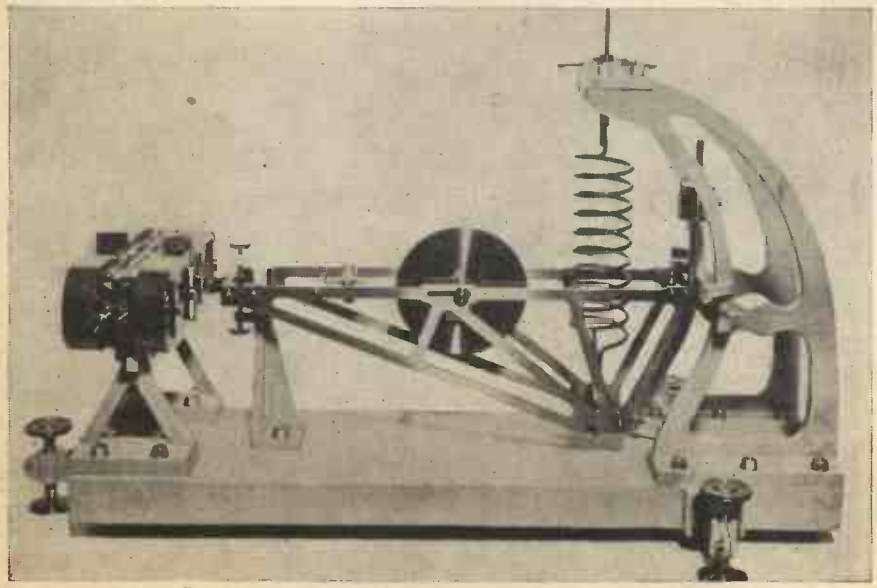
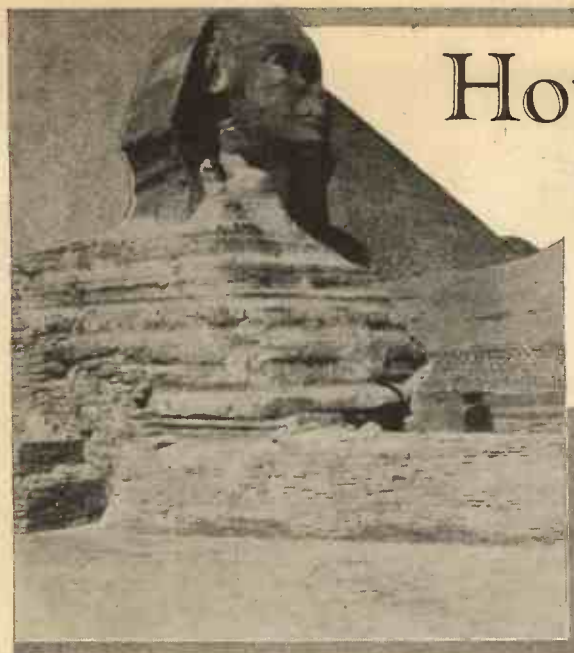


Fig. 5.—A view of a Galitzin Aperiodic Seismograph for recording the vertical component of the earthwaves. The record is obtained electromagnetically.

How the Pyramids and Sphinx were built

By G. Long



(Above) The Sphinx and (right) The Sphinx and Second Pyramid.

THE Pyramids and Sphinx form the most amazing group of structures ever raised by the hand of man, and represent one of the mightiest mechanical achievements in human history.

Although the Pyramids of Giza are the largest and best known, there are five other groups of monuments of the same kind, and these form a mighty line of majestic structures stretching along the margin of the Libyan Desert for a distance of nearly thirty miles.

The first to be erected was the famous Step Pyramid of Saqqara built by King Zoser between 2780 and 2820 B.C., or nearly five thousand years ago. Although less than half the size of the Great Pyramids—which we shall discuss later—it is of much interest, for it gave the idea to following kings for all the later monuments of this kind.

All these great buildings were intended for tombs, and the earliest made were square brick structures, containing inner chambers, and called Mastabas. King Zoser got the idea of building a series of platforms on the top of his Mastaba, each of which was smaller than the one below, and so formed a series of huge steps each about 30 ft. in height, and diminishing to the apex. The perpendicular height of the Step Pyramid is 200 ft., and the base is 413 by 344 ft. square.

The Kings who followed Zoser finished off their pyramids by filling up the steps and smoothing the outside so that a perfect Pyramid resulted, which gave a much more artistic and durable effect.

The Pyramid of Kheops

The Pyramids of Giza form a group of six, standing near to the amazing Sphinx (which is the largest statue ever carved by the hand of man). The biggest of the group is the Pyramid of Kheops (or the Great Pyramid), and the next is the Pyramid of Khephren, which now is only 2½ ft. less in height, but as it stands on a loftier base it actually looks higher. The third Pyramid is rather less than half the height of the first two, and the remaining Pyramids are tiny—they were built for *Queens, not Kings.*

Mere figures are quite inadequate to describe these stupendous structures, which are immeasurably the vastest buildings ever raised by the hand of man.

The Building of the Sphinx and Pyramids Represent one of the Mightiest Mechanical Achievements in Human History

The Great Pyramid is 746 ft. along each side (originally 756, and was originally 486 ft. high. The tip has now been taken away, and there is instead a platform about 12 yds. square, but the vertical height is even now 450 ft. This means that it would over-top St. Paul's Cathedral, with a city warehouse balanced on the top of the cross! The original cubic content was about 3¼ *million cubic yards*, and it consists of 2,300,000 separate blocks of stone, each having an average weight of 2½ tons, many of which were brought here from a long distance away.

The Third Pyramid.

How Was It Done?

Heroditus tells us that 100,000 men were employed at the task for 30 years; the first 10 were occupied in constructing a wonderful paved causeway extending from the Nile to the Libyan Mountains, for the transport of the stone. Part of this causeway can be seen half buried in sand, near to the Pyramids, and there is another, in better condition, which may have been a processional way.

The causeway was really a huge embankment, rising in a gradual slope from the river to the natural platform on which the Pyramids are erected. Originally it was 60 ft. wide, and 48 ft. high at the loftiest part. The stones were fitted closely together, and polished to reduce friction, and the blocks were dragged along by gangs of slaves. Ancient pictures tell us that they were mounted on wooden runners, and were dragged along by gangs of slaves, who pulled in *short jerks.* In one tomb painting nearly four thousand years old, a huge block of stone is being dragged by 172 men, who pull on ropes, while others urge it from behind with levers. Paintings and basreliefs show us exactly how it was done. A gang leader beat time for the pulls with a rod, or blew upon a trumpet. We can see now why the causeway was made of polished stones closely fitted together, and an old historian says that the blocks were placed so close together that it was impossible to put a needle between them when first built. This made a huge slide for the wooden runners, and in addition slaves were employed pouring oil in front of the sledges to reduce friction—or it may have been water to prevent the wood taking fire.

The Principle of Dynamics

This method proves that the Egyptians

The Processional Way and Second Pyramid.

at this early period had discovered the principle of dynamics, which modern science terms "The inertia of a moving mass." Most of us have noticed, at some time or other, when trying to shift a heavy object, that we start with a jerk and it moves, but when we strive to keep it going the weight seems to increase, and it pulls us up. This is why it is possible to move heavy objects in sudden jerks, which it would be impossible to drag along.

We have shown how the blocks of stone were brought to the site, but how were they raised into position hundreds of feet above ground ?

There has been much debate among the learned on this point, but there can be little doubt that the plan was first to construct the base in the form of a huge square platform, and then add to it layer by layer, raising the stones from one platform to the next by levers. The outside was left in the form of a series of steps until the Pyramid was finished. Then the polished outer casing was added, working from the apex downward. It was composed of carefully squared, and beautifully polished blocks of hard stone, which were so coveted by later builders that all of them have been stolen from the Great Pyramid, and the casing has been removed for a distance of more than half-way up from its neighbour. To-day the exterior consists of a series of blocks like huge steps, so that tourists can climb to the top. It is a fascinating experience, but exceedingly fatiguing in that torrid climate, which often makes the stones almost too hot to touch, and at the edge of the desert where the air is often full of fine sand. It is amusing to watch some of the stout, middle-aged visitors being hauled to the top by the natives. Three lithe muscular Arabs are detailed for the task, two pull his hands, and a third shoves from behind. Some of these Arabs are fine athletes, and I have seen one earn a few piastres by climbing from the ground to the top of the Great Pyramid and back again in eight minutes, of which period only a minute and a half was needed for the breakneck descent!

The Great Pyramid

And when we had descended, and gratefully plunged into the cool depths of the Mena House Swimming Pool, we realised what a martyrdom it must have been for that 100,000 miserable slaves who toiled here for 30 years. Their naked backs were seared with the task-master's whip, their limbs were cruelly bruised by the rough stones, and their whole bodies were racked by the effort of raising those mighty blocks by straining muscles and sinews.

The mass of the stones of the Great Pyramid is more than 5 million tons, the average weight of each block has been calculated at

The tiny climbing figure of a man (shown by the arrow) shows the scale of the pyramid.

2½ tons, and some individual lumps are far more, as there are stones visible more than 30 ft. long. The Pyramids are not solid, as is sometimes thought, but each contains one or more inner chambers, reached by a long passage, which is always on the north side, and some distance from the ground. In the Great Pyramid the passage is 3 ft. 11 in. high, 3 ft. 4 in. wide, and 106 yds. long; it is 49 ft. above the ground, and was originally blocked to protect the chambers from robbers. In the middle of the Pyramid is the Great Hall—28 ft. high and 155 ft. long. It is composed of gigantic stones, fitted so closely together that originally it was impossible to pass a hair between them. Beyond the Hall are two more chambers, in one of which the coffin of Kheops was found. It is thought that the sloping entrance passage may at some time have been used for astronomical observation—possibly for viewing the Pole Star which is visible in North Egypt. It is certainly strange that all the Pyramids have the entrance high up on the north side, and there are no Pyramids in the far *south* of the country where the Pole Star would be only visible at times, and that very low on the horizon.

The Greatest Statue in Egypt

The Sphinx is the greatest statue in Egypt, which is the land of colossal statues, but unlike the others—which were quarried and hauled to the spot where they were set up—it has always been here. Much of the stone for the Pyramids was quarried close by, and as a result a large hollow was created, containing a mass of grey limestone unsuitable for building purposes. When Khrephen was erecting his own Pyramid (the second) this mass of rock caught his eye, and the happy thought came to him of shaping it into a Sphinx, conceived as a human headed lion, as guardian to the sacred site. For many centuries the Sphinx was buried to the neck in sand, but it has recently been cleared and we can see a mighty recumbent lion, with the head of a man, and wearing the royal head-dress. The height from the pavement to the crown of the head is 66 ft., length 240 ft. The huge size of the noble head can be judged from these details—the ear is 4½ ft., the nose 5 ft. 7 in., and the mouth 7 ft. 7 in. in length. The features have been much defaced by wind-blown sand, but are still most majestic and impressive, although it was once used for target practice by the Mamelukes. During recent years several broken fragments have been replaced, and the head-dress—which was dangerously loose—has been made safe with concealed iron stays. And so the mighty Sphinx—the riddle of the ages—still gazes across the Valley of the Nile, as it has done for nearly five thousand years, and will do for many centuries to come.

Illustrating the size of the stones in the Great Pyramid.

Modernising Old Clocks

With the Aid of a few Simple Tools it is Possible to Convert Old-fashioned Clocks into Up-to-date Timepieces

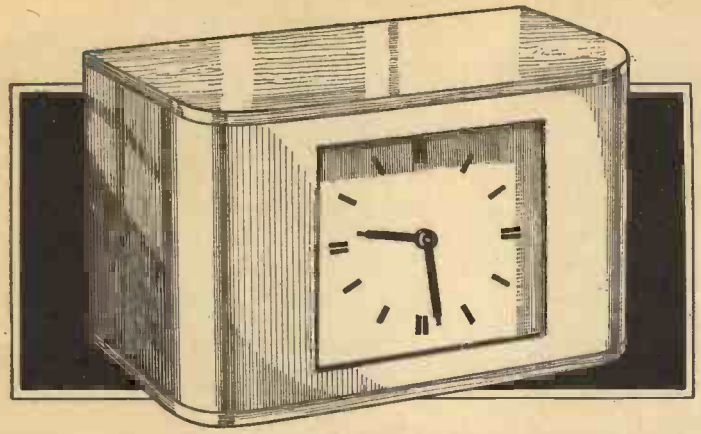


Fig. 1.—Showing how an old clock can be converted into a modern timepiece with the aid of a few simple tools.

IT seems a great pity to put a good clock in a little-used room when, perhaps, the figures contrast with modern furniture, or the case is scratched because, with a little care and forethought, it can be converted to a modern timepiece.

The clock illustrated in Fig. 1 is an example of what can be done with a few simple tools, and although, in this case, the movement was not old, the appearance would have been the same even with a ten-year-old movement. It is proposed to describe this clock, not with the object of duplication, but to suggest ideas for converting one of the reader's own timepieces to an up-to-date style.

The movement is first removed from its old case, and the hands and dial are taken off. These operations are individual problems, but they should present no difficulty.

Mounting the Movement

The movement can then be measured up and the size of the finished clock decided, bearing in mind that it is not wise to increase the dial, and incidentally the hand sizes, unduly. The movement has then to be mounted. This again is an individual problem, but Fig. 2 suggests various methods of securing it to a small platform, a method which will be found to score on the point of adaptability. In the disintegrated view of the electric clock (Fig. 3), the special platform, which also carries a mains transformer, will be noticed; this latter being dealt with later. The height of the clock can be fixed by the height of the two vertical supports, and it should be made to agree with the dimensions already decided upon.

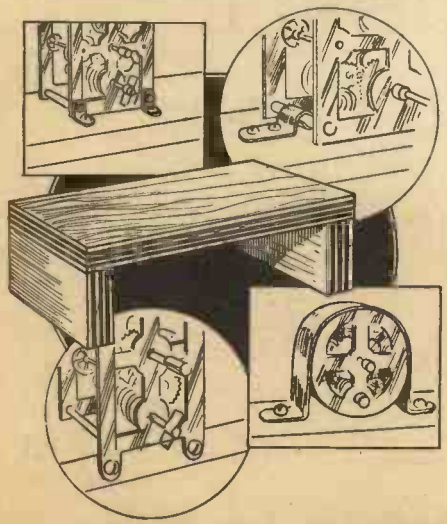


Fig. 2.—Various methods of clamping the clockwork mechanism to the plywood baseboard.

The Case

The movement can now be put aside, and the case prepared. Plywood and aluminium form the basis of this, further reference to Fig. 3 will explain the main principles. The plywood is slightly over $\frac{1}{16}$ in. thick, the aluminium being $\frac{1}{32}$ in. (or 21 S.W.G.). The wooden part should be prepared first, and consists of the top, bottom, two uprights, and the front. The square in the front is slightly larger than the required size, and two plys are removed on each side, making a recess to take the glass. A long strip of aluminium is then cut, its width being equal to the height to the wood framework. The aluminium, which will be found fairly pliable, is then shaped to fit, and fixed in position with six small countersunk brass screws. The square opening is then marked out and, after removal, it can be cut out by heavily scoring the four lines with a penknife guided by a steel edge. The square must be cut accurately, as the finished appearance depends upon this.

Pieces of $\frac{1}{4}$-in. walnut, figured oak, or any other wood to choice, are then cut to fit the top and bottom, allowing an overlap over the aluminium; $\frac{1}{16}$ in. will be sufficient.

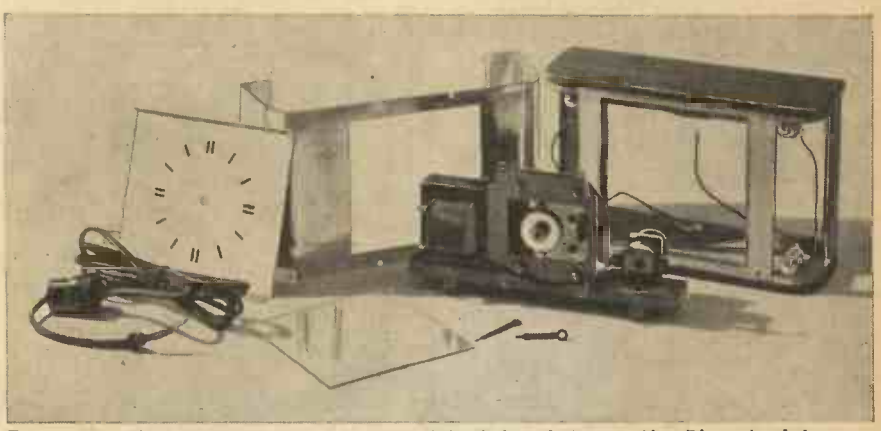


Fig. 3.—This illustration shows the various parts of the clock ready for assembly. Plywood and aluminium form the basis of this design.

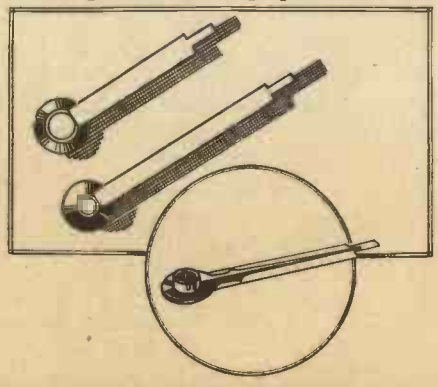


Fig. 4.—Old hands may be modernised by cutting out a suitable design as shown, and gluing it over them.

These can be fixed in position, the top piece being held by screws from underneath.

The Dial

Next on the list is the dial. Good-quality notepaper is suitable, and any markings (again to choice) representing the hours can be inked in, preferably with Indian ink. A piece of cardboard, cut to fit inside the wooden framework is then glued centrally on the back of the dial, the finished dial then being trimmed up.

Fixing again presents an individual problem, but small wood blocks glued in strategic positions should overcome the most obstinate case. The movement can then be placed in position, and fixed by two fairly long screws from underneath, one to each upright.

The Hands.

Concerning the hands, it may be advisable to inquire at a local jeweller's as it is difficult to make a neat modern pair. He should be able to supply you with a pair in keeping with the new idea, but make sure

that the sizes of the centre holes are correct.

As an alternative, however, it is possible to utilise the old hands in the way illustrated in Fig. 4, hands being cut from stout paper or foil with an appropriate finish, these being stuck over the old ones. The hands shown in Fig. 3 were made by this method.

A thin plywood back to exclude dust can be fitted at this stage, the top and bottom can then be stained and polished. Incidentally, as the area to be polished is relatively small, the possibilities of obtaining an extremely high gloss are legion, and the veriest amateur should be able to get at least a pleasing finish.

Treating the Aluminium

The clock is now almost finished, and it remains to treat the aluminium. Unfortunately this metal will not remain bright for

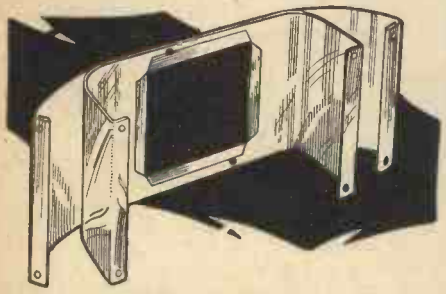


Fig. 5.—Showing how metal foil, as used for decorative purposes, may be fitted round the existing case.

any length of time, so it is useless to polish it unless some clear coating, such as varnish, is applied afterwards. There is also the disadvantage that the screws will show. Cellulose enamel, either sprayed or brushed on offers great possibilities, if care is taken in the countersinking for the fixing screws these should almost disappear, and with the variety of colours obtainable, a pleasing contrast is available.

An Attractive Finish for the Case

Yet another finish is to use metal foil as used for decorative purposes. This has a highly polished surface and can be worked round the aluminium. Fig. 5 shows how this is carried out, the foil being pulled tight around the aluminium when the back screws are inserted, the foil having previously been eased away while fitting the two front screws. Paper is even easier to fit than foil, and inquiries at a fancy-paper shop should produce an extremely varied collection from which to choose, wood-grained, crocodile skin, and metal foil with paper backing illustrating the diversity of finishes.

Preserving the Surface

A thin coat of clear varnish would both protect and preserve surfaces of these types. This then completes the clock, something new from something old, a definite improvement without undue trouble.

Earlier in the article it was mentioned that the clock taken as an example is fitted with a mains transformer. This steps down the mains voltage from 220 to 16 and four flash-lamp bulbs in series are connected to the secondary. These can be seen in Fig. 3, which shows how they illuminate the dial, the latter being set back slightly to assist the idea.

Colour Effects

With a bulb at each corner, the illumination is remarkably even, resulting in an extremely pleasing appearance. Tinted celluloid or paper serves to adjust the colour scheme if tints are preferred to normal light, a light amber tint producing an extremely attractive dial. A transformer is, however, rather a luxury, and two small mains bulbs in strategic positions (see Fig. 6) will prove almost as good if sufficient attention is paid to the reflectors. These are either automatically formed by the aluminium casing, or made with bright foil or paper-backed foil.

The Switch

A switch is included in the model clock to control the lights, and this is usually advisable although consumption with correct bulbs is quite low, the four flash-lamp bulbs accounting for only seven watts, and two mains bulbs of the correct type taking only ten watts. This switch could be extended, for instance two terminal points could be fitted and a twin-flex extension, terminating in a power switch taken to any convenient point such as over a bed. With this small consumption, however, it would be comparatively cheap to leave the light on all night, the total consumption over a fortnight being less than a unit, and the added convenience would be greatly appreciated.

Illumination

An alternative method of illumination is to light the dial from behind, the dial being made from opaque celluloid. Although not a difficult method providing that the dial is larger than the movement, it nevertheless requires a little more forethought and ingenuity to effect even illumination, and unless the reader is prepared to give these points the necessary consideration, it would be advisable to stick to the previously mentioned ideas.

Clock or Spring Movements

It is as well to mention that providing the house is wired for electric light it is immaterial whether the clock movement is spring or electric, the illuminated dial can be fitted in either case, and even without electricity, flash-lamp bulbs working from a battery or accumulator can be used. In the latter case it is best to use the switch system, as continuous running will be found to be rather expensive, but with the suggested method a shilling battery will last several weeks.

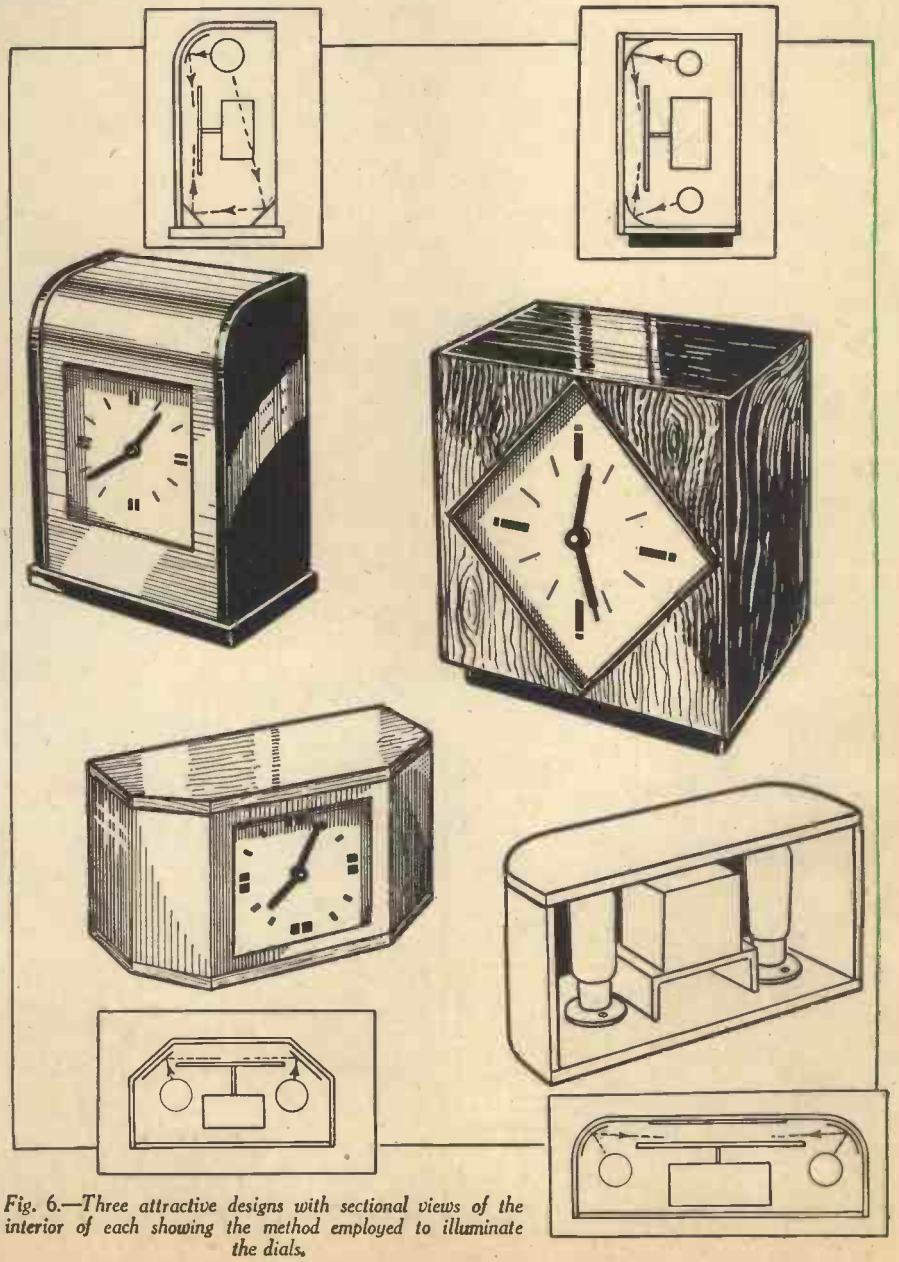
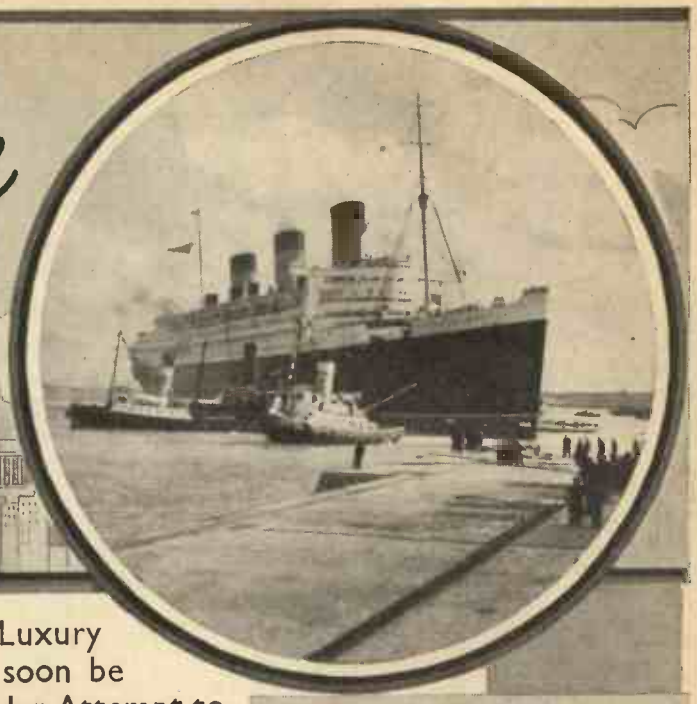


Fig. 6.—Three attractive designs with sectional views of the interior of each showing the method employed to illuminate the dials.

Wonders of the "QUEEN MARY"



This Great Luxury Liner will soon be Ready for Her Attempt to Win the much coveted Blue Riband of the Atlantic

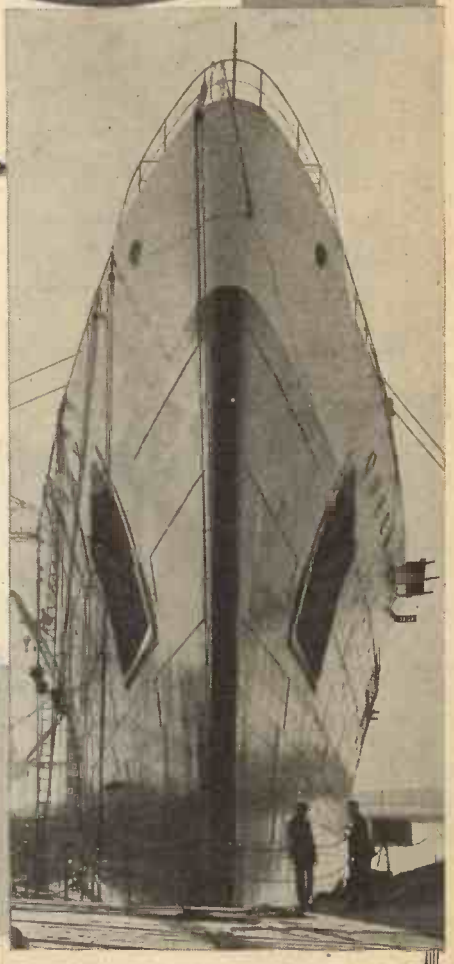
NO recent event has roused so much public interest and enthusiasm as the voyage of the *Queen Mary* from the builder's yard on the Clyde to her Home Port of Southampton. More than a million people went to see her in Glasgow, and the number who assembled to greet her on the South Coast could not have been less.

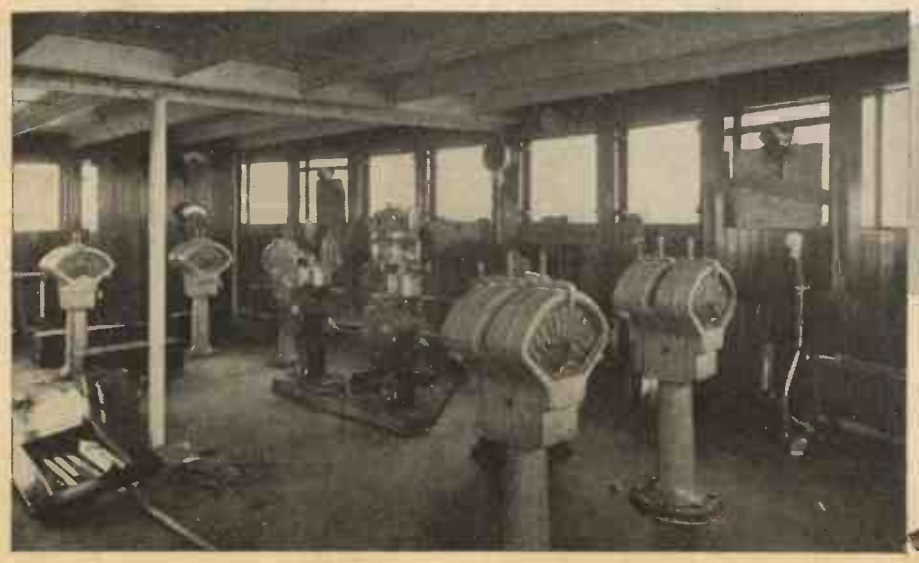
She has been well described as the "Wonder Ship," probably the world's biggest, most likely the fastest (this is written before her trials) certainly the latest, safest, most comfortable and up-to-date vessel in the whole world. As the leading sea-faring nation, the British have real pride in their ships, and it has been a matter of regret and resentment that the subsidised ships of other nations should have obtained an unfair advantage over our own unprotected merchantile marine. The injustice is the more galling because the three nations who have been the worst sinners in this respect, have defaulted to the tune of thousands of millions in the war-debts they *owed us*, and have repaid our generosity by trying to destroy our shipping. Happily this will fail, and it is good to know that the Wonder Ship is British, and that we still hold the trident.

Size and Beauty

When we first see the *Queen Mary* we are impressed by her *size* and *beauty*. Although so enormous she is as graceful as a yacht, but gives an impression of dignity that no small vessel can produce.

She is 1,018 ft. long, so that if she were up-ended she would over-top the Eiffel Tower, or if she were set in Trafalgar Square one end would be in the Strand and the other in Pall Mall. If she were placed in front of St. Paul's, the height from her keel to her forward funnel would over-top the Cross of the Cathedral. These funnels are so huge that they are larger than most of our main line railway tunnels. They would each accommodate three full-size railway engines abreast, while few tunnels will allow more than two to pass through. To those who travel in her, she will appear like a twelve-story building and her dozen decks are served by electric lifts. Cabins





(Above) The streamlined bows of the "Queen Mary" seen in the fitting-out basin at Clydebank.

(Left) The wheel-house on the bridge. It is from here that the "Queen Mary" will be controlled.

have hot and cold running water laid on, and most of them have their own private bath. The public rooms include theatres and cinemas, restaurants, shops and ball-rooms, swimming pools, squash and tennis courts, with some two acres of space for games.

Safety Arrangements

Safety is more important than comfort and recent disasters to foreign ships have brought this home tragically to the public mind. No ship ever built has such perfected safety arrangements. Fire is the worst of all perils of the sea, and this has been guarded against as never before. Fire detectors are installed, which automatically flash to the Bridge, a warning of any unguarded flame—even a thrown-down match would be recorded, and the scene of an outbreak can be smothered with fire extinguishing gasses by merely pressing a button, and greater conflagrations would be drowned by high-pressure water mains. Much attention has been given to the problem of fire prevention, by the avoidance of wood-work, safety paint, and perfected electrical wiring. Collision is a minor danger to so huge a ship, since any impact (except with a rock or iceberg) would scarcely be likely to endanger her, but all perils of this kind are provided against by the provision of a double shell to the ship, which is divided into many compartments, so that an actual leak would appear to be impossible. If, however, the worst should happen, no ship has been so liberally equipped with life-boats—and what life-boats! There are twenty-four of them, each having room for 145 people, which is more than the full complement of passengers carried by the first Cunarder—the *Britannia*—when she crossed the Atlantic. The life-boats are all fitted with Diesel engines, and some of them have wireless. Two of them are speed-boats, and are intended for rescue work if anybody falls over-board. When such an event occurs on a fast liner, she must inevitably be several miles from the drowning man before she can be stopped, and these speed boats can dash to the rescue like a flash, while special electrically equipped gravity davits can lower the life-boat to the water in one minute, with its engine already running. A heating circuit ensures quick starting in the coldest weather. The Bridge is supplied with every safety device known to science—gyro and magnetic compass, wireless direction finder, sub-marine signalling, hydro-electric steering, and she is in touch with both shores all the time by wireless.

(Above) The third propeller being lowered alongside the other two at Southampton Dock.

(Right) The curves of the "Queen Mary." Looking down on the bridge and superstructure of Britain's most modern liner.

Engine Rooms

Her engine rooms are an engineer's paradise. The estimated horse-power is 200,000, furnished by 24 water-tube boilers of the latest Yarrow type, acting through four sets of Parsons geared turbines. These are impelled by their working blades, as thin as those in your safety-razor, tested and fitted to a hair's breadth, and there are more than a quarter of a million of them! The gear wheels too, are amazing, each 14 ft. in diameter, and weighing 320 tons. The boilers are heated by oil fuel, smoothly fed through pipes, and needing neither shovels nor stokers. A separate set of engines is used to generate electricity for the ship, and its output is sufficient to supply a city of 150,000 inhabitants! It was an anxious and difficult task to float the *Queen Mary* down the Clyde to the open sea, but it was done skilfully and well. It was a wonderful sight to watch the gigantic liner as she entered the narrow entrance of the Graving Dock at Southampton.

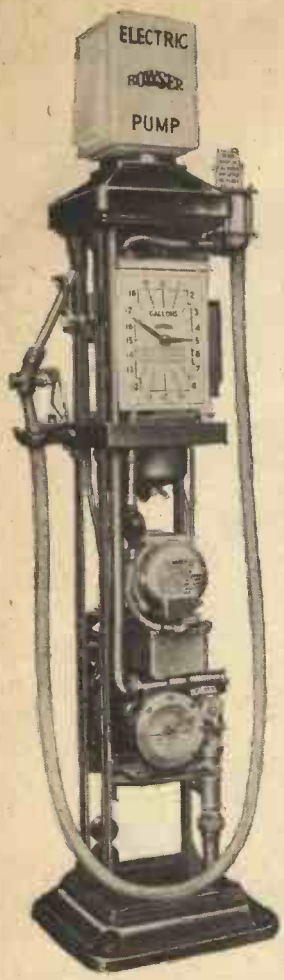
This Graving Dock is also a wonder in its way—the only one in the world that can accommodate the *Queen Mary*. It was opened in 1933 by King George V, whose name it bears. Its length is 1,200 ft., width 135 ft., depth 59 ft., and it contains 260,000 tons of water, which can be pumped out in four hours. The floor of the dock is 25 ft. of solid concrete, not only to sustain the enormous weight of a ship, but also to prevent the sea water pushing in from outside. The mighty gates of the dock weigh 1,800 tons, and are wide enough to form a bridge when closed.

(Left) This huge wall map adorns the 1st Class dining-room. By a system of lights the position of the ship is shown throughout the voyage.

HOW A PETROL PUMP WORKS

By Fredk. Jace

A Practical Article written in Everyday Language. The Illustrations, which were kindly lent by Messrs. S. F. Bowser & Co. (London) Ltd., Depict an Electric Pump and Show the Progress made in their Construction During the past Few Years

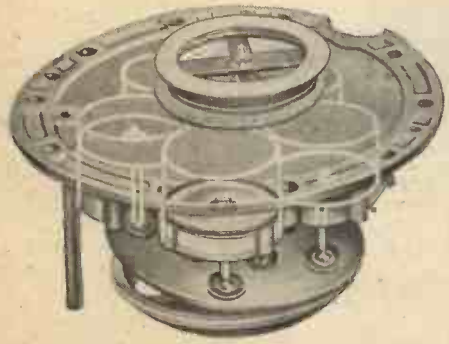


The Bowser electric pump, which incorporates many novel features.

TO the "man in the street" petrol pumps must appear to be of numberless kinds, shapes, sizes, and hues. This in a sense is so, but from the point of view of the mechanical principle on which they work, they can be divided, broadly speaking, into three main types, viz. the twin container type, the visible bowl type, and the piston type.

In the first place, it should be explained that the petrol is invariably stored in underground tanks which may vary from a few hundred to several thousand gallons in capacity. The tanks are placed underground for reasons of safety, and no licence would be granted to a garage to instal a pump if the tank were not so placed. As showing the immunity from fire danger of petrol stored in this way, there are many instances of garages having been burnt down with petrol tanks under the premises which have remained entirely unaffected by the fire.

The tank need not be situated in any particular position in relation to the pump. In exceptional cases it may even be as much as 100 ft. away from the pump. It is usual, however, to place it as near as possible so as to reduce the necessary piping, and because the longer the suction line the greater the resistance in pumping the petrol from the tank.

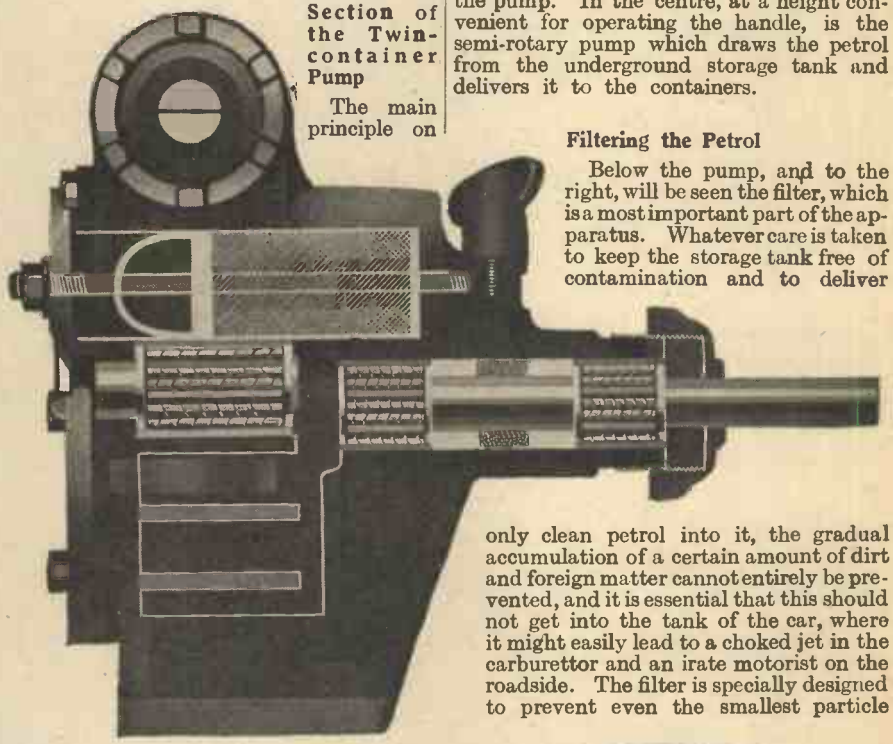


View showing the five measuring cylinders, with the valve changer top removed. The cylinder in front is filling with liquid and depressing the piston, forcing down the wobble plate.

Section of the Twin-container Pump

The main principle on which the twin-container pump works is the alternate filling and emptying of two separate containers of a fixed capacity, so arranged that while one container is being emptied into the hose and so the car, the other is being filled. The process is then reversed, and thus the filling of the car tank with the required quantity of petrol can be effected rapidly with a continuous flow. The two containers are of equal capacity, being either one gallon or half-gallon, the latter being used where it is desired to make deliveries as small as half a gallon at one time.

One of the advantages of this type of pump is its extreme and consistent accuracy, which cannot be dependent on any adjustment which could get out of order, however long the pump is in use. The containers are calibrated to hold an exact one gallon or half-gallon between the shut-off valve at the bottom and the small overflow aperture at the top. Once this calibration is set it cannot vary. The containers are made of glass, which is of a special quality to provide extra toughness and fire resistance.

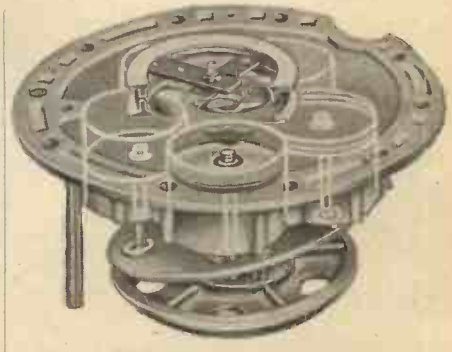


The above illustration shows the long shaft supported at four points throughout its length to prevent whip and at the same time the neck rings prevent the gland packing from oozing along the shaft and escaping as a result.

Most readers will no doubt be familiar with the general layout and appearance of the pump. In the centre, at a height convenient for operating the handle, is the semi-rotary pump which draws the petrol from the underground storage tank and delivers it to the containers.

Filtering the Petrol

Below the pump, and to the right, will be seen the filter, which is a most important part of the apparatus. Whatever care is taken to keep the storage tank free of contamination and to deliver only clean petrol into it, the gradual accumulation of a certain amount of dirt and foreign matter cannot entirely be prevented, and it is essential that this should not get into the tank of the car, where it might easily lead to a choked jet in the carburettor and an irate motorist on the roadside. The filter is specially designed to prevent even the smallest particle getting by. It is easily dismantled for cleaning the gauzes.



Showing how the liquid is discharged through the same port, but inside the circular valve, which is shown broken away for greater clarity.

From the pump the petrol passes into one or other of the containers through a two-way valve at the bottom. This valve alternately connects the container either with the pump or with the outlet to the hose, so that petrol can only be pumped into one con-

tainer at a time, and only the other container at the same time can empty into the hose. While the petrol is rising in the container that is being filled, the air which is displaced is not allowed to escape, but is compressed by the rising liquid and used to force out the petrol which is leaving the emptying container, thereby increasing the speed of delivery.

How the Valve Acts

Having arrived at the stage where the petrol in the one container has been emptied into the hose and so to the car, while the other is full and overflowing through the small aperture in the top, it is then necessary to reverse the valve in order to open up the full container to the hose and to connect the empty container to the pump for refilling. This valve reversal, which in earlier models was done by hand, is now effected automatically by means of the liquid pressure which is set up by continuing to work the pump when the container is full, and only a small amount can get away through the overflow aperture. This pressure is made to operate a piston working in a cylinder. When and only when the filling container is quite full, the piston is moved across by the pressure generated, and effects the reversal of the valve. At this point an important provision is the synchronisation of the filling and emptying of the containers, so that one is not filled before the emptying of the other is completed.

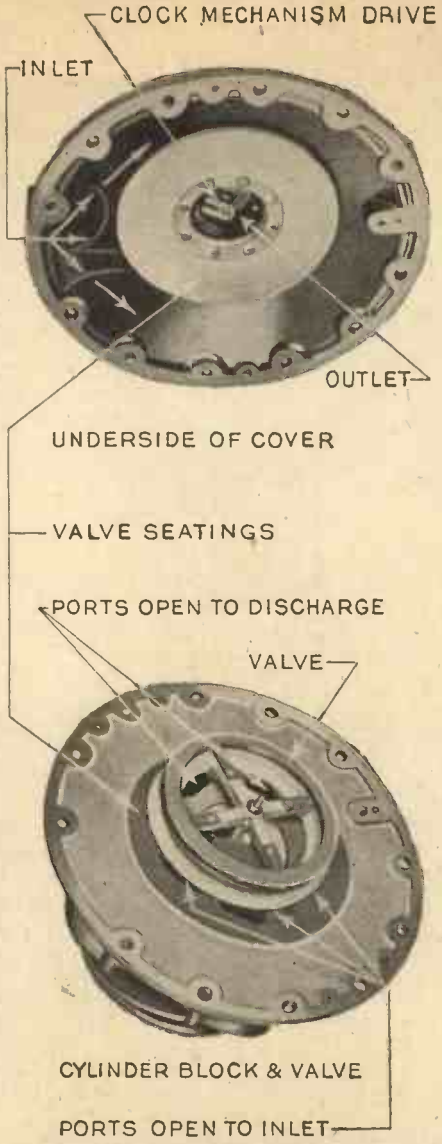
This process of measuring out through the containers could be continued indefinitely so long as the pump handle is worked, but in order to regulate the amount asked for by the motorist on each occasion, there is a further refinement provided in the form of the indicator which is the square box-like fitting above the semi-rotary pump with the setting wheel at the side. Before a delivery is made to a car, the wheel is set to show at the small window nearest the wheel the figure for the amount required. Until this setting is made, petrol cannot be pumped up as the pump remains out of action by means of an air-release device. After setting the required amount, the pump is worked and as each gallon or half-gallon is delivered from the container the amount appears at the second window, when the pump is again automatically put out of action, and will not pump any more petrol until a new setting is made. Thus the motorist can only be given the amount for which he has asked.

The Overflow

Another clever device is the method of disposing of the small amount of petrol which overflows through the top of the container when it is filled. This runs away to what is called the trap, which is seen to the left of the semi-rotary pump. It cannot be carried away through an open pipe, because this would not allow the displaced air to carry out its important function of accelerating the discharge of the emptying container. The trap, without the use of floats, which are always vulnerable and liable to give trouble, prevents the passing of any air.

One other feature of the pump calls for special mention. This is what is called the high-level discharge. It is possible to have the hose attached to the outlet from the containers at a point just below the bottom of the latter, but while this is quite suitable for many locations and for supplying most forms of vehicle, it is an advantage to have the hose connected at a higher point, to allow of the use of an overhead swing arm. The designers had been faced with the problem of making the petrol, when it leaves the container, go "uphill" and then down again through the hose. The air pressure referred to above partly meets this difficulty, but this is not entirely sufficient to ensure that every particle of the measured quantity passes over into the hose. There is, therefore, an additional syphoning device in which a small internal syphon tube takes the last drop over, and puts it on its way to the tank of the car.

The accuracy of these pumps is almost uncanny, and they are tested to the last drachm—a minute amount which few motorists would think of taking into account in considering accuracy of measure. In addition, every pump selling petrol has now to be tested and stamped by the Weights and Measures Authorities, and their test as laid down by the latest regulations is a very stringent one.



A view of the cylinder block with the top casting lifted and tilted to show the upper valve casing.

Other Types of Petrol Pump

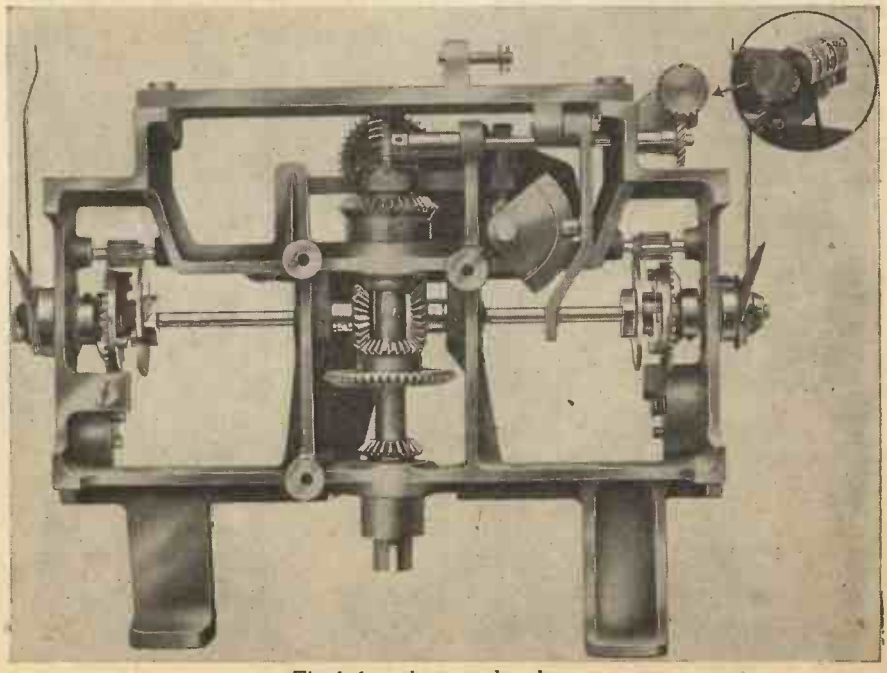
In conclusion, it might be of interest to give a very short description of the working principles of the other two types of petrol pump referred to previously.

The essential feature of the visible bowl pump is a wide open bowl, either made of glass or of metal with glass windows, and usually with a total capacity of five gallons. This bowl is filled to a certain height by means of a hand-pump, and then allowed to run out into the hose. The amount is regulated by a sliding overflow tube, which is set before filling is commenced, and after filling the bowl to the overflow point a valve is opened.

The amount that is delivered to the car can be watched by means of marks and figures on the side of the bowl.

In the case of the piston pump, the pump which draws the petrol from the storage tank is in itself a measuring device. The stroke of the pump is regulated by stops which can be set to different amounts.

The piston of the pump is worked up and down by means of a handle operating a rack and pinion, and as each stroke is made the amount is indicated on a dial.



The clock mechanism and totalisor.

Measuring Candle-Power

How to Make an Instrument by Which Lamps can be Compared and Their Powers Worked Out

SOMETIMES it is required to measure the candle-power of a lamp or to compare the intensities of two lamps. In photography, for instance, when taking prints from a negative by the aid of an electric light, it is useful to be able to calculate the exposure for another lamp of different candle-power. In other hobbies, too, an instrument by which candle-power can be measured might come in useful.

The illumination power of a lamp is found by comparing the intensity of illumination of a surface on which it is shining, with the intensity of a surface illuminated by a standard or known power of light. It is measured in standard candles, otherwise known as candle-power. A standard candle is made to certain specifications. The National Physical Laboratory sells what are known as sub-standards, that is, lamps of a known candle-power measured in relation to a standard candle. The intensity of illumination at one foot from a source of light of one candle-power is one foot-candle.

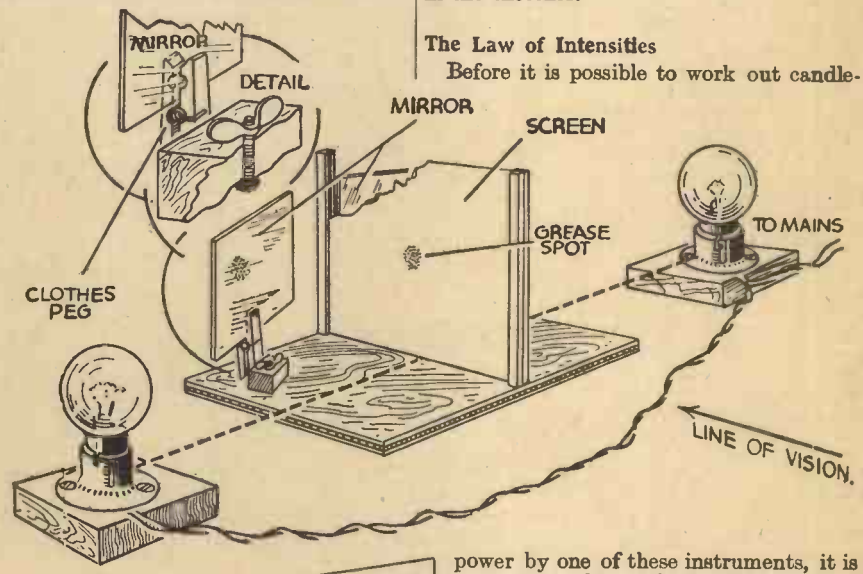
Relative Intensities

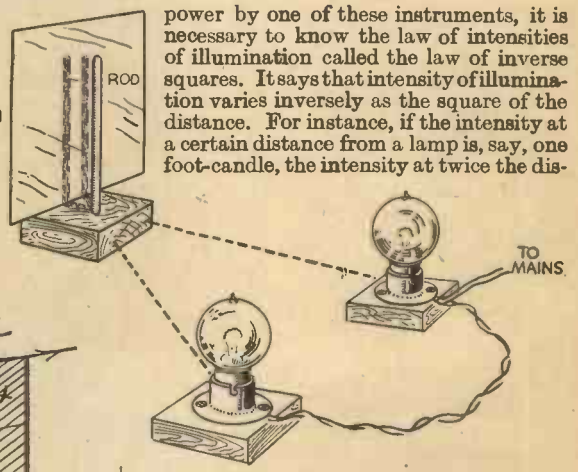
Instruments for measuring relative intensities of illumination are called photometers. There are several different kinds, and two of them are both fairly accurate and easily constructed. The first is very simple indeed; it consists only of a screen, which can be a piece of white paper, and a short length of wooden or metal rod about $\frac{1}{4}$ in. in diameter. The rod is mounted vertically about an inch or so in front of the screen and shadows from the two lamps, one of known and the other of unknown candle-power, thrown side by side on to the screen. The distances of the lamps from the rod and screen are then adjusted so that the shadows are of the same intensity. By a method of working to be given, the relation of these two distances can be used to obtain the candle-power of the lamp of unknown power.

The Grease-spot Photometer

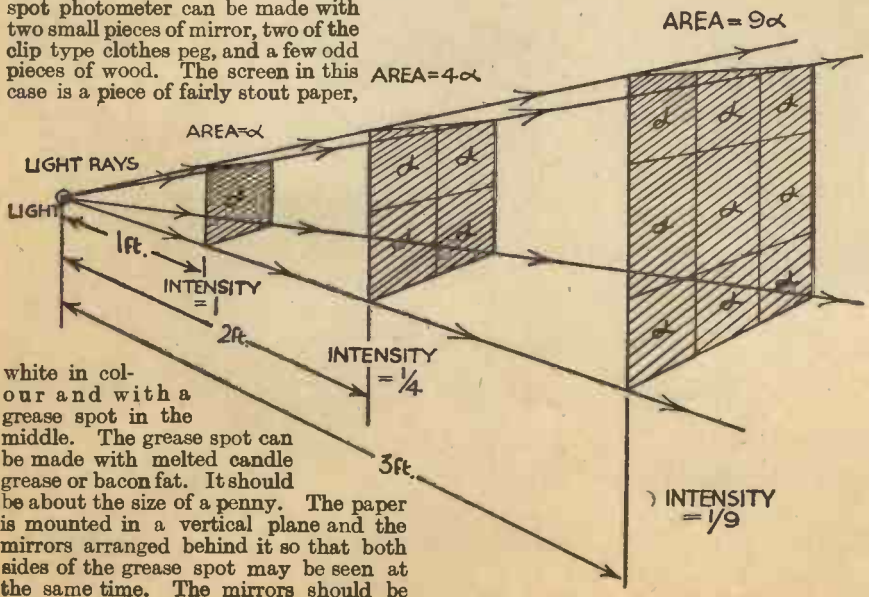
The second kind of instrument, which is known as the grease-spot photometer, is slightly more accurate than the first, which is called the shadow photometer, as the colours of shadows vary and therefore make it rather difficult to match them. A grease-spot photometer can be made with two small pieces of mirror, two of the clip type clothes peg, and a few odd pieces of wood. The screen in this case is a piece of fairly stout paper, white in colour and with a grease spot in the middle. The grease spot can be made with melted candle grease or bacon fat. It should be about the size of a penny. The paper is mounted in a vertical plane and the mirrors arranged behind it so that both sides of the grease spot may be seen at the same time. The mirrors should be adjustable, and one way this can be done is to clip them in the clothes peg which should be fastened to swivelling blocks of wood held in place by nuts or wing-nuts and bolts. The diagram shows this clearly. The two lights are now placed, one on each side of the photometer, and their distances adjusted until it can be seen in the mirrors that both sides of the grease spot have the same brightness.

If these instruments are intended to measure the power of electric lamps, two holders should be made. These consist of lamp sockets on a wooden base equipped with two terminals. Care should be taken, of course, not to touch the terminals if the lamps are connected up to the mains and the current is on. The lamps should be connected up, with flex, in parallel as shown in the sketches.





(Above)—The grease-spot photometer. (Right)—The shadow photometer. (Below)—A diagram of the principle illustrating the law of inverse squares.



The Law of Intensities

Before it is possible to work out candle-power by one of these instruments, it is necessary to know the law of intensities of illumination called the law of inverse squares. It says that intensity of illumination varies inversely as the square of the distance. For instance, if the intensity at a certain distance from a lamp is, say, one foot-candle, the intensity at twice the distance is not half a foot-candle, but $\frac{1}{2^2}$, which is a quarter of a foot-candle. At three times the distance it is not a third, but $\frac{1}{3^2}$ or one-ninth of a foot-candle. Incidentally, this law also applies to heat radiation, magnetic attraction, gravity, electrical force, etc. Photographer readers should remember it as, when they are taking prints, if the distance of the printing frame from the lamp is doubled, the exposure should be 2^2 or 4 times as long, and if it is trebled, the exposure should be 3^2 or 9 times as long, and so on.

Calculations

Here is an imaginary working for a photometer, which can be adapted for other re-

(*Continued on page* 490)

Masters of Mechanics

Dr. Rudolf Diesel and his Epoch-making Invention

The last portrait taken of Dr. Rudolf Diesel.

IT is only since the Great War that the now world-famed Diesel engine has come into its own. Previously, the Diesel engine experienced a hard struggle for recognition against the inertia of engineering custom and convention, against severe competition in the world of prime-movers and, last, but by no means least, against powerful vested interests. To these facts must be added the observation that the early Diesel engines were not anything like so efficient and trouble-proof as are the modern Diesels. The early engines of the Diesel type gave a considerable amount of trouble. Sometimes they ran erratically and, when repairs were needed, it took workmen of the very highest skill to execute the job. The early Diesels were even dangerous. It is, indeed, on record that the inventor himself, Dr. Rudolf Diesel, nearly lost his life in a Diesel-engine explosion. Fortunately, however, all the early troubles which were experienced with the Diesel type of engine have been overcome and, gradually at first and then with an increasing rapidity, the Diesel engine has taken its place among the world's most serviceable and indispensable prime-movers.

For the benefit of the reader whose acquaintance with the Diesel engine is only very slight, the following short explanation of its working principles will not come amiss.

The Principle of the Diesel Engine

The Diesel engine operates by virtue of a very well-known principle, a principle whose manifestations have been experienced by nearly everybody. Who, for instance, has not noticed the heating up of the barrel of a cycle-tyre pump after the latter has been in operation for a few minutes ?. True, the warming up of the pump is due, to some extent, to the friction of the plunger against the inner walls of the barrel, but there is also another factor at work. When air or any other gas or mixture of gases is compressed, its temperature rises and, within limits, the rise in temperature of the gas is fairly well proportional to its degree of compression. If a gas is very strongly compressed, it becomes so hot that, provided the gas is a combustible one and is mixed with the necessary amount of air or oxygen, it ignites quite spontaneously.

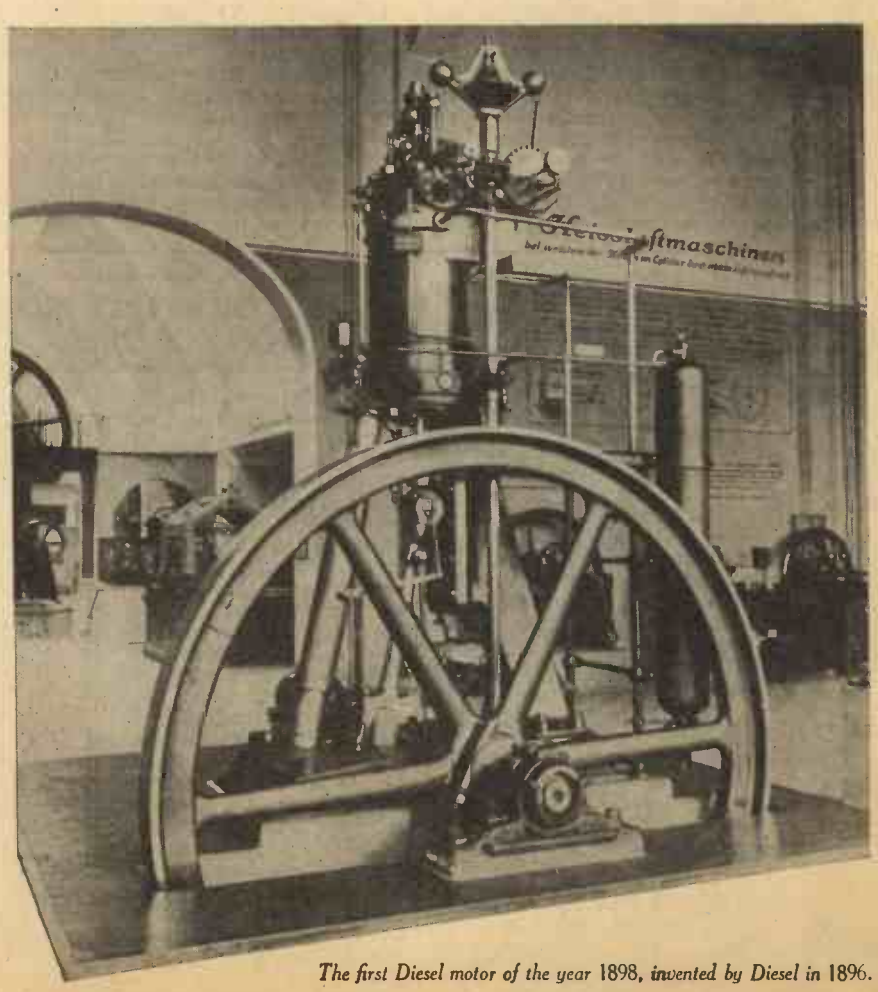
In the above fact we have the underlying principle of the Diesel engine. Such engines are also termed "Compression-ignition engines" because the ignition of the gaseous charges in them takes place, not by the application of any external flame, or by the regular passage of an electric spark, but simply and solely by the strong compression of the gaseous charge, this compression being intense enough to heat the charge up to its ignition point.

Power Stroke of the Engine

In actual practice, the Diesel engine draws air into the cylinder with the downward stroke of the piston. The succeeding compression stroke strongly compresses the air in the cylinder head and matters are so arranged that when the piston has reached the top of its stroke an automatic valve is opened and a charge of fuel is forcibly injected into the cylinder head. The fuel instantly ignites in the compressed and heated air and, owing to its rapid combustion, the piston is forced downwards, this latter movement of the piston constituting the power stroke of the engine.

There are, of course, a number of modifications of this basic principle. Nevertheless, in all engines of the Diesel type, the simple principle of compression ignition remains unchanged.

Although engines of the Diesel type are being used in increasing numbers on transport vehicles, and may even perhaps be employed at some future time for ordinary motor-car use, the modern high-power Diesel engine is essentially a stationary engine. Its specialised use is for driving electrical generators. In this field, it is in direct competition with the steam turbine. A Diesel engine usually has a relatively small fuel consumption. It is steady in action, runs at high speeds and, nowadays, is very reliable. The heaviest of liquid fuels



The first Diesel motor of the year 1898, invented by Diesel in 1896.

may be used in a Diesel engine. Indeed, the earliest Diesels worked on coal dust, and engines which run on mixtures of coal dust and oil are quite common.

The Inventor

Dr. Rudolf Diesel, the inventor of the engine, was born in Paris, of German parents, on March 18th, 1858. From his earliest years he showed a decided bent towards mechanics and, during his teens, he studied general engineering at the Technical Colleges of Augsberg and Munich. Later he obtained engineering assistantships at various works, and about the period of his introduction of the Diesel engine, he was managing an engineering works in one of the suburbs of Paris.

In his own handwriting, Rudolf Diesel has left the world an account of how his mind was first directed to the possibility of constructing a compression-ignition engine. In a volume of manuscript notes, he writes :

" When, in the year, 1878, my esteemed teacher, Professor Linde, of the Polytechnic School at Munich, explained to his students during a lecture on thermodynamics, that the steam engine only transformed some 6 to 10 per cent. of the available heat of the fuel into effective work, and further demonstrated, by means of Carnot's theory, that all the heat introduced was converted into energy on the gas expanding isothermically, I made a note at the edge of my notebook : ' Study whether it is possible to make practical use of the isotherm.' "

Here lay dormant the first beginning of the modern Diesel engine. For years Diesel turned the physical problem over and over in his mind. After a lapse of fifteen years, Diesel's ideas began to take practical shape. In 1893 he published a book entitled *Theorie und Konstruction eines rationellen Warmemotors zum Ersatz der Dampfmaschinen und der heute bekannten Verbrennungsmotoren* (*The Theory and Construction of a rational heat-engine to replace the steam engine and the modern internal-combustion engine*). The book attracted some notice and, as a result of it, Diesel was financed by a number of interested firms, such as Krupps and Sulzer Bros., in the further study of and in the practical construction of his engine.

It must be remembered that at that period the ordinary gas engine was not built in large sizes and that the turbine engine was only in an experimental stage. Thus, the ordinary reciprocating steam engine virtually held the field in the world of high-power prime-movers.

Diesel's first compression-ignition engine appeared in the year 1893. It utilised coal dust or heavy oil as a fuel. It was of the single-cylinder type and it was mounted on a heavy iron bed let into a base of concrete.

Slow Progress

Despite the obvious cleanliness of the Diesel engine, and the absence of a steam-boiler and the necessary furnaces essential to the operation of the latter, the new engine progressed but slowly at first. Even in 1910—thirteen years after the introduction of the first working Diesel—the number of Diesel engines in Great Britain was less than half a dozen. As we have seen, however, early faults in the engine had a lot to do with this lack of practical recognition. In 1920, however, there was something like a hundred and twenty commercial Diesel plants in operation in this country, and since that period, the Diesel engine, in its various modifications, has forged ahead in all the principal countries of the world.

Dr. Diesel met with an extremely tragic end. On the night of September 30th, 1913, he caught the Antwerp-Harwich mail-packet steamer to England. But he never arrived in this country. The vessel had hardly proceeded half-way on its journey when the celebrated engineer was discovered to be missing. A rapid search of the ship was made and the cry " Man Overboard ! " went up. The boat was stopped and, in the blackness of the night, a rowing boat was lowered on to the waves. For two or three hours, a careful search of the waters was made for any possible signs of the missing man. It was all, however, to no effect. Eventually, therefore, the Harwich-bound vessel proceeded on its appointed course. Rudolf Diesel was no more.

Suicide was mooted during the subsequent investigations, but whether Dr. Diesel died by his own actions or whether his untimely demise was purely accidental was never revealed. The tragedy was heightened by the fact that, at the time of its occurrence, Dr. Diesel was just at the height of his fame. He had few known worries and the engineering world was then beginning to realise and to acknowledge the tremendous and, indeed, the unrepayable debt which it owed to him.

The Modern Diesel Engine

In his book on the principles of the Diesel engine, Dr. Diesel wrote :

" The working of present-day heat engines by no means satisfies the requirements for economical combustion ; thus the hope is justified that my new engine will fulfil its object and reduce the fuel consumption to that degree possible with the means in the hands of modern science."

Such was the hope of the engine's inventor. It is a hope which has fulfilled itself probably far above the wildest dreams of its originator. The modern Diesel constitutes one of the world's most economical engines, if not, in fact, *the* most economical prime-mover, so far as actual fuel consumption is concerned. In the early days of electric-current production when dynamos were belt-driven, a steam engine would suffice for the driving of the generators. Nowadays, however, when the prime-mover is invariably coupled directly to the dynamo or generator shaft and when the engine and generator are combined together into one compact and neat-looking power unit, the Diesel engine is often essential for the purpose of power production. More and more is it coming into use. It is, as we have seen, cleanly economical, efficient, fast-running, reasonably trouble-free, and reliable, and it is readily erected within a confined space.

TRACES OF METALS FROM TONS OF ORE

OF all the trick devices which the modern mining engineer employs to work up traces of metals from tons of ore, that called froth flotation is the most fascinating. By buoying up fine particles of metal in an air bubble, it is quite possible to treat gold ores which contain only 1 ton of gold in 200,000 tons of ore. Also, copper pyrite, zinc blende and galena (lead sulphide) are won from ores containing only 1 or 2 per cent. of metal.

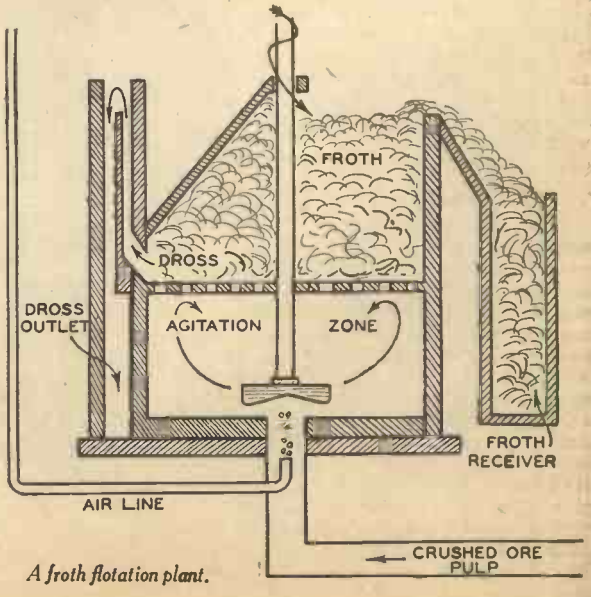
If froth flotation had not been perfected to its present refinements, the world would be shorter of gold than it already is, and the electrical industry would be hampered in development by prohibitive prices for copper and lead. As it is, mining engineers are going over the old dumps of tailings in order to work up the dross of older processes by modern flotation methods.

A Physical Process

Froth flotation is a purely physical process. The ore is stirred up with water, to which is added a trace of oil, a little soap or creosote, and water glass or other alkali. The oil prevents the metal in the ore from becoming wet. The soap makes the water froth, and the alkali ensures that the earthy dross is turned into a wet mud by the water. Naturally, the dry metal floats up with the froth, because of the air bubbles which cling to it. Thus, by a proper selection of substances, a 95 per cent. concentration of metal is frequently secured.

The right selection of reagents added to the water, is largely a matter of experience. The engineer in charge of the flotation circuits is always ready to try something new. One mining camp in Alaska got stocked with a few hundredweight of carbolic soap. Alaska is rather cold, and as there was not much run on the soap, it eventually found its way to the flotation engineer. He tried it in one of his flotation tanks, and to his surprise, obtained a really notable increase in efficiency. Having an investigator's mind he looked for the cause, and found out that it wasn't the soap, nor the carbolic acid in the soap, but the small amount of the dye called rhodamine which is used to colour carbolic soap red.

Froth flotation finds uses nearer home. It is used to clean coal slacks from ash on modern colliery washery plants.



A froth flotation plant.

The Making of Radium

What Radium Looks Like—Its Cost, Manufacture, and Properties. These and many other worth-knowing Facts concerning the world's Wonder-Element are described below

WHEN, on December 26th, 1898, Madame Curie announced for the first time the discovery, made by her husband and herself, of a new element which she happily-named *Radium*, she can hardly have imagined that the chemical curiosity then exhibited would, before long, form the basis of a large industry. Such, however, was the case, for in 1902, barely more than three years after radium was given to the scientific world, the commercial production of this remarkable substance was begun.

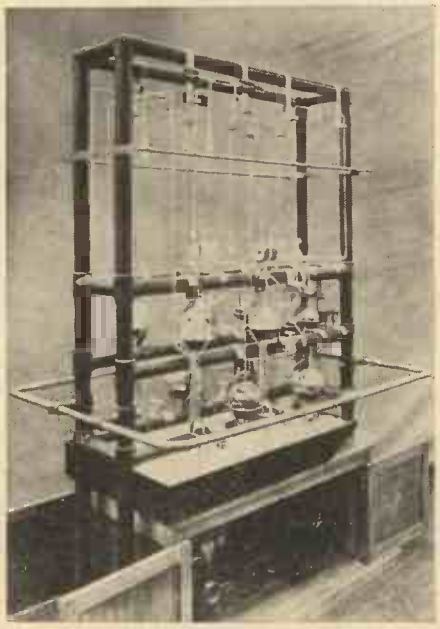
In 1902, despite the enormous difficulties of its extraction from ores, radium was not an extraordinarily expensive material, it being valued about that time at 15 marks per milligram. As, however, the many-sided properties of radium became better understood, and, more particularly, as its applications for medical purposes began to be realised, the production price of the precious material rose rapidly. In 1903, radium was priced at 24 marks per milligram, 224 marks per milligram was its cost in 1906, whilst a year later the 1906 figure almost doubled itself. At the end of the war, radium salts brought about 700 marks per milligram. Since that time, however, production costs have gradually decreased with the result that a milligram of radium bromide may now be purchased for approximately 270 marks, a sum equivalent to about £13 or £15. The purchaser of a milligram of radium bromide, however, does not get much for his money, this quantity of radium salt being able to fit comfortably on a decent-sized pin-head.

The Rarest Element

Radium, whilst not the scarcest of the known elements, is certainly the rarest one which is produced on a commercial basis. At first, the world's radium supplies came from the uranium ore known as "Pitchblende," which is found in Bohemia. Then, when American radium production got into its stride, the precious element was located in the carnotite ores mined in Paradox Valley, Colorado. Still later, richer supplies of radium were found in the copper-bearing minerals situated in the Belgium Congo and these later ores, together with those emanating from the Colorado mines, now constitute the world's main sources of radium.

Even in the richest of radium ores, there is only a fraction of a grain of radium present per ton of the ore. Moreover, it is certain that radium will never be found in much greater quantity for the reason that it is formed by the decay of uranium, a still heavier metal. Now, since this process of transformation or decay is an exceedingly slow one and since, also, radium, itself, decays in like manner, forming, eventually, lead, it follows that it is impossible for large supplies of radium to accumulate in the earth's crust.

In the Paradox Valley mines, Colorado, radium is present to the extent of about one gram to 250 tons of ore. The Belgian Congo mines have a higher percentage of



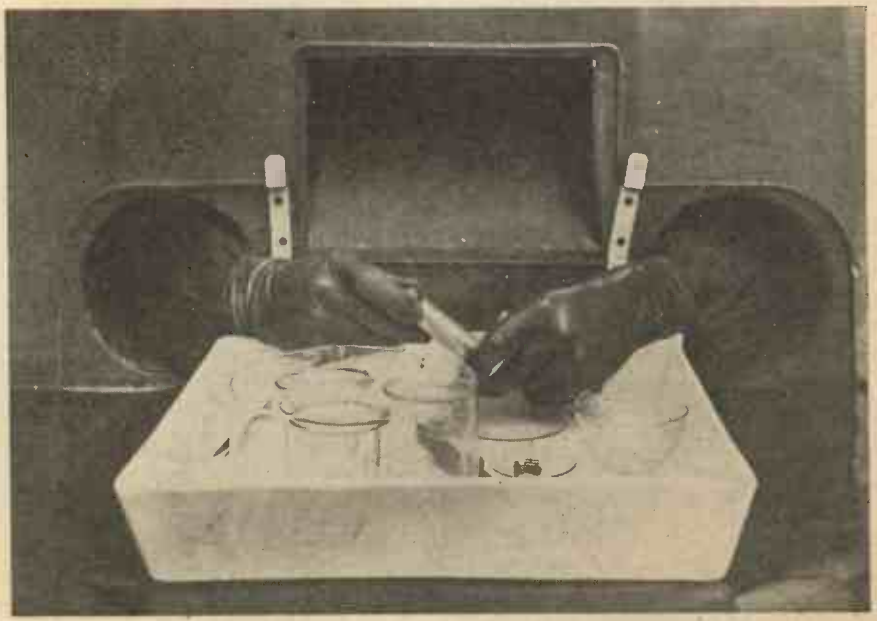
The complicated chemical apparatus employed for the purpose of collecting "Niton," the gas evolved by radium salt. Apparatus similar to this is installed in all hospital laboratories.

radium, yet, even with these ores, about eight train loads of crushed ore, representing more than 200 tons of the material, are required for the extraction of a single gram of radium salt, a quantity which, incidentally, is less in bulk than a thimble full.

Three Main Stages

It is possible to divide the production of radium into three main stages. The first of these stages consists of the selection and crushing of the ore and the removal of the "sterile" material. This is effected by treating the crushed ore with sulphuric acid which dissolves out the copper, uranium, radium and iron. To this acid-extract various chemical treatments are applied and finally a white powder, known as "crude sulphate" is produced. This is chiefly a mixture of radium and barium sulphates in the proportion of 1 part of radium sulphate to 125,000 parts of barium sulphate.

In the second stage of radium production, which is carried out at the refineries, the radium and barium sulphates are converted into chlorides and, at the same time, the radium concentration of the mixture is much increased. The third stage of radium manufacture consists in the separation of the pure radium and barium chlorides by the tedious process of "fractional crystallisation." This consists in repeatedly crystallising the solutions of the mixed chlorides, radium chloride being less soluble than barium chloride and thus tending to crystallise out first. Many hundreds of these crystallisations are required before the barium and the radium salts are finally separated. Finally, however, when pure



How radium compounds are handled. A "radium box," lead-lined, with arm-holes through which the operator thrusts his completely gloved hands and looks down at the operations through a lead-glass window in the front of the box.

radium chloride or bromide is obtained, it is carefully dried and then hermetically sealed in small glass tubes in the glass of which a length of platinum wire is fused in order to conduct away positive electricity which would otherwise collect in the tube.

The largest radium factory in the world produces only 5 grams of radium salt per month, a quantity which would fit easily into a teaspoon.

What It Looks Like

Many people have sought to know what radium looks like and, usually, these enquiring individuals have been greatly surprised when they have been informed that only a handful of scientists have ever seen radium. Even the majority of hospital workers who are accustomed to handling radium preparations every day in their lives have never actually seen "the real thing." Radium is a metal. It has a white metallic lustre and it melts at about 700 degrees Centigrade, which is approximately fifty degrees higher than the melting point of aluminium. In order to prepare metallic radium one has to electrolyse a radium salt, such as radium bromide, using mercury for the cathode. The liberated radium amalgamates with the mercury and the resulting radium amalgam is then distilled in a current of hydrogen. The mercury distils away, leaving the radium metal behind.

For all commercial and medical purposes, however, radium is never used in its pure metallic form. It is always employed in the form of its salts. In appearance, a salt of radium, such as, for instance, radium bromide, is very like Epsom salts. Usually, however, radium salts are self-luminous. This luminosity is not a property of the radium salt itself but is due to the presence of extremely small traces of impurities which exist in the salt and upon which the radium acts with the production of the luminescence.

A curious fact about a radium salt is that no matter to what degree of heat or cold it may be exposed, the preparation invariably has a temperature some degrees higher than that of its surroundings. Also, rising from the surface of the radium salt is a luminous haze, a sort of chemical will-o'-the-wisp. This is a gas which is continually given off by the radium salt. The gas is called "Niton"—the "shining one,"—and it is this gas which is the most used in all the applications of radium, for it possesses all the properties of radium and is more easily conveyed from place to place than the radium salt itself.

Its Curative Properties

"Radium needles," for instance, such as are employed for curative purposes in hospitals, are simply needle-like glass tubes containing definite amounts of Niton. The hospital has its carefully preserved store of radium salt and from this material the radium needles are filled. Since a mass of radium salt will continue to evolve Niton for a period of nearly 2,000 years, it follows that the hospitals of our present generation need never fear a stoppage of their supplies.

Radium cures ulcers and other malignant growths of the flesh, but, at the same time, when applied in greater amounts, it can also act as a most potent and deadly flesh-rotting agent. An unprotected tube of radium carried in the pocket would quickly create a most painful ulcer in the neighbouring flesh of the carrier. All workers in radium take the utmost precautions not to

A specimen of radium ore from the Belgian Congo mines.

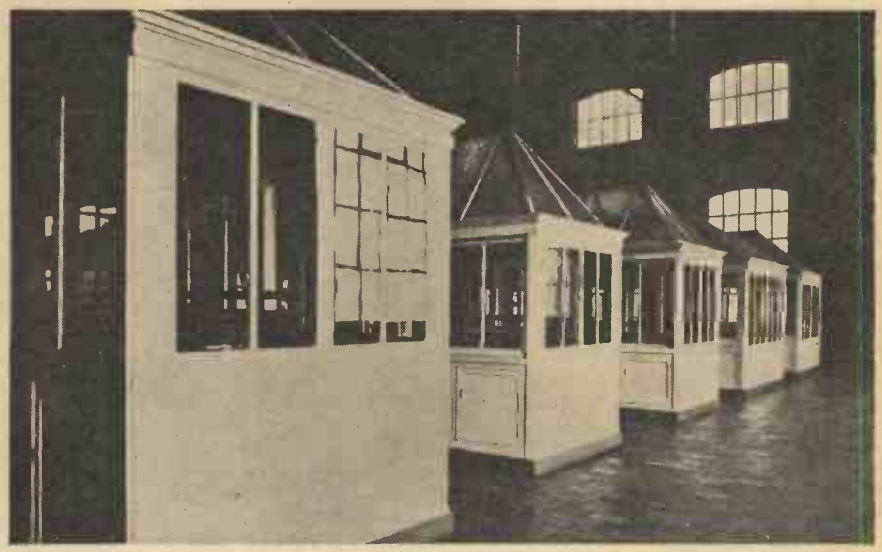
allow any of the rays evolved by the material to come into contact with their flesh. Thus, during the commercial production of radium, the final crystallising operations necessary for the obtaining of the pure radium salt are carried out in separate lead-lined, lead glass-windowed cubicles. This is not merely for the purpose of guarding against possible loss of the material, but it is also to ensure that a minimum amount of harmful radium emanation escapes into the outer air of the factory.

Individuals who handle radium salts always protect their hands with thick rubber gloves. The hands, thus protected, are then thrust through arm-holes contained in a lead-lined glass-windowed box into which the radium materials have been placed. As he handles the precious yet potent radium preparation, the operator looks through a lead glass screen which is placed conveniently above the arm-holes in the box. In this manner, all radium preparations are commercially packed without any harm being done to the packers.

Luminous Paint

One part of radium salt mixed with twenty-thousand parts of zinc sulphide confers the property of self-luminescence upon the latter material. Of such, consist the many radium paints which are employed nowadays for rendering permanently luminous the tips of watch-hands, the figures of watch dials, electric switch-indicating buttons, compass points and for numerous other purposes. In this connection, it should be stressed that radium paints are *permanently* self-luminous and that they do not require frequent exposure to strong light for the renewal and continuance of the luminescence as is the case with the more common and non-radium luminous paint preparations.

It has been estimated that quite a quarter of the world's radium production goes into the making of self-luminous paints. The remainder of the radium supplies are, of course, taken up by scientific and medical institutions. Radium production may possibly, at some future time, be cheapened in consequence of the working out of better methods of extraction and purification of the precious material. But, as pointed out previously, radium cannot occur in the earth's surface in any large quantities and thus this nowadays much-talked-of substance can never become a common material.



For the purification of radium salts, the employment of separate lead-lined glass-windowed cubicles is necessary, as explained in the article.

Varnishing Hints

MOST forms of woodwork can be improved by varnishing them; the varnish not only improves the appearance and keeps the surface clean, but also preserves the material. There are two general classes into which varnishes can be divided—one is that which includes all those having methylated spirits as a solvent, and the others have linseed oil and/or turpentine as their base. Spirit varnishes are quick-drying, but do not generally give so good a finish as the oil varnishes. It is often a good plan, though, first of all to apply a coat of spirit varnish (such as shellac), and then to follow this with a coat of oil varnish. The shellac fills the grain and hardens the surface, whilst the oil (copal is the most common and best kind) varnish produce a glossy finish. The shellac has a slight tendency to lift the grain, and so it is usually best to rub down with fine glass paper between the two coats. Shellac varnish can be bought ready mixed or may be made of solid shellac in methylated spirit. It should be made very "thin," otherwise, it is liable to dry white or sticky.

Oil varnish is usually treacly, and to obtain a good finish it must be applied as thinly as possible, starting at one end and gradually working towards the other, spreading the varnish out as far as it will go. If it is put on too thickly it will not dry hard, nor will it give so glossy a finish. All varnishing should, however possible, be done in a room which is free from dampness.

DRIVER

POWER TOOLS

A Line of Motor Driven Precision Machine Tools.

SUPERIOR TYPE
for
AMATEUR HOME WORKSHOPS
and
WORKS COMMERCIAL PRODUCTION

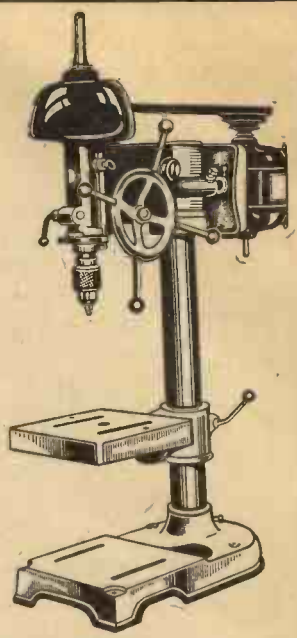
BEAUTY IN MACHINERY

WITH STURDY UTILITY

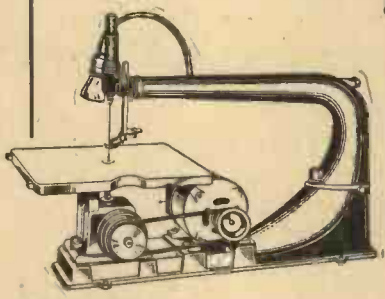
DESIGN AND ACCURACY ABOVE AVERAGE STANDARD. DRIVER TOOLS ENABLE REALLY HIGH-CLASS UNITS TO BE OBTAINED AT MODERATE PRICES.

If unable to obtain, we can advise of source of supply

Manufactured by
WALKER TURNER COMPANY INC., PLAINFIELD, NEW JERSEY, U.S.A.



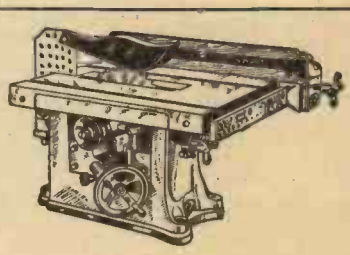
DRILL PRESS
Six-splined Spindle. S.K.F. Ball Bearings. Jacobs 0"—½" Drill Chuck. Pilot Wheel Calibrated Feed. Positive but soft action. Spring return. ½ H.P. Motor.

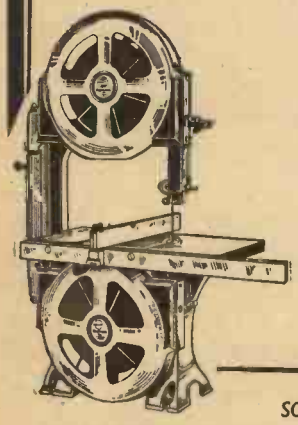


JIG SAW
24" Jig or Scroll Saw. Arm may be swung to right or left. Tilting Table. Graduated Quadrant. Streamline Design. Does Vertical Accurate Metal Filing of various patterns.

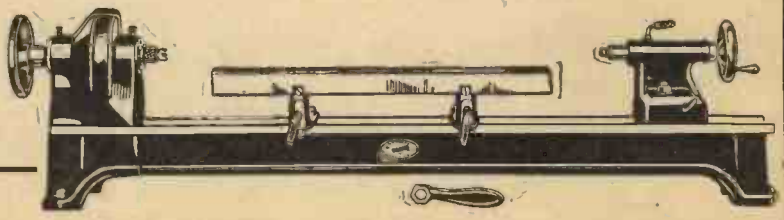
JOINTER
Long. Heavy Construction, 4¼" Cutter Head, 5,000 R.P.M. S.K.F. Bearings. Tilting Fence. Dual Purpose Guard. Spring Hold Downs. 28" Overall.

8 in. BENCH SAW
16" x 13" Table, extends to 25". Worm Gear Raising and Lowering Table tilts to 45 degrees. New style Ripping Guide. Sawdust Chute in base. S.K.F. Ball Bearings. Geared Indexing Mitre Gauge.





LATHES
Wood or Metal Working with Compound Slide Rest. Hollow Head Spindles. Left end of Spindle threaded for Large Face plate Work. S.K.F. Ball Bearings. Morse Taper Centres. Tail Stock Set-over for Taper Turning. Extra Strong and Rigid throughout.



12 in. BAND SAW
Most completely equipped Band Saw built. Balanced Wheels—Rubber Faced. 6 S.K.F. Ball Bearings. Tilting Table, 12½" x 12", extensions to 18" x 12". Ball Bearing Guide Rollers. Extra Capacity Feature.

SOLE CONCESSIONAIRES—

E.P.BARRUS LTD.

35-37, UPPER THAMES ST. LONDON.E.C.4

The Dam showing the sluices, only a few of which are working.

In this beautiful park are the homes of the employees working on the Dam.

THE ASWAN DAM

AT the time of writing a project is under consideration to make use of the waste water power from the Aswan Dam to generate electricity. Few people are aware that the dam is so enormous that if all the sluices were closed so that the Nile flowed over the top, it would form a waterfall vastly bigger than any in the world, and many times greater than Niagara itself.

From the dawn of history Egypt has been the land of mighty monuments, and it still contains some of the greatest structures ever raised by the hand of man. Although the Aswan Dam weighs more than a million tons, this is less than a fifth of the mass of the Great Pyramid, which was erected nearly five thousand years ago. Even so, in some respects the Dam is a much more important mechanical achievement, for it was built across the bed of a rushing torrent, while the Pyramids are merely placed on dry rock. The Pyramids too are devoid of practical value, while the Aswan Dam has already saved millions of lives from famine, and has brought hundreds of thousands of acres of desert into regular cultivation.

The Agricultural Position

In order fully to understand its value, we must consider the agricultural position in Egypt. Except for a few districts in the Delta, the whole country is practically rainless, having neither *rainy season*, nor *rainy region*, and yet its cultivated area is the most fertile in the world, and can produce five crops in a year. From the remotest antiquity there has been "corn in Egypt" when harvests failed elsewhere, and this was due to the annual floods of the Nile. Four or five thousand years ago, production was increased by the BASIN SYSTEM of irrigation, which is still used. An area of land is enclosed by earthen banks, and is filled with water 4 or 5 ft. deep during the floods. This not only saturates the ground so that it can produce a crop as soon as the floods recede, but also soaks the subsoil so effectively that shallow wells along the line of the canals will yield throughout the whole year, and thus permit of continuous cultivation by hand labour.

Perennial Irrigation

Even to-day there are basin areas in Egypt

> The Aswan Dam has Brought Hundreds of Thousands of Acres of Desert into Regular Cultivation

of 50,000 acres, but they are giving place to a better system called *Perennial Irrigation*, by which water is available in the canals all the year round, and so can flow naturally over the land. The root difficulty in arranging this is that *most of the land is higher than the level of the Nile*, except when in flood. If, however, a dam is placed across the river to raise its level, the water can then be carried to the higher land by means of canals. These, however, have to be very long, because the drop of the River Nile is only 6 *inches to the mile*, and as a 3 *inch drop must be allowed in the canal to* cause the water to flow forwards, this means in effect that if we raise the water 6 ft. it needs 24 miles of canal to carry it.

Rapid Development

In spite of this difficulty, the development of the country has been so rapid under British rule—which abolished the graft and extortion formerly universal—that so many of these canals were made that the whole of the water in the Nile was used up! Incredible as it may seem, it is yet a fact, that during the years from 1890 to 1902 not a single drop of Nile water reached the sea during the months of May and June each year. There was also the problem of an occasional "low Nile" during the flood season. The average rise is 30 ft., and it may occasionally reach 35 ft., but there have been bad seasons when it did not exceed 8 ft. No doubt the *seven lean years* foretold by Joseph, were periods of low Nile, and such have always been followed by widespread famine before Britain came to

Navigation canal and set of docks. The canal is 1¼ miles long, and has a rise of about 80 ft. by means of the docks.

The Aswan Dam, showing the water held above it. The height of the Dam at first was 130 ft., but it has since been raised 17 ft., and the thickness doubled.

Egypt. Thus in 1877 low Nile caused many deaths through famine, and 947,000 acres of cultivated land went back to desert. But the skill of British engineers, and the mighty works rendered possible by the peace and prosperity which we have brought to a previously bankrupt country, have abolished all risk of loss through low Nile. Thus in 1913 the flood level of the Nile was the lowest for 150 years, but thanks to the Aswan Dam—completed one year earlier—agriculture went on as usual, and there was neither water shortage nor famine.

The Designers

The Aswan Dam was designed by Sir William Willcocks, and Sir Benjamin Baker was the chief of a group of distinguished engineers who carried out this stupendous task. The site selected was at the head of the First Cataract, 3½ miles above the town of Aswan, at a spot where the world's greatest river hurls itself through a rocky gorge with great violence. The rush of water had always been a serious hindrance to navigation, ships had to be hauled up by huge gangs of natives, just as they still are on some Chinese rivers to-day. The Aswan Dam solved this problem also, for by means of a side canal, and a series of six gigantic locks, ships can now climb to the summit of the Cataract by their own power and in calm water. The reason for the selection of the site was chiefly that the bed of the river here was solid granite, a most important point when it is desired to anchor a wall which holds back millions of tons of water. The actual water weight is 2,400 million tons. Two tremendous difficulties faced the engineers from the beginning of their task. The first was the problem of the silt, or Nile mud held in solution. During the flood season a vast amount of earth is carried in the stream, and any interruption in its flow would cause the mud to drop *behind the wall*, and speedily fill up the river bed to the top of the dam, leaving only the world's biggest waterfall. This actually happened to another Dam on the Val de Infierno in Spain. The second problem was the rush of water below the Dam, which was liable to sweep away the river bed, and so undermine the foundations of the stupendous wall built upon it.

A Problem Solved

The first and greatest problem was solved by a very simple idea. The sluices were made at the *bottom of the dam instead of the top*, and so scoured the bed of the river above the Dam and carried all the silt through. There are 180 of these mighty gates—140 at the bottom, each 23 by 6½ ft., and 40 upper sluices, for the escape of surplus water. The Dam is 1¼ miles long, and holds back a lake 185 miles in length,

The memorial stone of the Aswan Dam.

which perhaps exceeds even the Gatun Lake in area, and if so is the world's largest artificial lake. The weight of the water is 2,400 million tons, and it has entirely drowned the beautiful temples on the island of Philæ a mile or so above the Dam. The top of the great pylons only is visible at high water, but at low water the whole island is again dry.

The Height of the Dam Raised

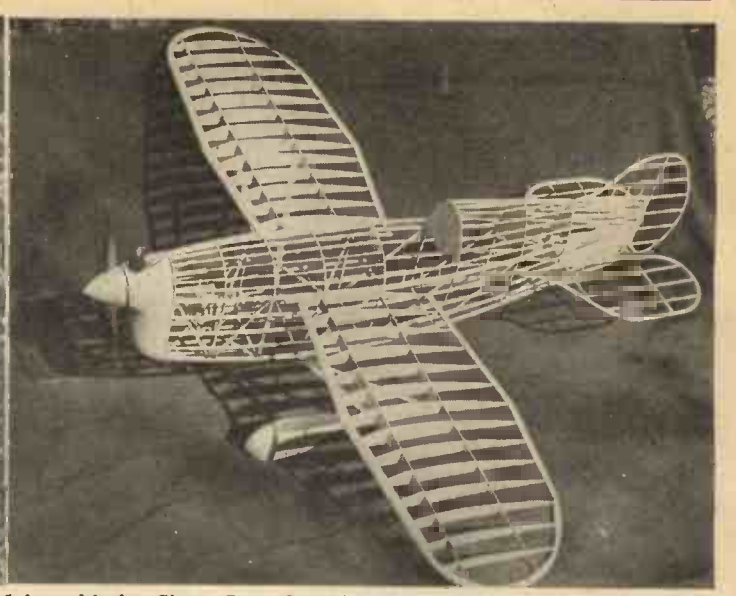
The height of the Dam at first was 130 ft., but the scheme was so great a success that in the years 1907 to 1912 it was raised 17 ft., and the thickness was doubled. The first cost was 3 millions sterling, and the additions cost another 1½ millions. In cross-section it is triangular, being very much thicker at the bottom, the top forms a splendid main road, with room for three cars to pass. The rush of water through the sluices is awe-inspiring. Before the Dam was raised, the maximum flow of waters was estimated at 34½ ft. per second, that is about 24 m.p.h., and it was considerably increased by the additional head of water pent up after the additions. Even when the Nile is not in flood the roar of the escaping waters from a few only of the sluices is deafening, and the spray rises in clouds above the top of the wall. This torrential rush has scored deeply into the granite bed of the river, and it has been found necessary to expend a quarter of a million pounds in constructing an apron of masonry, surfaced with smooth cement to protect the river bed below the outlets.

The Navigation Canal, by which vessels ascend to the top of the Dam, is a great work. It is 1¼ miles long, and has a total rise of about 80 ft., by six huge locks. This is a little less than the rise at Gatun on the Panama Canal, but of course that was built some years later.

The Cost of Water

The Aswan Dam has saved the cultivators of Egypt, and as long as it has been under British administration, the poorest peasant has only paid the same rate for water as the richest landowner. The fellahin—or small farmers—are hard-working decent fellows, they pay from £3 to £6 a year rent per acre for their land, and can live on holdings of 2 or 3 acres, sometimes even less. They raise the water by hand, using the Shadoof, which is simply a bucket suspended from a beam, having a counterweight, at the end of a swinging pole. Working from dawn to dusk one man can thus water 4 acres, but a sakia or irrigation wheel worked by bullock or camels can water as much as 12 acres. When the land is very elevated a team of Shadoofs are placed one above the other, and so raise water by hand to incredible heights. British residents in Egypt have recently informed me that if we leave the country there is grave danger that the vital service of water, upon which the lives of the peasants depends, will be ruined by the usual Oriental graft and corruption.

Small farmers obtain water by hand, using the Shadoof, which is simply a bucket suspended on a beam, having a counterweight at the end of a swinging pole.



(Left) Fitting the tail unit of a petrol model and (right) A 5-ft. model of a Chester Racer designed around a Hurlemann motor.

MODEL AERO TOPICS

By F. J. Camm

A 6 c.c. Petrol Engine

MESSRS. J. Hallam & Sons have recently submitted to me for test a sample of their "Nipper" Aero Petrol Engine. It weighs 6 oz.—1 oz. per c.c.—the propeller weighs 2 oz., the height is 4¼ in., and it drives a 14-in. diameter propeller at 3,000 revolutions per minute. Every engine is tested before despatch. Under test the engine starts remarkably well, and by means of the jet adjustment one is enabled to get the correct rich starting mixture and to close the jet down after the engine is started. The engine starts quite easily with a flick of the finger. Lubrication is by the petroil system—one part of oil to 5 parts of petrol, 1 oz. of fuel running the engine for 15 minutes. A steel cylinder liner is employed with a cast-iron piston and floatless carburetter fed from a suction tank. The engine with carburetter, contact breaker, miniature sparking plug, and propeller costs 3 guineas, or complete with tank coil and condenser £4. If fitted with flywheel and fixing brackets it costs £3 10*s.*

A set of castings and blue prints costs 10*s.* 6*d.*, the propeller casting 4*s.* 6*d.*, the miniature plug (⅜ in.) 3*s.* 6*d.*, or if a detachable plug 6*s.* 6*d.*, the 8-oz. ignition coil 12*s.* 6*d.*, the 1-oz. condenser 3*s.* 6*d.*, and the 7BA contact point 3*s.* The engine is very well designed, and I am glad to note that Messrs. Hallam have tackled the problem of producing even smaller petrol engines in view of my recent comments on this subject.

The Model Aircraft Club

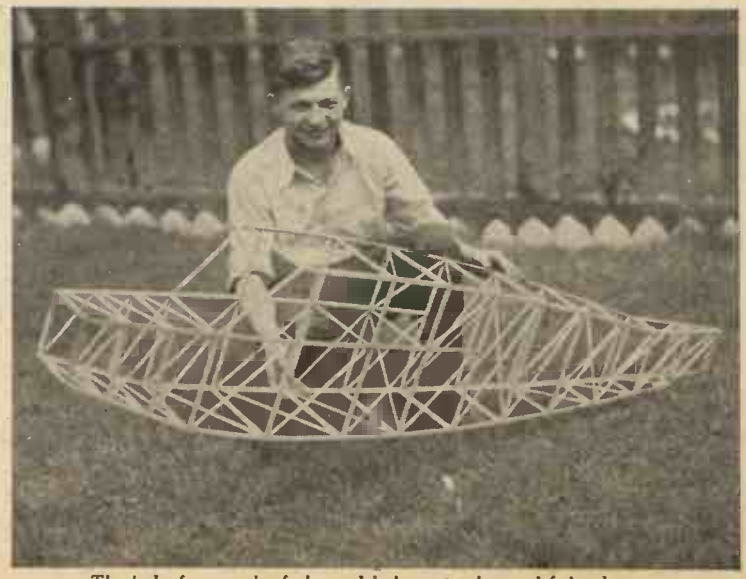
The above Club have arranged a construction and flying contest which will take place on Saturday, May 30th, and Sunday, June 7th, at Wimbledon. Cash prizes will be awarded and free membership for one year. Any type or design of model aeroplane may be copied, but must be constructed by the competitor, although items such as the propeller, wheels, and gear need not be made by the competitor. Competitors are advised to make any of the well-known designs such as those which have been published from time to time in PRACTICAL MECHANICS, and also in "Model Aeroplanes and Airships," and "Power-driven Model Aircraft." Marks will be awarded for design or resemblance to type, workmanship and finish, stability and gliding, and flying. Entries should be sent to the Hon. Competition Secretary, Mr. H. Fialko, 31 Whites Row, London, E.1.

New S.M.A.E. Rules

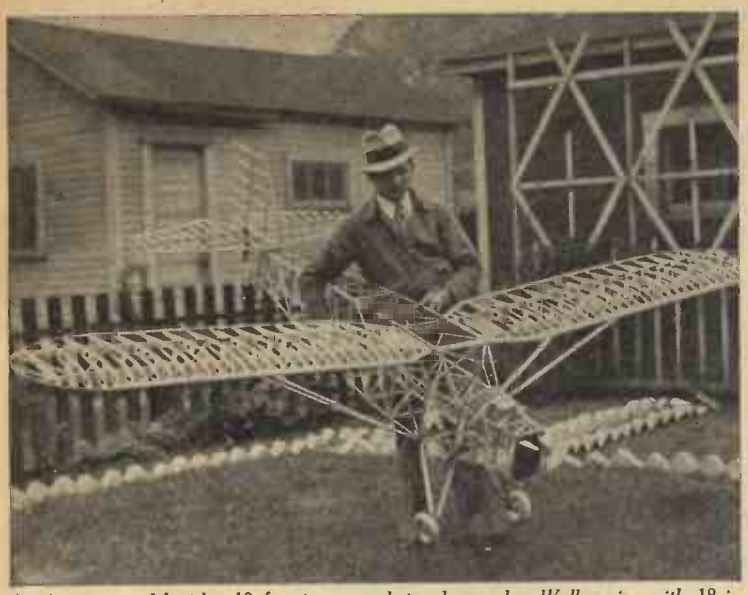
In view of my previous criticisms of the S.M.A.E. rules it gives me pleasure to record that they have now been amended in accordance with the suggestions I made. An important rule is that no privileges whatsoever are accorded either a fellow or a patron of the S.M.A.E. and to enter a competition he must either join an affiliated club or pay the correct fee. There are only about eight fellows of the S.M.A.E. The Council is to consist of delegates nominated by each affiliated club, and all officers of the Society retire annually. Personally I should have welcomed the addition of a rule defining who is a professional and who is an amateur and barring from competitions any member who is engaged on the making of model aeroplanes and/or parts for profit. I regard this as really important, but no doubt this can be adjusted a little later on.

The Wakefield Cup Fund

The S.M.A.E. have booked three cabins which will be filled with a complete team of six and a Manager, the remainder of the ten berths being occupied by visitors. The cost to a visitor is in the neighbourhood of £60. The competitions themselves will be held at a three-day meeting at Akron from June 30th to July 2nd inclusive, the Lord Wakefield Cup and the admirable Moffat Trophy being flown during this meeting. At the invitation of the National Aeronautics Association of America the English team will be allowed to compete in all events at this meeting, and a comprehensive list of entertainments for the British visitors has



The body framework of the model shown in the top left-hand corner.



An American model with a 10-ft. wing span, designed around a Wall engine with 18-in. propeller, 12-in. pitch.

been arranged. The team will arrive in New York on June 26th and leave for England on July 8th or 10th.

Windsor Model Aero Club

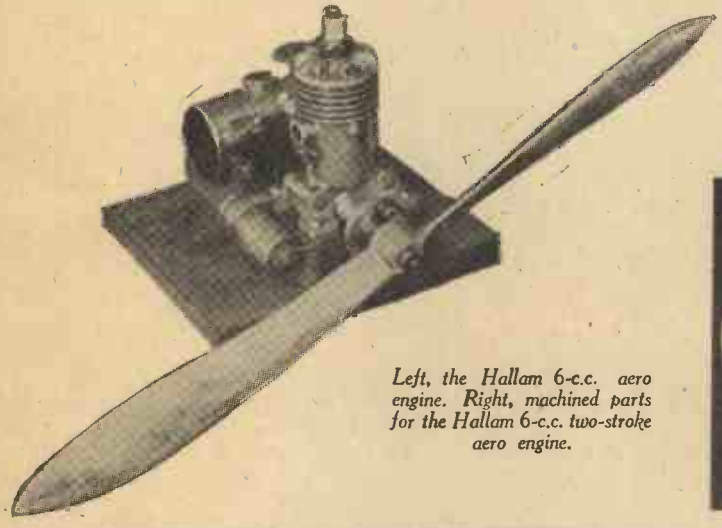
Readers should note that the above Club founded in Windsor, Berkshire, before the War is not connected in anyway with another club of similar name operating from the Manchester district.

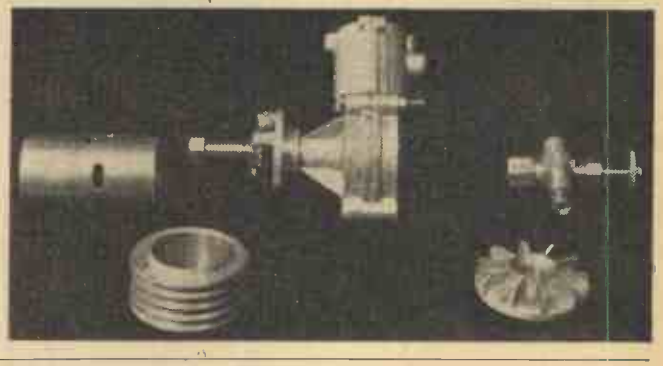
In America

I show a further group of illustrations this month of some American petrol models, from which it will be observed that the designs for some reason or another closely follow full-size practice. The detail work is amazing, but in spite of the fact that there is an almost ludicrous copying of full-size form, most of the models fly fairly well, although the best performances have been put up by those which would be termed "freaks" in this country. The workmanship in the models shown is of the finest, although I should have preferred less Balsa to have been used. Some of the detail work is more apparent than real and instead of skilled jointing, neat little fittings, and other items which standardise the English model, plain, butted, and grooved joints are used, and reliance is placed upon the fabric and the doping to hold the structure together. Some of the fuselages are covered with Japanese tissue doped with banana oil. All the same, they are fine-looking jobs when complete, although their durability cannot be of a very high order.

A Wingless Model

I have received news that a Japanese inventor claims to have produced a wingless model aeroplane. Although the available details are scanty, it would appear that it has been quite successful. It would seem that some system of rotors replaces the normal cambered wing, and I look forward with interest to receiving further details. In America, of course, several successful rotor-type model aeroplanes have been produced, and some of them have been marketed. I cannot understand why it is that we always seem so far behind the times in the commercial aspect of model aircraft in this country, bearing in mind that we have had longer experience. At the present time an enormous amount of model aircraft material is imported into this country from America, who have themselves imported it from Japan—a somewhat curious way of doing business.





Left, the Hallam 6-c.c. aero engine. Right, machined parts for the Hallam 6-c.c. two-stroke aero engine.

"Studio Portrait Lighting," by Herbert Lambert, F.R.P.S. 88 pages. 34 plates. Published by Sir Isaac Pitman & Sons, Ltd. Price 15/-.

THIS is a second edition of a complete work on the subject of portraiture in the studio, and the subject of lighting is, of course, of primary importance. No matter how good the camera or subject, or how skilled the operator, if the lighting is badly chosen the picture will not show the subject at its best. Every subject requires individual selection of the lighting source in order to hide defects in the features or to enhance others, whilst certain types of subject, such as children or "character types" will only be brought out at their best when a particular combination of lighting is employed. For instance, an aged person whose face is very wrinkled is a very difficult subject if the shadows are to be more or less completely hidden, and this is in fact one of the subjects which is illustrated in one of the plates, where reflected and direct, side and front lighting is employed with splendid effect. The plates show actual portraits, and on the facing pages the studio layout is shown with the values of the light sources. The book deals with the traditions of portraiture, the theory of tone reproduction, the various light sources (arc, gas-filled lamp, mercury vapour, etc.), and the arrangement of the studio. In the appendix there is a complete explanation of the mercury vapour lamp.

"Colour Photography," by R. M. Fanstone, A.R.P.S. 171 pages. 14 plates. Published by Sir Isaac Pitman & Sons, Ltd. Price 12/6.

THIS interesting treatise on photography in natural colours is a new edition of the book written by the late Capt. Owen Wheeler, F.R.P.S., who was, of course, the inventor of the Dyebro process. The book has been brought up to date by excluding some of the details in the first edition which are no longer practicable and includes other processes which were not in existence at the time of the first publication. Thus, the book is practically re-written and includes, in addition to an explanation of the history of photography in colour, a complete explanation of the various essentials and details of the many processes which may be used. The book is divided into four parts, covering respectively the theory and history, the practice in general, special processes, and finally the miniature camera, the cinema and art in colour photography. At the end of the book there are twelve separate full-size art coloured plates showing the complete make-up of a picture in the Dyebro process, including the separate colour prints in each stage, and the final amalgamation of the three-coloured prints to form the complete picture. The book gives formula, dark-room data, safelights, and all essential details to enable the photographer to embark on this interesting branch of photographic art. It is a valuable production.

THE MAINTENANCE OF DOMESTIC ELECTRIC MOTORS

An Instructive Article Dealing Mainly with the Series Type of Motor.

THESE notes are intended to deal with the ordinary small-power or fractional horse-power motors found in the modern household. It is admitted that certain types of apparatus, such as lifts, require special motors, but as these are found only in hotels and larger residences, the maintenance of lift motors has not been dealt with. For the purpose of this article we could confine ourselves to the series type of motor, but since other forms are coming into use, some notes on these will not be out of place.

The Series Machine

This is used on all small apparatus where the load is constant. It is idea for fan driving and vacuum-cleaner work, but its use in such tools as hand drills and polishing heads may puzzle the reader. There are two very big points in favour of the series machine, the first being cheapness, and the second that it is a universal motor, *i.e.* can be run on both A.C. and D.C. of the same voltage. This means that a manufacturer can send a machine out without troubling about the nature of the supply. The racing of series machines in these two applications is apparent to all who use them, once the polished article is removed from the brush or buff the motor revs. up, similarly when the drill is started and when the hole is cut. Constant-speed machines have many applications apart from those mentioned above, as refrigerator operation, pumps, and compressors, etc.

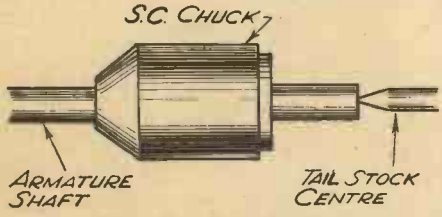


Fig. 1.—The method of mounting the armature.

The types of motor met with in the average installation are given in the table on this page, but do not be surprised if you find some variations from this. It is best to judge from the apparatus the type of motor you would expect to find. The series machine is undoubtedly the most common, but is generally overrated to prevent racing when the load is removed or slightly lessened. This is very noticeable on drills, dental apparatus, etc., and as a result, the effects of overloading have often to be dealt with. When overhauling a machine, it is necessary, before dismantling, to examine the bearings by shaking the shaft. If the machine is in running order, run it and make a note of any obvious faults such as sparking at the brushes, vibration, noise, lubrication, and bearings, and bearing wear in relation to the nature of the drive.

Brush Connections

If possible, the motor should be completely dismantled, and the connections to the brushes should be noted, for a reversal would mean a change in the direction of rotation of the armature. Clean all the parts, wipe old oil out of the end bells, wash out the lubricating cup with clean petrol and pass a fine wire through any oilways. Test the brush pressure and freedom, and observe that they slide easily in the holders. If a brush needs replacing, write to the makers for a new one and *don't* try to "fudge" one up from a larger size. Never use a battery carbon, the sparking will surely ruin the commutator and the machine will shut down on its own accord. The bearings in most machines are plain bushes, and if worn, it will necessitate the use of a lathe to replace them. The original bushes must be pushed or tapped out of the end bells. Ball-races are more often fitted to the constant-speed machines than to the series, but when worn, they emit a nasty scream which rises to a higher pitch on stopping or starting. In replacing the ball-races it is generally necessary to use a screw-press or a bench vice, but with most machines, the end bell is too large to fit in the vice. Before condemning a ball-race, try the effect of a wash out and some new grease; a dry and dirty race is very similar to a worn one. Several makes of the smaller type of polishing machines are fitted with ball-races and very short shafts, so that the pumice and polishing materials find no difficulty in entering the bearings in spite of every precaution. If you service this type of machine, make certain that the bearings are cleaned and re-greased regularly.

TYPES OF SMALL POWER MOTOR

Type.	*Application.*
Split phase or repulsion starting	*Small non-reversing drives similar to D.C. shunt machine.*
Series commutator	*Vacuum cleaners, sewing machines and other light work.*
Repulsion induction	*Reversing and non-reversing for pumps, lifts, cranes, etc.*
Synchronous	*Clocks, timing apparatus, and picture reproduction, etc.*

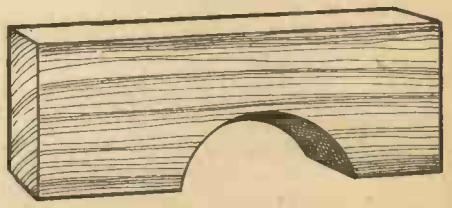


Fig. 2.—Constructional details of a sand-paper holder.

Cleaning the Commutator

The commutator should present a dull coppery surface without blackening or filling of the bars. Clean with fine sandpaper and remove all dust. Unless the machine has only been slightly used, the commutator will need treatment, but if the brushes have worn a definite groove in the bars, the whole armature must be set up in a lathe and the commutator skimmed down. In most cases, the original centring holes or marks will be present in the armature shaft, and if these are used, make sure that the commutator turns truly with the shaft. In this method the armature is driven through a carrier and catch plate, but a more accurate method is as follows. Take a self-centring drill chuck, and very accurately centre the

shank, grip one end of the shaft in this, place the other in the self-centring chuck, and run in the usual way on the tailstock centre. The drill-chuck shank should be cut down to a convenient length before centring, and once made, may be used on any armature within its capacity. This method of mounting ensures that the commutator runs in exactly similar conditions as in the motor housing (Fig. 1). If the commutator is pitted and rough, make a wooden holder to fit over it as in Fig. 2, and with fine sand-paper, reduce the surface. Make a holder for the armature as in Fig. 3, place the sand-paper in position and rotate the armature. After treating the commutator, the mica between each segment will be on the same level as the copper, and must be reduced below this level. The simplest way is to use a slotting-saw with a blade that just goes between the segments, one or two strokes will be sufficient. Have the armature in the stand and hold with one hand while cutting with the other. Failing the slotting-saw, use part of a hack-saw blade with one end ground flat, so that it will cut to the ends of the bars. After slotting, sand-paper the commutator again to remove any burrs and scratches (Fig. 4).

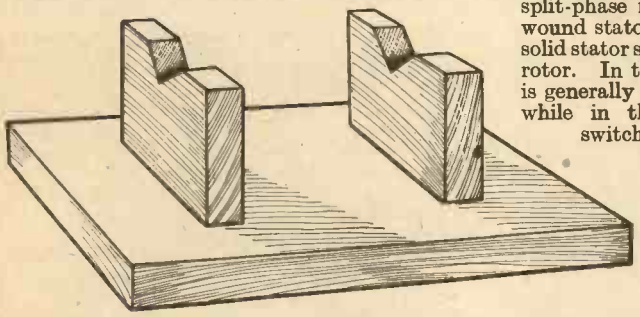


Fig. 3.—A simple armature holder for use whilst testing, etc.

Care of the Armature

Reassemble the motor, fill the grease cups, etc., and connect to the mains through a series resistance. Rotate the armature to see that all is free, test the brushes and then switch on. Let the armature crawl for some minutes so that the brushes will bed in. Do not allow it to rev. on the full mains voltage, but it can be brought up to normal speed by cutting out some of the resistance. If all is satisfactory, replace the motor in the machine and run up to speed again. Do not put the load on immediately, and don't be alarmed by any sparking at the brushes, as this will diminish when they bed down. A very simple variable resistance consists of 4 or 5 batten lamp holders mounted on a board, wired in parallel and connected to an adaptor through a length of flex. To test a motor, connect the ends of the flex to its terminals, insert, say, a 40-watt lamp and switch on. To increase the current, add more lamps, to decrease it put in a smaller one, but always switch off when changing the lamps. When you have reassembled a fan motor, do not run it for long periods without the fan, or it will overheat. This is very important with small fans such as used in hair driers.

Synchronous Motors

The next most common motor is the synchronous as found in electric clocks, but if this goes wrong return it to the makers or a clock repairer, as this work is beyond the average reader. If a clock fails for no apparent reason, examine the plug to see if the supply is *on*, test the connections to the clock and then test the windings for continuity. The mechanism of most "Warren" clock motors, is sealed and runs in an oil bath and cannot be interfered with, but some of the simpler clocks may be opened up and examined, although we never recommend this practice. If a clock stops, a few judicious inquiries will probably reveal the fact that the fuses have blown, or the clock has been knocked or dropped during household cleaning and dusting operations.

The above notes apply to all motors with commutators and brush gear. In dealing with other types, pay attention to the freedom of the brush lifting or shifting gear. In the repulsion motor, there are no connections to the armature, the brushes being connected through a stiff wire. In the repulsion start-induction run, the brushes are lifted from the commutator and the segments shorted when the machine gets up to speed, so that the armature acts as a squirrel-cage rotor. There are two types of split-phase machine, the first with a wound stator and the second with a solid stator similar to the squirrel-cage rotor. In the first case the starting is generally by a "Twinob" switch, while in the latter, a centrifugal switch cuts out the starting winding. In the "Capacitor" start, an old idea which has become popular due to the vast improvements in condenser manufacture, is that the rotor is a squirrel cage and the stator has two windings. The starting winding is sometimes left in circuit. In concluding this paragraph one point must be emphasised, and that is, if you have cause to break any connections, make a note of them before doing so, and place the diagram in some safe place.

Gramophone Motors

The electric gramophone motor is often neglected, due, of course, to the fact that it is never seen, but there is no excuse for this. Gramophone motors are divided up into three classes; for direct current only, for both A.C. and D.C., *i.e.* the universal motor, and the induction motor for A.C. only. All the above notes apply to gramophone motors, but there are a few points which require special emphasis. The first is lubrication. A well-used machine should be oiled and greased about three times a year, using only oils recommended by the makers or such products as "His Master's Voice" lubricants. Don't put oil in grease cups, or grease where oil is required, and never oil the commutators. Some skill is needed in dismantling a small motor; be extremely careful when handling the armature and do not bend the shaft by careless manipulation. In the disc type of induction motor, once the disc is removed, clean it most carefully, care being taken during the removal, as it is very easy to bend the disc while extracting it from between the poles. If a motor fails to run there are two very useful clues to the trouble. If the armature and turntable spin freely then the fault is electrical, but if the table is stiff, the fault is probably mechanical, *i.e.* tight bearings and lack of oil. The connections of an induction motor appear complicated, but if you have not the maker's sheet, note these carefully and put away for future reference. In the universal motors, a sliding resistance is often included for voltage adjustment and speed regulation. It is advisable to clean the contacts on this with fine sand-paper and remove all dust and particles of emery with a stiff paint brush.

Faulty Condensers

The fixed condensers, connected across the brushes of universal and D.C. machines to reduce sparking and interference, sometimes break down, and this is generally indicated by overheating of the regulating resistance and loud cracklings in the speaker.

In conclusion to these notes we must add some words on installing a new motor. Any power motor must be dried out and given a "megger" test before putting on the mains. This is rather beyond domestic equipment, but if you have access to a "megger," it forms interesting work. When unpacking a machine such as a fan, vacuum-cleaner or hair drier, make sure that all material is removed from the blades and that the armature is free to revolve, and if you know definitely that the motor and electrical gear are damp, keep in a warm room to dry it out. When a polishing machine is used with wet mediums, regularly test the earth connections to both the switch and motor, since operators using the switch with wet hands might receive fatal shocks. If provision be made for an earth connection, *use* it; always use the earth pin on a power supply—this is very important. Most vacuum-cleaners are provided with an adaptor so that they may be used from the lighting points, but if your house is wired for power, and there are sufficient sockets, change over to these, and by using a three-core cable, earth the metal frame of the cleaner.

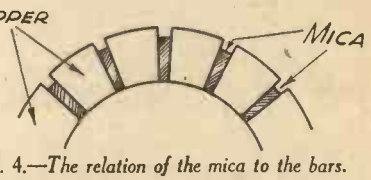
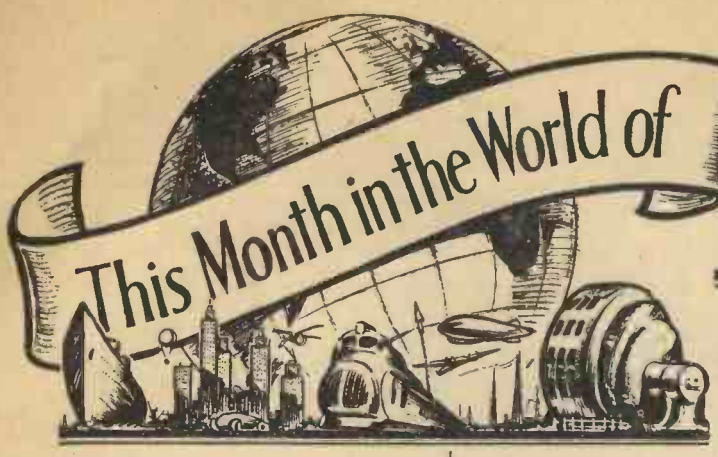


Fig. 4.—The relation of the mica to the bars.

Pay attention to all plug and motor connections, avoid cat's whiskers, and if a length of flex looks old reject it, because you may be sure that it will give trouble. Flexible connections to portable apparatus generally become faulty near the plug and at the point where the cable enters the appliance. On ordinary flex, the cotton covering soon slips down and exposes the rubber unless certain precautions are taken. Always use the cable clamps, but don't apply such force as to cut the insulation. Bind the flex with stout thread for about one inch, as this adequately protects the insulation against normal use.



Across America in 9½ Hours

A NEW record for the transcontinental journey between California and New Jersey has just been set up by Mr. H. Hughes, who flew a Northrup monoplane. He accomplished the journey in 9 hours 27 min., which is equivalent to an average ground speed of 259 m.p.h.

150,000 Horse-power

THE installation of a new turbo-alternator has just been completed at the Battersea power station. Its capacity is more than 40 per cent. greater than the next largest set in Britain, and it is easily the largest in Europe. The turbine is a 3-stage unit, the high-pressure stage operating with steam at a pressure of 600 lb. per sq. in. and a temperature of 825° F. It has a total horse-power of 150,000 and drives an alternator which delivers 105,000 kW. at a pressure of 11,000 volts. Except at times of peak loads, this set is capable of supplying the whole of London with electricity.

Safety in Mines

ALTHOUGH the Davy lamp and its modern descendants have done much to reduce the number of explosions in coal mines, serious catastrophes are still too frequent. Ignition of an explosive mixture occurs so readily as the result of some steel tool striking a flint, that considerable interest is likely to be taken in a new type of miners' lamp which has been invented, and which incorporates a device for warning when a dangerous concentration of explosive gas has accumulated.

A New Type of Level Crossing

STATISTICS show that in the U.S.A. a level-crossing accident occurs at the rate of one every 81 min., and that only 13 per cent. of the crossings have any form of barrier.

To reduce this heavy toll, a new automatic barrier is being adopted which is operated by the approaching train in a somewhat similar manner to the vehicle-operated traffic lights in this country. On the approach of a train, an illuminated barrier rises from the surface of the road. It rises slowly to a height of 4 in. to warn approaching cars, and at this height a car can pass over it without damage. It then rises to its full height of 10 in., at which height it forms a conspicuous and effective barrier. It is stated that a car weighing 2½ tons has been driven against the barrier at a speed of 30 m.p.h. without damage to the barrier, the car—or even the passengers!

Natural Gas Supplies

CERTAIN districts of America are fortunate in being able to obtain large supplies of natural gas from deep wells, and many towns derive their complete supplies from such sources. South-Western Ontario is particularly well supplied with natural gas resources, which is excellent for cooking and heating purposes, and it is stated that the total value of Ontario's natural gas output is over £1,000,000.

You can speak to your neighbour across the street without any wires by this simple device, seen being demonstrated by Dr. J. B. Kramer, of the G.E.C. It is simply a flashlamp and a microphone joined together and fed from the same battery. As you speak the light varies and so you can cause your voice to travel along the beam of light to your neighbour's window, where a photo-cell will change the light back to current, easily amplified and reproduced by loud speaker.

The Demand of Convention

A NEW cargo liner of 10,000 tons to be propelled by oil engines has just been ordered from Messrs. Harland & Wolff for service between England and South America. An oil-engined vessel requires only very small pipes to carry away the exhaust fumes, but such is the demand of convention that the vessel will carry a funnel of normal size. The surplus space in the funnel will not be wasted, however, but it will provide the living and operating quarters for the wireless operator, and will also accommodate the captain's bathroom!

Coal Petrol

TWO months ago we commented on the first petrol-filling station to supply British Coal Petrol to motorists—in Kensington. The number has now risen to nearly fifty, and each pump is surmounted by a globe shaped like a sack of coal.

Very Low Temperatures at the Science Museum

A SPECIAL Exhibition has been opened at the Science Museum to illustrate the production and uses of extremely low temperatures. Among other exhibits, the liquefaction and solidification of various gases is shown with their industrial applications. The meaning of the Absolute Zero of temperature and the methods used to attain and measure the lowest temperatures are shown by actual demonstrations.

Visual Telephone Service

IT is learned that a service of visual telephony has just been inaugurated between Berlin and Leipzig. No technical details, however, are yet available.

A New Use for Cathode Rays

IT is at present impossible to say with certainty what makes motor-car brakes squeak. To ascertain the cause, the Institution of Automobile Engineers have designed a special apparatus which utilises a cathode-ray tube to record the conditions causing a squeak.

Motor-cars to Run on Liquid Oxygen?

A CONTINENTAL firm has patented an arrangement for operating internal combustion engines with liquid oxygen. Hitherto this has been regarded as impossible on account of the instability of liquid oxygen, but if the technical difficulties have been overcome, it is an invention of great importance. Not only would greater power be developed, but all carbon deposits would be avoided.

Knitting Machines

THE knitting machine was the first important industrial machine to be invented—in 1589—and to-day it is quite the fastest. Knitting a woman's stocking of fine texture, the machine makes 1,500 stitches per second. A single stocking often contains over a mile of thread, and about 750,000 stitches.

Invention & Progress

A New X-ray Apparatus

ONE of the difficulties in taking X-ray photographs of the heart and lungs, is the length of time required for the exposure. With stationary apparatus, an exposure of $\frac{1}{4}$ second is required, while portable apparatus requires at least 2 seconds, and with such long exposures, considerable movement often spoils the pictures.

Considerable interest will, therefore, be taken in a new apparatus which is not only portable—thus permitting a patient to be X-rayed in bed—but which only requires an exposure of $\frac{1}{30}$ second. Only two sets are at present in existence in Great Britain.

For very rapid exposures, a power of 36 kilowatts is required, but such is the design of the gear, that no more energy is drawn from the mains at any one time than is required to light an ordinary electric fire.

Transatlantic Air Mail

ARRANGEMENTS are in course of preparation for twenty experimental transatlantic flights between New York and Copenhagen. Ten flights will be made in each direction, *via* Greenland, Iceland, and the Shetland Isles. It is understood that no passengers will be carried during the experimental flights.

The Ice Danger on Aircraft

ONE of the curious facts about ice formation on aircraft is that it only accumulates when the temperature is between 26° and 32° F. and under certain conditions of humidity. Such a temperature is often encountered, even during the summer. The ice only accumulates along the leading edges of the wings, the struts, and the propellers, and although it does not add seriously to the load, the change in wing section is often extremely serious, as the flow of air over the wing is altered and the response to the controls is affected. An instrument has recently been invented by Air Ministry experts and is now being made by the Dunlop Rubber Company. Small pipes are fitted to the leading edges of the wings and a special liquid is forced through tiny holes along the pipes. The liquid melts a thin layer of the ice which cannot then stick to the wing surface. By thus eliminating adhesion, the accumulation of ice is prevented. Sufficient liquid is carried to permit five hours' continual use.

Oil in Great Britain

SUFFICIENT evidence of the existence of petroleum in this country has been found to justify the expense of test drilling on a considerable scale. Although reports are favourable, only actual drilling can determine whether the yield will be in commercial quantities. Indications of petroleum in considerable quantity have been observed for some time, and the test drilling is now in progress.

Resin "Glass"

A NEW glass-like substance, which is actually a form of synthetic resin, is now being manufactured by a branch of Imperial Chemical Industries. There are two forms, known as Perspex and Diakon. The former is very flexible, it is much lighter than glass, and does not become so brittle at low temperatures. It is being used by the Royal Air Force for covering in cockpits. Diakon is a more solid product and is now being used for lighting fittings, medical equipment, fountain pens, and other purposes.

New Aircraft Carrier

IT is learned that a new aircraft carrier, of 22,000 tons, is being built for the Navy. As was mentioned in a recent article, these vessels are extremely vulnerable and many authorities consider that we should build a number of smaller carriers to spread the risk.

A "pocket Carrier" has actually been designed and may shortly be built. The proposed vessel has a length of 360 feet, a displacement of only 3,000 tons, a speed of 28 knots, and a cruising range of 5,000 miles. Launching of the machines would be by catapult and landing would take place on the fixed tail at the stern, where arresting gear would be fitted to stop the machines after touching the deck.

More and Cheaper Radium

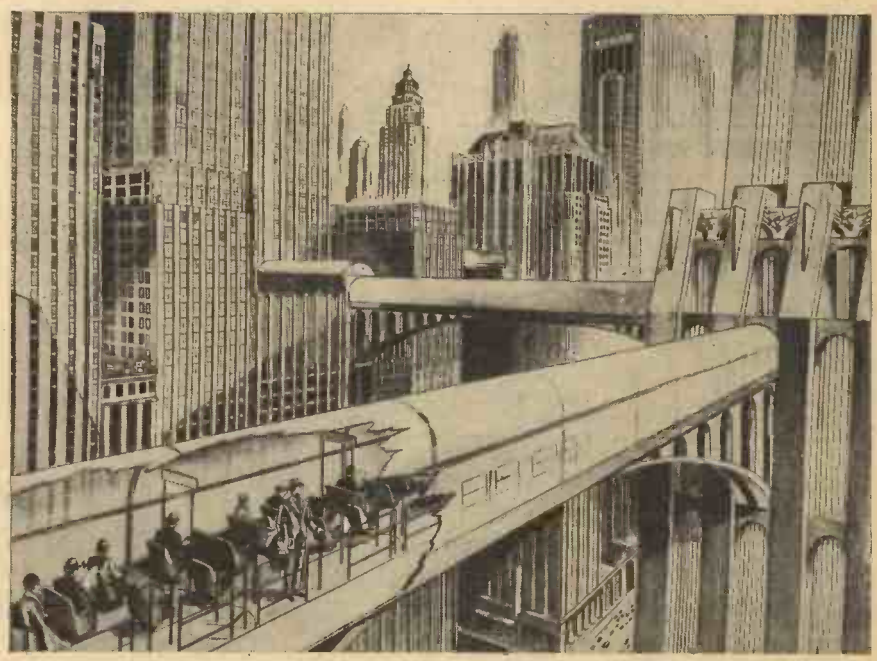
FOUR years ago radium cost £15,000 a gramme, and was obtained almost entirely from the Belgian Congo. Thanks to the discovery of radium-bearing ore in Canada, the price has now fallen to £8,000 a gramme, and greater supplies will, therefore, be available for the hospitals.

It is estimated that there is less than 800 grammes of refined radium in the world—less than 2 lb. After refining, the radium is packed in sealed glass tubes, each containing 50 milligrammes. A second glass tube is placed outside the first and the whole is sealed in an inch-thick lead cylinder. Radium is very dangerous to handle frequently and the rays cannot pass through thick lead. Before distribution in London, the radium is kept in a specially constructed lead safe weighing two tons.

For use in hospitals, the radium is mounted in small "needles" of iridio-platinum, which are widely used for the treatment of cancer. An article on "The Making of Radium" appears on page 463.

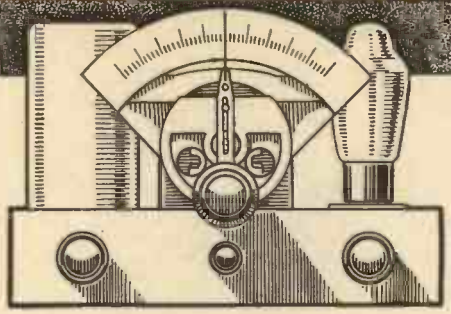
America's Latest!

A DRAWING on this page shows the "Biway" suggested by Norman W. Storer, a Westinghouse engineer, as a partial solution of the transportation problem in congested areas. It would consist of two platforms moving at different speeds in a continuous loop, passing through sky-scrapers at about the level of the tenth floor. At intervals of 100 yards or less would be entrances to the local or slow platform, which would come to a stop eighty-five times an hour and have a maximum speed of 12½ m.p.h. At its top speed, passengers would transfer to the express platform, which would be provided with seats. The carrying capacity would be 200,000 persons an hour, past any given point.



Mr. N. W. Storer's idea for solving the problem of transportation in congested areas in New York.

The PRACTICAL MECHANICS WIRELESS EXPERIMENTER



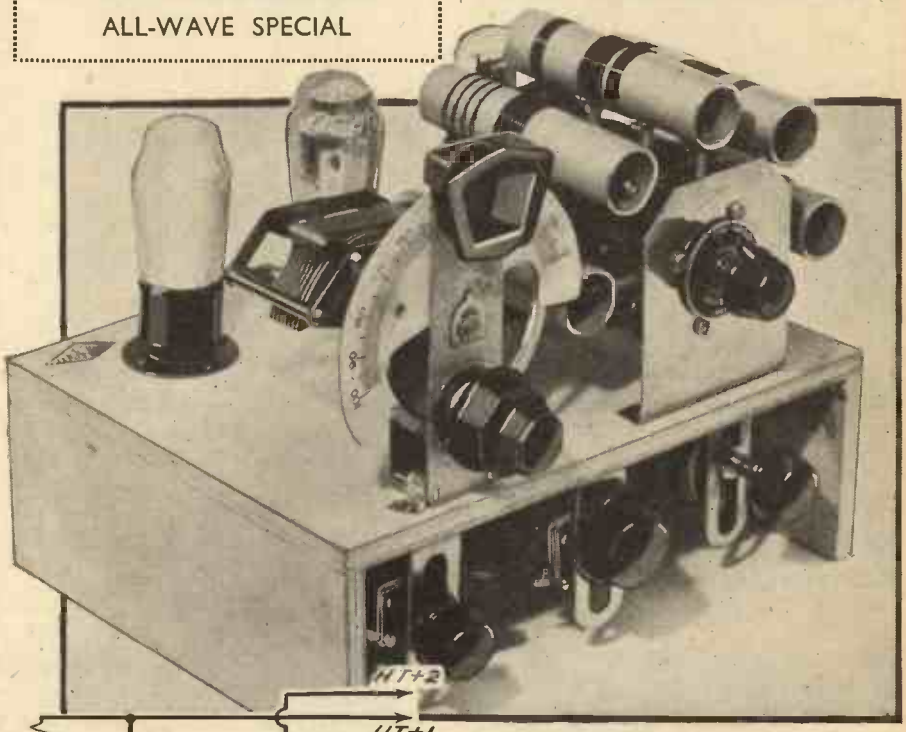
THE "PRACTICAL MECHANICS" ALL-WAVE SPECIAL

Full Constructional and Operating details of a Simple-to-Build three-valve Set which will Receive Broadcasts on all Wavelengths, and thus has a World-wide Range.

THE ordinary broadcast receiver is designed to cover wavelengths from 200 to 500 or 550 metres, and from 850 to 2,000 metres, with very slight variations in the minimum and maximum ranges on both bands. For all normal purposes this does, of course, provide ample entertainment value for the average listener but it by no means covers all the available broadcasts. In the gap between the medium and long waves there are many stations which cover principally commercial transmissions, aircraft, etc., and perhaps do not offer any interest to the man in the street. But below 200 metres there are literally hundreds of transmissions, many of which are actually entertainment programmes and which provide a varied fare for those who can tune in to them. Quite a number of stations which are familiar to listeners on the standard broadcast bands (as those between 200 and 550 and 800 to 2,000 metres are called) have stations on shorter wavelengths which radiate the same programme for the benefit of the short-wave listener, and there is a very important reason for these short-wave transmissions. It is found that under certain circumstances the range of a station, with a very much lower power, is much greater when the wavelength of the transmission is reduced, and it is possible for an amateur, using only sufficient power to light an ordinary electric lamp bulb, to be heard from one side of the world to the other under suitable conditions.

Why Short Waves are best

There are many reasons why the short waves are to be preferred to the broadcast wavelengths, and one is the fact that the programme may be sent out in a beam so that it will conserve all its power in one direction and thus will reach further than if it is sent out broadcast, or radiated equally in all directions. Thus you will find, if you tune to the short waves, that there are many stations which have what are known as "Empire" transmissions on various wavelengths which are directed to various colonies, and in addition to English there are German and other transmissions sent out in this manner.

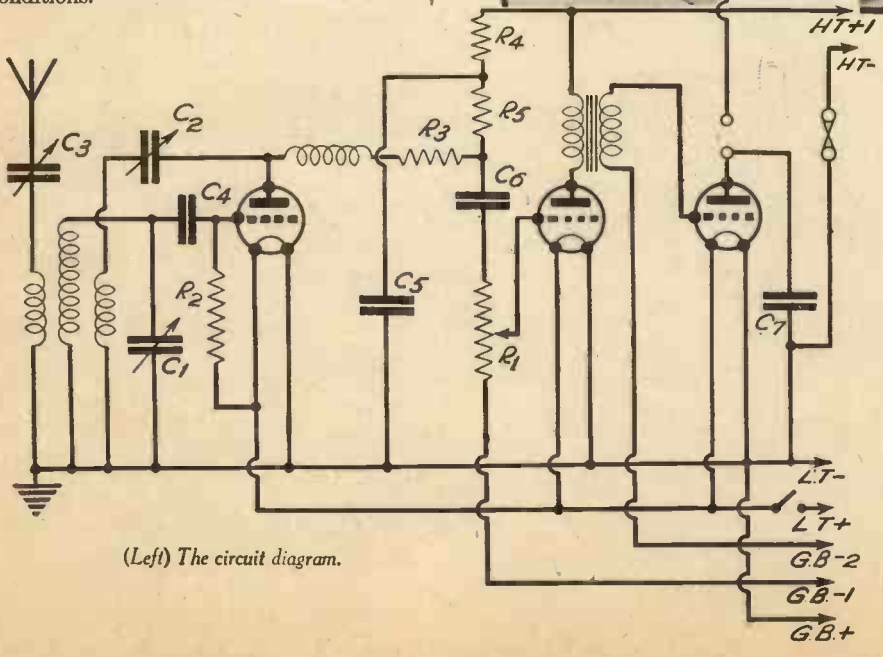


A front view of the receiver.

Special Transmissions

In certain countries there are also special transmissions on the short waves such as the radiations sent out by the American Police for the police cars, and in this country too we have such transmissions, although the actual wavelengths employed are not made public. There are amateurs in all countries of the world who use the short waves and it is possible to hear some of the very interesting workings of these amateurs between one country and another if suitable receiving apparatus is employed.

Many of the sets which are now to be seen in the shops and which are designed for all-wave reception, as this combination is called, are of the superhet. type, but it is not necessary to employ such an ambitious type of circuit to obtain the benefits of all-wave reception.



(Left) The circuit diagram.

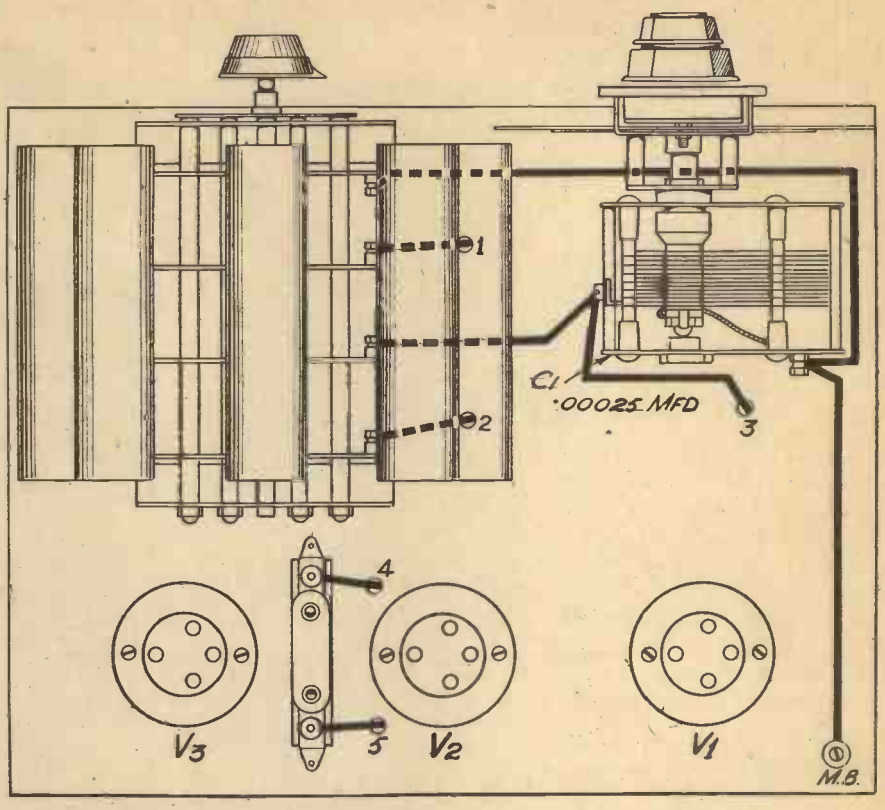
The Circuit

In the All-Wave Special, which is the subject of this article, a simple detector and two L.F. stages are employed, but the all-wave feature is obtained by utilising an unique commercial coil unit in which separate coils for each wave-band are employed, and the selection of the appropriate coil is made by means of a self-contained switch. It is possible to fit a number of these coils and thus any desired bands may be covered. The coils which are specified for the receiver may be selected to cover any wavelength from the seven supplied by Messrs. Bulgin, and thus the range is at the discretion of the user. The detector stage employs reaction in the usual way, and each coil consists of three windings, one for the grid circuit and one for reaction, with a separate smaller coil for the aerial coupling. The coupling between the first and second valve is by means of resistance-capacity components, and the grid leak of this stage is made of the variable type (in the form of a potentiometer) so that the volume may be easily controlled. Between the second and third valve a transformer is employed, and a parasitic oscillation stopper is included in the grid lead to the output valve. A fixed condenser is also included in the anode circuit of this valve to by-pass any H.F. currents which may have leaked so far and will avoid difficulties when headphones are worn. To ensure smooth reaction and to obviate certain defects which are sometimes experienced with a short-wave circuit there is also a small resistance included in the anode lead of the detector valve, and this is further provided with decoupling components.

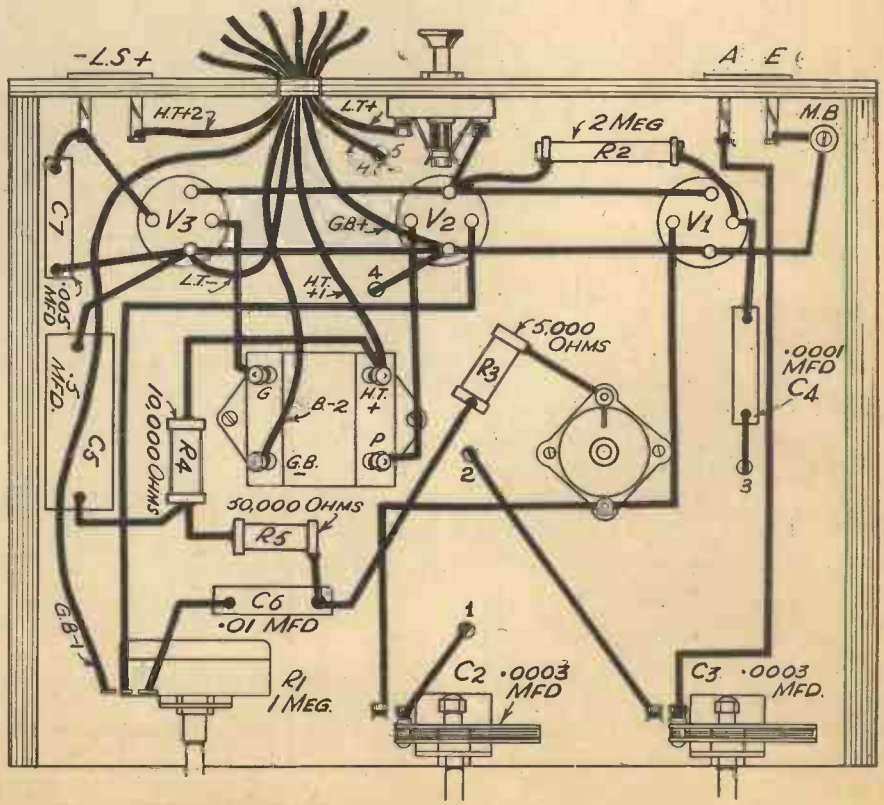
List of Components.

- Coil Chassis No. S.W. 22, with five S.W. Coils (Bulgin).
- One ·00025 mfd. (C1) Tuning Condenser, type 1040 (J.B.).
- One dual ratio S.M. Drive, type 2092 (J.B.).
- One ·0003 mfd. (C3) Aerial Condenser, type 2094 (J.B.).
- One ·0003 mfd. Reaction Condenser (C2), type 2094 (J.B.).
- Four fixed Condensers: ·0001 mfd. (C4), ·01 mfd. (C6), ·005 mfd. (C7), ·5 mfd. (C5) Tubular (Amplion).
- Four fixed Resistances: 2 meg. (R2), 50,000 ohms (R5), 10,000 ohms (R4), 5,000 ohms (R3) (Amplion).
- One Variable Potentiometer, 1 meg. (R1) (Reliance).
- One H.F. Choke, No. H F.O. (Wearite).
- One L.F. Transformer, 3·5/1 Niclet (Varley).
- Three Valveholders, 4-pin (Clix).
- One 2-point on-off Switch, S22 (Bulgin).
- Two Socket Strips, A/E and LS (Clix).
- Six Plugs: H.T. −, H.T. + 1, H.T. + 2, G.B. +, G.B. − 1, G.B. − 2 (Clix).
- Two Spades: L.T. −, L.T. + (Clix).
- Three Component Brackets (Peto Scott).
- One Metaplex Chassis, 10 in. by 8 in. by 3½ in. (Peto Scott).
- Three Valves: D210, D210, P215 (Hivac).
- One 120-volt H.T. Battery, Drydex Super-Life (Drydex).
- One 9-volt G.B. Battery, type H1001 (Drydex).
- One 2-volt Accumulator, type DMG-C (Exide).
- One Microfuse and holder, 100 ma. (Microfuse).
- One Speaker, Stentorian Junior (W.B.).

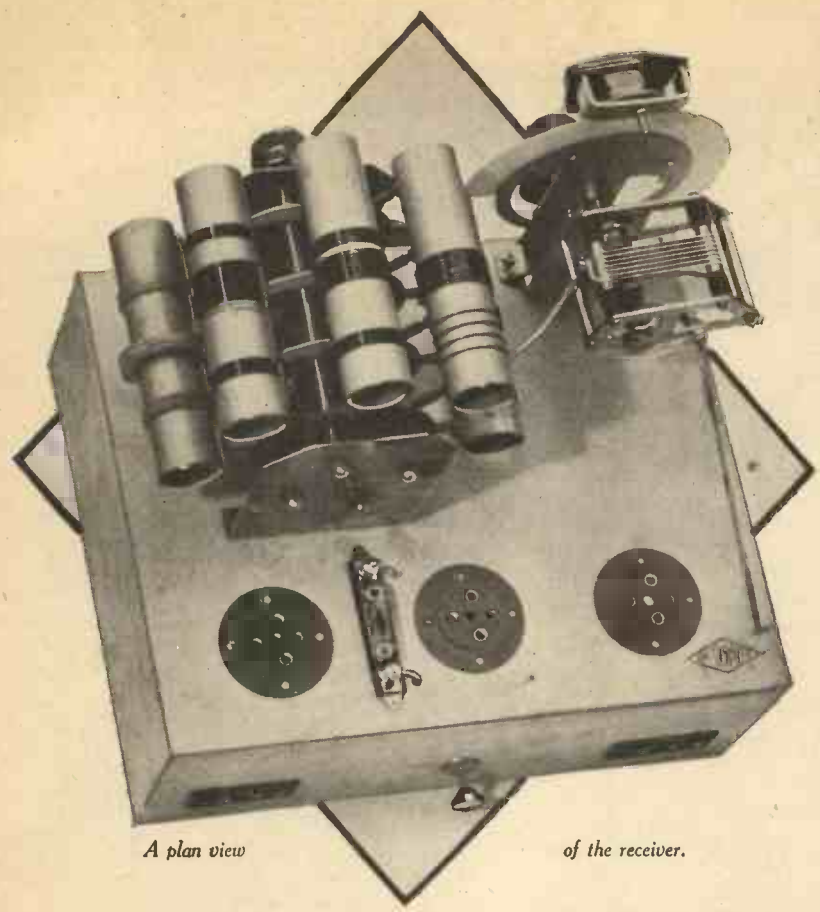
THE TOP AND UNDERNEATH CHASSIS WIRING DIAGRAM OF THE "PRACTICAL MECHANICS" ALL-WAVE SPECIAL



M.B. = METALLISED BASEBOARD.



M.B. = METALLISED BASEBOARD



A plan view of the receiver.

valves and coils may be inserted, and in the latter case it is necessary to ensure that the coils are placed in the holders in the correct relation. The four pins on each coil are equidistant, but by examining the connections which are soldered to the pins it will be seen that at one end the pin is used as the connecting point for three wires. This is the earth pin and should be inserted into the socket nearest the control panel.

The detector valve is placed on the left (viewing the receiver from the panel) and the output valve on the right. The L.F. valve is inserted in the centre socket, and the H.T. and L.T. leads should be connected as follows. H.T. 1 should be inserted in the 99 volt socket, and H.T.2 into the 120 volt socket. G.B.—1 should be inserted in the 1·5 volt socket and G.B.—2 in the 7·5 volt socket and the loudspeaker should be joined to the speaker sockets. Connect the aerial and earth and switch on the set. By turning the reaction control until the receiver is heard to oscillate and setting the wave-range switch so that the medium-wave broadcast band is in use the receiver may be tested for normal performance. When satisfied that this is in order and that no mistakes exist in the wiring, etc., the switch may be turned to one of the lower wavebands and the short waves searched. Certain wavelengths are only heard during daylight, whilst others will not be heard unless it is dark and therefore some care is needed in the selection of the necessary band. In general it may be taken that wavelengths between 16 and 25 metres may be heard best in daylight, but from 25 to 170 metres the effects of darkness will be noticed and in certain cases no signals at all will be heard except under favourable conditions.

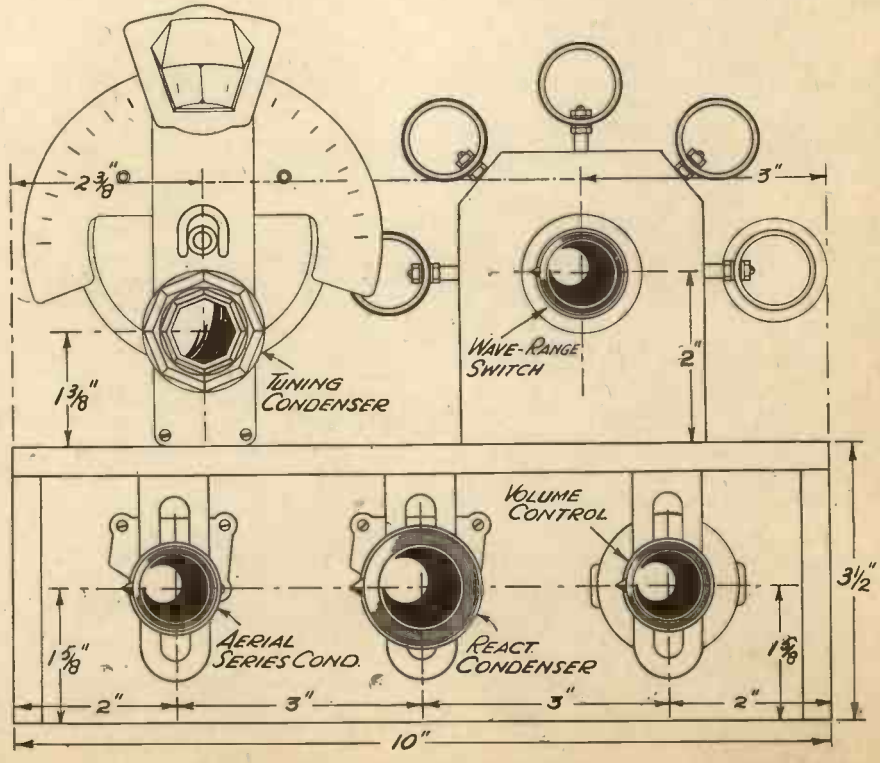
To obtain smooth reaction and to get the best results the aerial condenser will have to be adjusted on various wavelengths, but in general the volume control will not require to be used on short waves unless headphones are being employed and bad interference is experienced. Thus there are actually only three controls to be manipulated, and when a setting of the aerial condenser has been found to give satisfactory results over all waves it will be possible to ignore this and to carry out all tuning on the main tuning condenser and the reaction condenser. The receiver should be kept in its most sensitive condition by adjusting reaction just short of the oscillation point and this is indicated by a "breathing" sound in the phones or loudspeaker.

The Layout

As will be seen from the illustrations on these pages, the layout is extremely simple, and the incorporation of the complete coil unit enables the wiring to be greatly simplified. The tuning condenser is mounted to the left of the coil unit, and there are three further controls mounted beneath the chassis on small brackets to bring the control knobs into line and enable the chassis to be placed in any cabinet simply by the removal of the knobs. The controls, reading from left to right are: series aerial condenser, reaction, and volume control, and it has been found convenient, in order to preserve a balanced layout for the control panel, to place the on-off switch on the rear chassis strip. It is situated between the aerial and earth sockets and those employed for the loudspeaker.

Construction

The constructional work is extremely simple and there are only three holes to drill in the chassis, these being 1 in. in diameter. At the rear the hole for the switch may be drilled, but the metallised surface should be removed before fitting the switch. For the socket strips either separate holes for each socket or a slot to accommodate all of them may be employed. To enable the interconnecting wires to pass from one side of the chassis to the other ¼ in. holes may be drilled, or a gimlet may be employed to make the necessary hole. It is, however, preferable to use a large hole and to employ sleeving over the wires to prevent short-circuits against the metal surface. Carry out the wiring with the stiff wire which is sold for the purpose and which is provided with an insulated covering, stripping this covering away where the wire has to be fitted to a terminal. When wired according to the Wiring Diagram on page 480, the



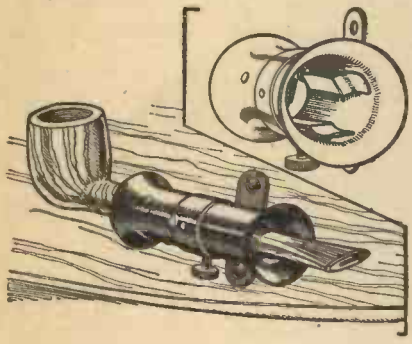
The panel layout.

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.

Valuable to Pipe Smokers

IF you are smoking your best briar pipe when driving the car and the pipe goes out, what do you do with it? You cannot knock it out, because ash trays are seldom large enough, and if you put it into the cubby hole it distributes ash all over the place, and probably gets scratched. You



An ingenious pipe holder for the motorist.

do not like to ram the pipe hastily into your pocket because it might not be quite dead.

However, the pipe problem has now been solved by the old-established firm of Webley and Scott, Ltd. They have produced a spring holster for pipes. It is screwed on to any convenient spot on the car and consists of a horizontal tube with a bell mouth at each end and a triple set of leaf springs inside. You just thrust the stem of your pipe into the holster, the springs take hold of it, and maintain it in position with the bowl vertically upwards. It does not damage the pipe, is well made in steel, and finished in the best blue, like a gun barrel.

An adjusting screw permits it to be set to take any size of stem. Finally, the price is 3*s.* 6*d.* by post. [191.]

"Keeping Things Hot"

THE hotplate shown below is fitted with heat insulating handles and feet, and is therefore perfectly safe for use on a polished dining table or other delicate surfaces. The device measures 10 in. square, and stands 2½ in. high. The plate is bright polished aluminium with a body finish of black crystalline enamel. The current consumption is 100 watts (10 hours' use for the cose of only one unit of electricity). It is supplied complete with 2 yards of flex and an adapter for use on lighting or power circuits. It costs 7*s.* 6*d.* [192.]

This hotplate will be found ideal for keeping things hot.

Change of Address

OWING to the continued increase in the sales of the Humatagraph hygrometers and hygrostatic controls it has been found necessary to make arrangements to provide better facilities for their manufacture. The firm have therefore made arrangements for the manufacture of the instruments to be transferred at an early date to the large and well-equipped factories of The Autovac Manufacturing Company Limited, at Stockport, near Manchester. The offices will also be transferred to Stockport.

The design and construction of the instruments is being continually improved so as to ensure under all conditions that high degree of accuracy and that high quality of finish which have caused the extension in sales, and necessitated the further development of the manufacturing side. [193.]

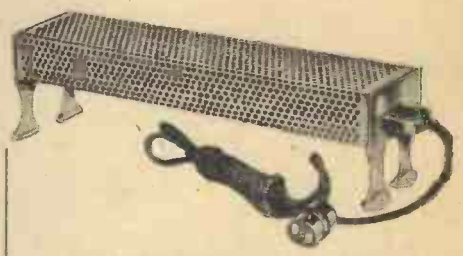
An illuminated globe atlas.

An Illuminated Globe Map

DECORATIVE and useful with a lamp inside, this ingenious globe can be run from the mains. Much useful information is given on the map such as the speed of the earth, main shipping routes, currents of the oceans, solar information, and radio stations with call signs marked. It costs £1 8*s.* 6*d.* [194.]

A Universal Radiator

THE heater shown on this page has been designed to give all the advantages of central heating at a fraction of the cost. It does not depend on beam radiation for its efficiency, but is entirely a convection heater. It will bring any room to an equal temperature and gives the same degree of comfort as does the hot-water radiator. The electric parts of this heater are entirely shielded and it is not possible to accidentally touch any "live" parts. A special three-core cable is supplied enabling the outer frame to be earthed. There are two models: a standard model plated throughout, and a bathroom model vitreous-enamelled white with plated end frames. The feet are so arranged that the radiator can be screwed on to a skirting board or into any other position required. It can be mounted flat, horizontal, vertical, or even upside down without affecting the performance. The standard model costs 10*s.*, and the bathroom model 12*s.* 6*d.* [195.]

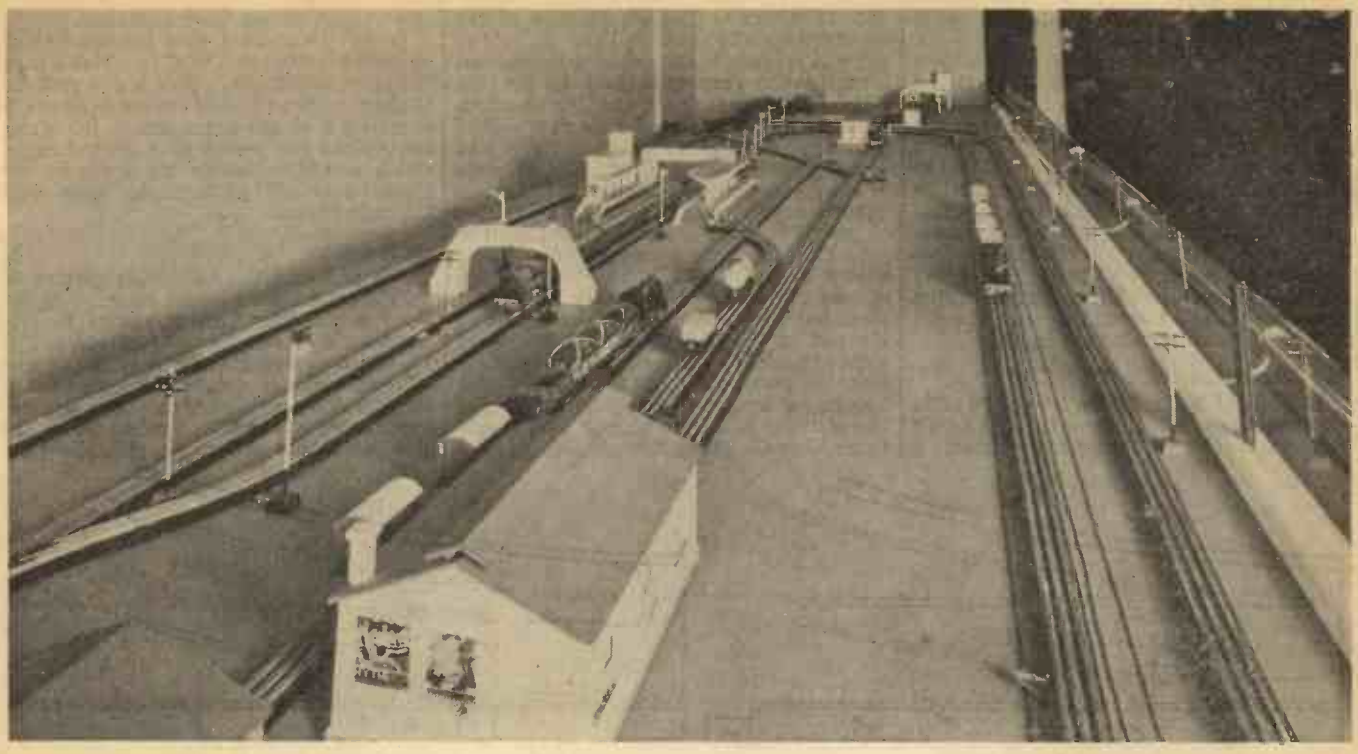


An extremely useful radiator for the home.

A Floodlit Shaving Mirror

NO matter how inconvenient or awkward the bathroom, the shaving mirror shown will overcome all difficulties associated with lighting. The mirror can be hung on a wall or stood on a shelf, and a 15-watt glare-free S.B.C. lamp provides diffused illumination on the face of the mirror. The mirror measures 7 in. by 5 in., and is supplied complete with 2 yards of flex and adapter for use on ordinary lighting circuits. It costs 7*s.* 6*d.*, or in white enamel fittings, 8*s.* 6*d.* [196.]

A floodlit shaving mirror is a novelty that will appeal to men.



Adapting the Twin-Train Table Railway

By E. W. Twining

Continued from page 426 of Last Month's Issue

BEFORE going further with the use of the locomotive mechanism for engines for other gauges and before leaving the 00 gauge I want to say something regarding the twin-train track and particularly about the points to main and branch lines. There are available, for those who are putting down a twin-train railway system, points which are worked either mechanically and manually or electrically from a distant position where levers may be installed in a signal cabin. Both the mechanical and the electrical are similar in appearance except that the first has a lever beside the track whilst the second has an electro magnet for moving the switch tongues. The excellent thing about the electrical points is that it can be operated either by hand or by the passage of current.

Straight and Curved Track

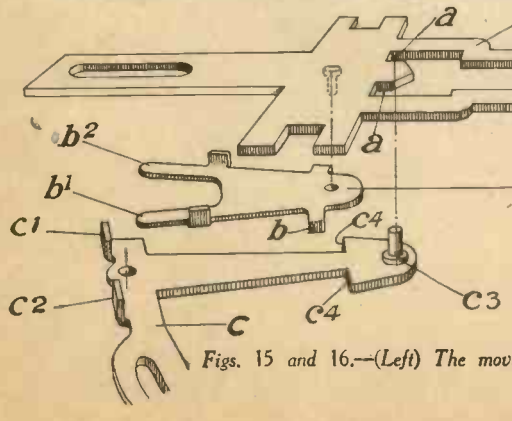
Before going into the design of the point control I should, I suppose, refer to the ordinary permanent way were it not that I have already touched upon the matter of the current conducting arrangement of the rails, so that the circuits will be already understood: besides this Mr. Bassett-Lowke, in his article in the December issue, described the scheme and told his readers that the rails are mounted upon moulded plastic bases. These bases are so modelled that they reproduce the ballast and sleepers. In this connection I might suggest that those who are laying their track permanently may very well pick out the ballast with a light warm grey flat paint, leaving the sleepers their present black. This would very much enhance the realistic appearance of the track. If I were putting down track for myself I should also paint the rails—which are of bright tin plate—with a flat brown colour: the natural colour which full-size rails assume when they rust.

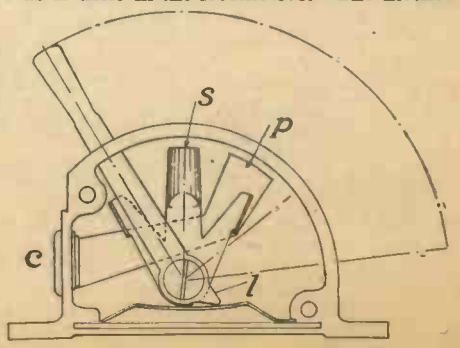
Electrically Operated Points

Points are obtainable arranged for either right-hand or left-hand turnout. In his article Mr. Bassett-Lowke gave, on page 160, a photographic view of a left-hand point. This shows admirably the external or surface appearance, the necessary insulating spaces which break the continuity of each of the rails, the switch tongues and the armature of the electro magnet. This latter is on the broken rectangle projecting to one side of the moulded plastic base. The coil does not appear: it is concealed by the armature.

Even if one has a set of these points in one's hands little more than what is visible in the photograph can be seen, for the mechanism is completely hidden, even on the underneath side, by a plate extending from one side of the base to the other.

By the owner of the twin-train track, if he has the usual amateur railway mechanic's bump of curiosity, will want to see the works, so, in order to save him the necessity of doing so, I have opened up the hidden secret and publish it for his benefit. As a matter of fact, the manufacturers do not box up this mechanism in such a way that it can be seen by just unscrewing something as is done in the locomotive. The method





Figs. 15 and 16.—(Left) The moving plates and (right) the point switch lever.

of securing is more simple than that, but it is more permanent.

Just as every one of the twin-train components is clever and ingenious so is the point mechanism. But this, I think, is the cream of ingenuity for, although the switch tongues are moved by a fraction of a second's impulse of current through the coil of the electro magnet, the switch tongues after each movement are rigidly locked in either position, so that nothing but another movement of the armature will shift them. No wheel flange can disturb them or foul them: such movement can be imparted to the armature either by current through the coil or by a sharp touch with the finger.

The Mechanism

In Figs. 11 to 14 I have set out to scale the moving parts of the gear through which the armature moves the switch tongues. I have drawn everything as it would appear if the base were turned upside down, so it will be seen that the drawings represent a right-hand turnout. The whole of the base is not shown—only the broken rectangular part which contains the gear; that is to say, the switch tongue end, and here I have indicated the tongues by dotted lines.

Fig. 14 shows a side view of the coil and *D* the armature: *d* and d^1 are two lugs extending downward from the armature into the base where they engage with two slots in a sliding brass plate *A*. This with the other moving plates *B* and *C* are shown in all the sketches and also in perspective in Fig. 15.

It will be seen that the attraction of the armature to the pole of the core in the coil causes the plate *A* to slide upwards, whilst the small spiral spring pressing against the plate returns it to its first position after current is cut off. To run through the sequence of movements I refer the reader first to Fig. 11 where the switch tongues of the track are open to the main line. Note that plate *A* is made to slide at its upper end on a pin passing through a slot; on the pin, which is fixed in the base, arm *C* is pivotted. At its lower end plate *A* runs in a pair of guides *g*. Plate *B* is pivoted upon *A* and moves with it. Note that in Fig. 11 plate *B* is over to the right-hand side.

The energising of the magnet causes plates *A* and *B* to move to the position shown in Fig. 12, the amount of movement being shown at *m*, but, of course, they do not remain there: the spring at once returns them but I have shown them in Fig. 12 at the end of the first movement because I want to explain what happens. On plate *B* there are two lugs b^1 and b^2 and on *C* also two lugs c^1 and c^2. The upward sliding of the plates causes b^2 to engage with c^1 and turns lever *C*. This, through link *E*, pulls over the switch tongues. The tilting of lever *C* causes the extension arm on *C*, which carries pin c^3, to move over to the right—compare Fig. 12 with Fig. 11. On this arm are two shoulders c^4 (see Figs. 13 and 15) and on the return travel one of these shoulders engages with lug *b* on plate *B*. Plate *B* is thus thrown over to the left and so is ready for the next movement of the tongues when b^1 will thrust against c^2. On completion of the return stroke to position shown in Fig. 13 the pin c^3 on the extension arm of *C* will drop into slot *a* of plate *A* and so lock the whole mechanism in position so that the switch tongues are immovable.

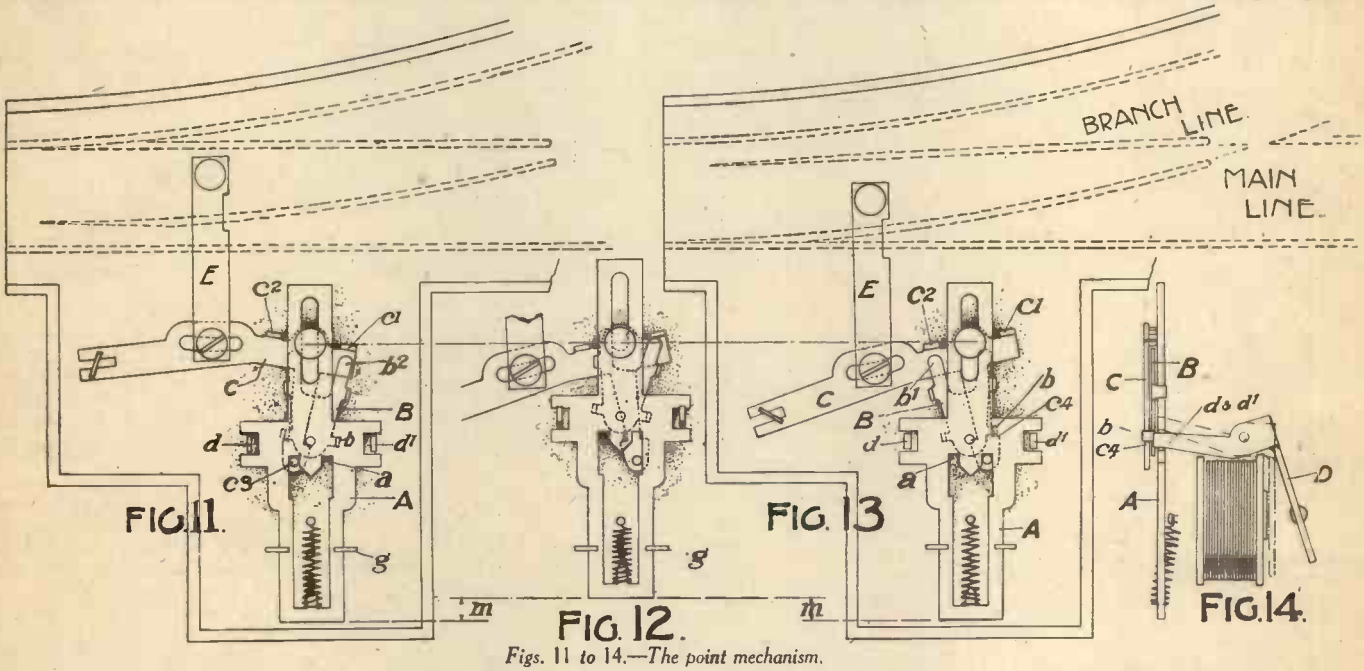
The link *E* is clamped in *C* with a screw secured in a curved slot. This is to allow of adjustment of the travel of the switch tongues. Such adjustment is set by the manufacturers and cannot be altered or interfered with except by ripping off the plate which covers the mechanism.

It will be noticed that beyond link *E* there is a slotted end to *Q* in which I have indicated a crossbar. This is not material to the important part of the mechanism: it is merely a simple arrangement for giving semi-rotary movement to a ground signal which is visible beside the track in Mr. Bassett-Lowke's photograph, page 160, December issue.

Point Levers

For applying the energising current to the electro magnet a switch lever is supplied by the makers. This is shown in side elevation with cover plate removed in Fig. 16. Like everything else it is simple and efficient. The ingenious point about it is the fact that a number of them can be fitted together by means of two split pins on one side of the case of each; which pins push into sockets on the other side of the case of the next lever and so a whole bank of levers can be built up for placing in a signal cabin. The pins not only join up the cases but make a common electrical connection for one side of the circuit. The other connection is made separately to each switch by plugging in, at the socket *c*. Connecting with the socket *c* is a plate *P*. *S* is a contact switch plate which is caught and thrown over by the lever. The range of movement of *S* is such that it travels beyond *P* and so, whichever way the lever is moved, a passing contact only is made between *P* and *S*, but the duration of contact is sufficient to allow of the movement of the armature on the points electro magnet. The lever is securely held in either position by the lug *l*, which is pressed upon by a flat leaf spring in the bottom of the lever case.

(*To be continued*)



Figs. 11 to 14.—The point mechanism.

Sharpening and Setting Woodworking Tools

By "Home Mechanic"

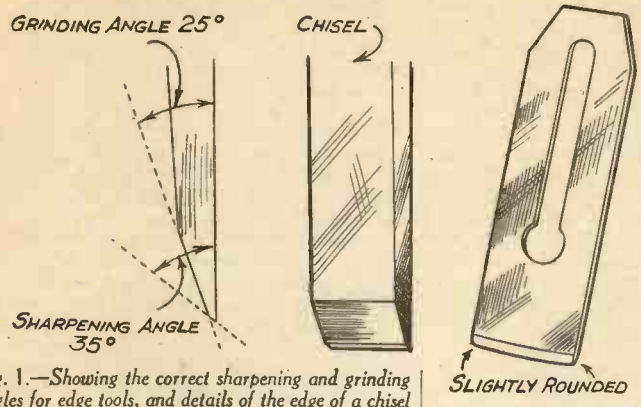


Fig. 1.—Showing the correct sharpening and grinding angles for edge tools, and details of the edge of a chisel and plane iron.

IT would probably be true to say that by far the greatest difficulty experienced by amateur carpenters and all who work in wood is caused by the use of tools which are incorrectly sharpened or adjusted. The sharpening of a chisel or the setting of a jack plane looks so utterly simple that many workers think that the job could not possibly be done wrongly; then when their work does not come up to expectations they loose heart and think that their skill is lacking. In nearly every instance these same people would find that the results of their labours would be far more satisfactory if the tools had been properly prepared. In short, the secret of good woodwork lies with the preparation of the tools.

The First of Two Articles in which the Methods of dealing with Chisels, Plane Irons, Spokeshaves, Gouges, and Saws will be fully Described.

Edge Tools

Of all the woodworking tools which are employed by the average worker those coming under the heading of edge tools are most frequently used. This broad classification covers chisels, gouges, plane irons, spokeshaves, and similar tools which actually cut, rather than scratch (as does a saw, for example). If any of the cutting tools mentioned is examined carefully it will be seen that the end is formed to two different angles, as shown in Fig. 1. There is the so-called grinding angle, which makes 25 degrees with the face, and the sharpening angle, which makes 35 degrees with the face. Generally speaking, it is not essential that these exact angles be maintained, but only slight deviation should be countenanced except when working in extremely hard wood and when the chisel is being driven by means of a mallet.

The Oilstone

In the first place it may be assumed that the tool—whether it be a chisel or a plane iron—has been correctly ground, by the method which will be described later. In order to keep the cutting edge perfectly sharp it is necessary only to use an oilstone. A medium-grade washita stone is most convenient for normal use, although there are occasions when a very fine stone is required in addition; this is normally the case only when particularly delicate work is being carried out.

A few drops of neatsfoot or thin machine oil should first be run on to the stone when the chisel can be sharpened by running the edge backward and forward over the stone, as shown in Fig. 2. The first essential is that the chisel should be held correctly, the blade being gripped by means of the thumb, third and fourth fingers, as shown, the first two fingers running down the back of the blade so that the tips are within ½ in. or so of the edge. The left hand is then placed over the right so that the blade and the first two fingers of the right hand are held securely. Next, place the edge to be "stoned" on the oilstone so that it is at an angle of about 45 degrees to the sides. It remains then to rub the edge backward and forward over the surface, all the time taking care that the tool is maintained at the same angle (35 degrees) to the face of the stone.

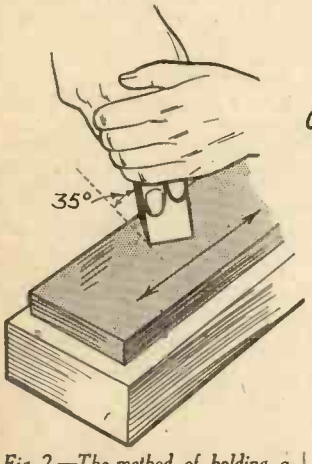


Fig. 2.—The method of holding a plane iron or chisel for sharpening.

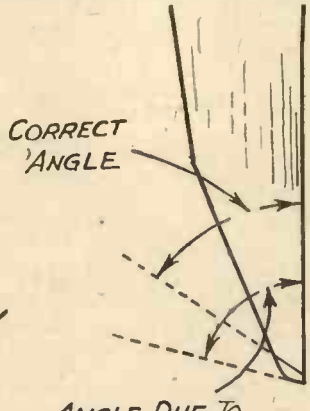


Fig. 3.—The effect of "rocking" the tool when sharpening is shown above.

The Sharpening Angle

It is by no means an easy matter at first to do this, for there is a tendency to allow the tool to "rock" so that the edge is rounded as shown in Fig. 3. Should this occur the tool will be comparatively blunt however long the sharpening process is continued. The reason is made obvious in Fig. 3, where it will be seen that although the "average" angle of sharpening is 35 degrees, the angle formed at the extreme end may be as much as 50 degrees. In order to avoid the tendency of the tool to "rock" the wrists must be kept rigid, as also must the shoulders, so that all the movement is from the elbows. This condition can best be ensured when the bench is approximately half the height of the worker.

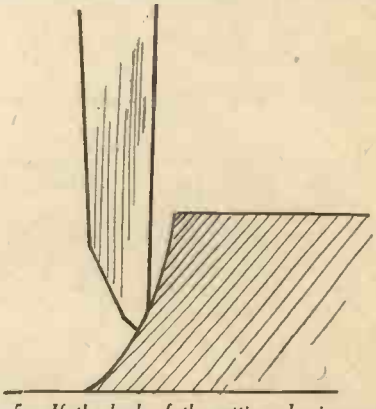


Fig. 5.—If the back of the cutting edge is rounded, a chisel cannot be used for paring vertical edges, besides which it is set to the wrong angle.

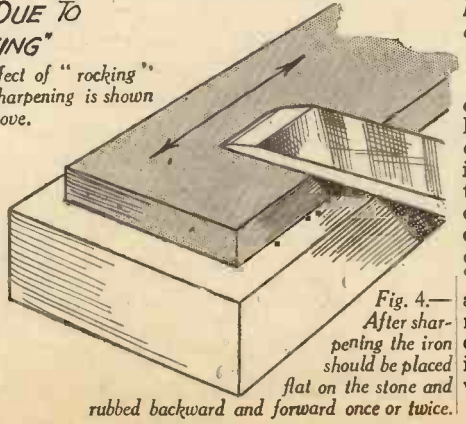


Fig. 4.—After sharpening the iron should be placed flat on the stone and rubbed backward and forward once or twice.

In sharpening care must be taken that

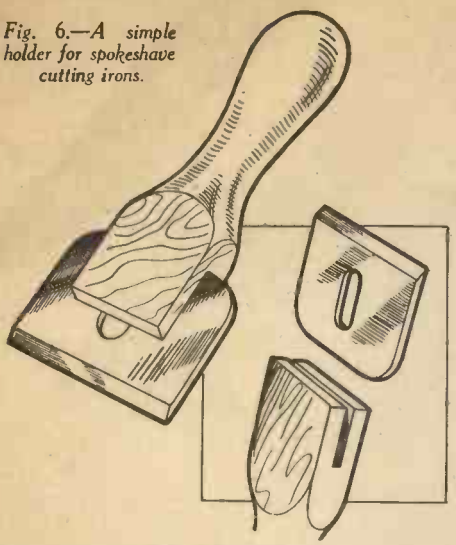


Fig. 6.—A simple holder for spokeshave cutting irons.

the cutting edge is kept straight and at right-angles to the centre line of the blade, but little difficulty should be experienced in this respect provided that the surface of the stone is perfectly flat. This condition applies principally to a chisel, for the edge of a plane should be just slightly rounded to prevent the corners from digging into the wood. To keep it flat, sharpening should be carried out not only down the centre of the stone, but also down the two sides. Even when care is taken in this respect a certain amount of hollowing takes place in the course of time, and this should be removed by rubbing the surface of the stone over a flat piece of sandstone.

Removing a "Wire Edge"

By the time the edge has been made perfectly sharp, and all chips have been removed, it will be round that the edge has become so thin that for a distance of $\frac{1}{32}$ in. or so it bends over. This thin strip is known as the "wire edge," and it can be removed to a certain extent by turning the chisel over and lightly running the back—

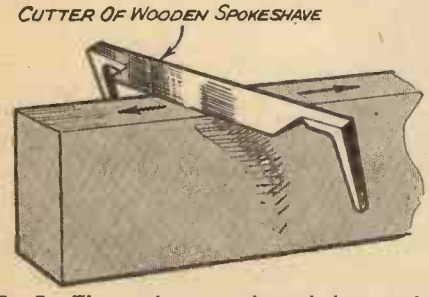


Fig. 7.—The iron from a wooden spokeshave can be sharpened as shown above.

or flat side—along the oilstone, as shown in Fig. 4. In doing this, however, particular care must be taken to see that the back is *perfectly* flat against the surface of the stone. If the tool is allowed to be otherwise the edge will be rounded over as shown inset in Fig. 4, with the result that the correct angle will not be obtained; the tool will not be properly sharpened, and if a chisel it cannot be used for paring vertically due to the fact that it will tend to move outward, as shown in Fig. 5

Even after this process there may be a slight wire edge, and this must be removed or else it will tend to damage the otherwise sharp edge, and so blunting the tool very quickly. The wire edge can be removed by stropping, and the experienced joiner may strop against the fleshy part of the left hand. The beginner is not advised to attempt this, however, for the results may be serious. Instead, he should lay a strip of soft leather on the bench and, holding the tool at an angle, lightly rub it over the leather, rubbing first one side, and then the other, of the cutting edge.

Sharpening a Spokeshave

The general method described above is applicable mainly to chisels and plane irons, although it can be applied to blades of metal-framed spokeshaves by making a wooden handle, as shown in Fig. 6. There is a saw cut in the end of this so that it can grip the cutting iron.

The blade of a spokeshave of the wooden-frame variety must be treated in a rather different way, as shown in Fig. 7. It will be seen that the oilstone is stood on one edge so that the cutting iron can be rubbed over it with the prongs overhanging at each side.

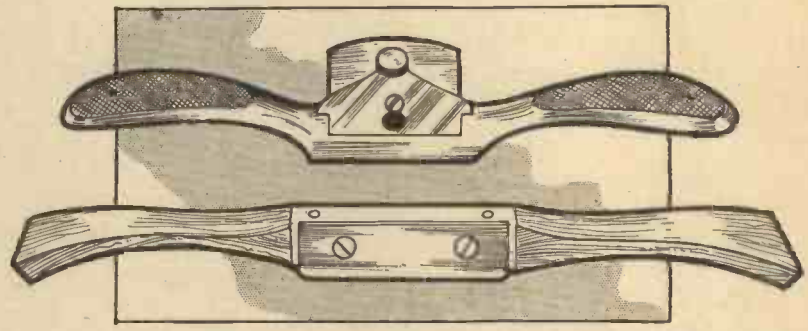


Fig. 8.—Metal-framed and a wooden-framed spokeshaves. The cutting iron shown in the wooden one is of a different type to that shown in Fig. 7.

Immediately after use the oilstone should be thoroughly wiped over with a rough rag to remove all oil as well as the fine grains of metal which have been rubbed off the steel. If this is not done the pores of the stone will become clogged so that they will not "bite" on the metal. If, by mischance, the stone has not been properly cared for and the surface has become smooth, it can be rejuvenated by washing it with a little paraffin, this being thoroughly dried off afterwards. Another precaution which should be taken is to see that the stone is covered after use so that dust cannot settle on it. Where it is boxed, this can be done simply by fitting the lid, but otherwise the oily rag should be used to cover it.

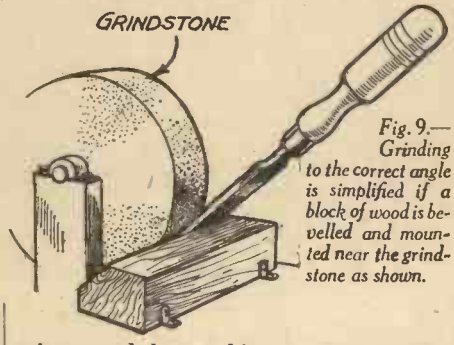


Fig. 9.—Grinding to the correct angle is simplified if a block of wood is bevelled and mounted near the grindstone as shown.

Firmer and Paring Gouges

Tools such as gouges, especially those which are ground on the inside of the curve (paring gouges), cannot be sharpened on an oilstone of the ordinary kind; instead, oilstone slips should be used. The slips can be bought from any tool merchant, and are rather like an elongated egg in section, the two edges being curved to different radii. The gouge is held against the corner of the bench and tilted to a convenient angle, after which the slip, lightly oiled, is rubbed over the edge with a circular motion, working from side to side of the curved cutting edge. This is simplified if the tool is slightly rolled when proceeding across it with the slip.

Outside-ground gouges (firmer gouges and those used for woodturning) are dealt with rather similarly, but by using a flat face of the slip. After rubbing the outside of the curve, the gouge is turned over and any wire edge removed by rubbing the curved edge of the slip along the inside, and keeping it flat against the tool.

Forming the Grinding Angle

After a chisel or plane iron has been sharpened a number of times the end becomes "stubby," as shown in Fig. 11, and it should then be ground because sharpening is a tedious process due to the fact that there is such a large area of metal in contact with the oilstone. The same principle applies when the edge has become badly chipped or snipped due to running against a knot or to touching a nail. The chief difficulty is to keep the tool at the correct angle to the grindstone and several tool-holding devices have been devised to facilitate the matter. The usefulness of these tools cannot be denied, but their expense would not be justified in the case of the average amateur. An alternative is to bevel a block of wood and mount it near the circumference of the stone as shown in Fig. 9; the correct angle for the bevel can be determined by trial and depends upon the diameter of the stone

If the tool is held firmly against the guide

(*Continued on page* 490)

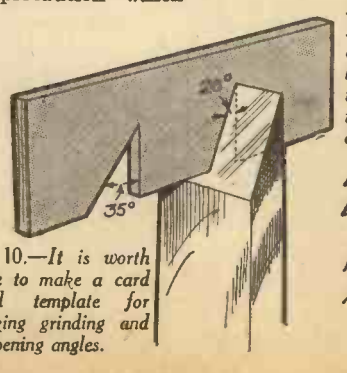


Fig. 10.—It is worth while to make a card board template for checking grinding and sharpening angles.

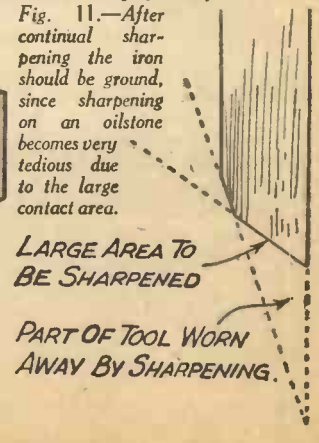
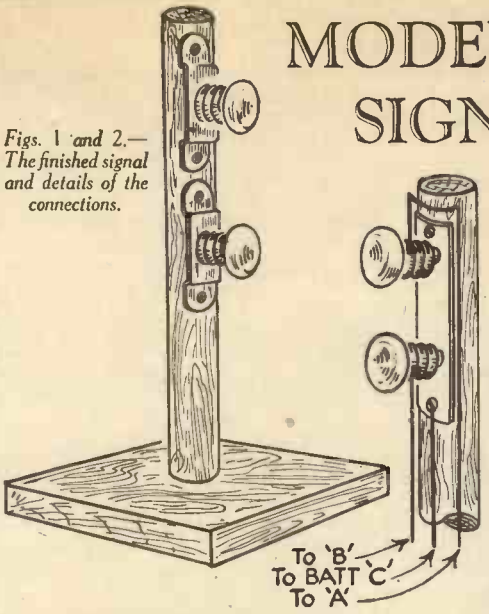


Fig. 11.—After continual sharpening the iron should be ground, since sharpening on an oilstone becomes very tedious due to the large contact area.

MODEL RAILWAY SIGNAL LIGHTS

By S. Boocock



Figs. 1 and 2.—The finished signal and details of the connections.

MODEL railway layouts can generally be improved by the addition of one or two accessories, similar to that described in this article.

Fig. 1 shows a model signal having a red and green lamp, which is quite simple to construct. For the base use a piece of wood about 3 in. square and ½ in. thick. With a brace and bit, bore a hole half-way through the centre of the base to take a piece of ⅜ in. or ½ in. dowel rod about 6 in. long, and glue the rod in position. If you do not possess a brace and bit, simply screw or nail the upright to the base.

The Lamps

Two lampholders to take ordinary pocket bulbs may be bought for a few pence. Screw these to the dowel rod but remember to use very short, thin screws, to avoid splitting the wood. Perhaps you would rather make the lampholders than buy them. Cut a strip of tin 1½ in. × ⅜ in., and nail it to the dowel rod. This tin will make contact with the bottom of each bulb, and must be connected to the battery by the wire marked *C* in Figs. 2 and 4. Contact with the sides of the bulbs is made by scraping an inch of insulation from pieces of bell wire. Twist the bare parts of the wires tightly round the bulbs, and connect the other ends to the switch contacts *A* and *B*, as shown in Fig. 3.

The lamps may be covered with green and red cellophane, or tissue paper. A better method, however, is to stain the glass.

The Switch

This is made on a baseboard about 3 in. or 4in. square, and the switch arm is a piece of tin 2 in. × ⅜ in. Make a handle by bending up a short piece of tin at the end, or by nailing a short piece of dowel rod at one end. Nail the other end to the base, as shown in Fig. 3. For the contacts, cut two pieces of tin 1 in. × ½ in. and nail or screw them in position. Bend them over so that they will form clips into which the switch arm can be pushed. Some readers may wish to make a wooden box to hold the battery, and the switch can then be mounted on this box.

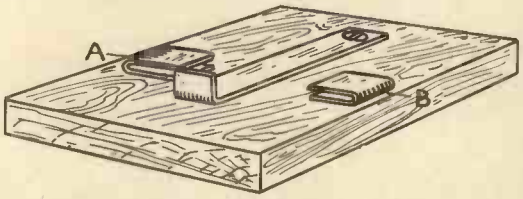


Fig. 3.—The method of making the switch contacts.

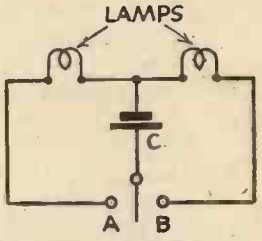


Fig. 4.—The theoretical circuit.

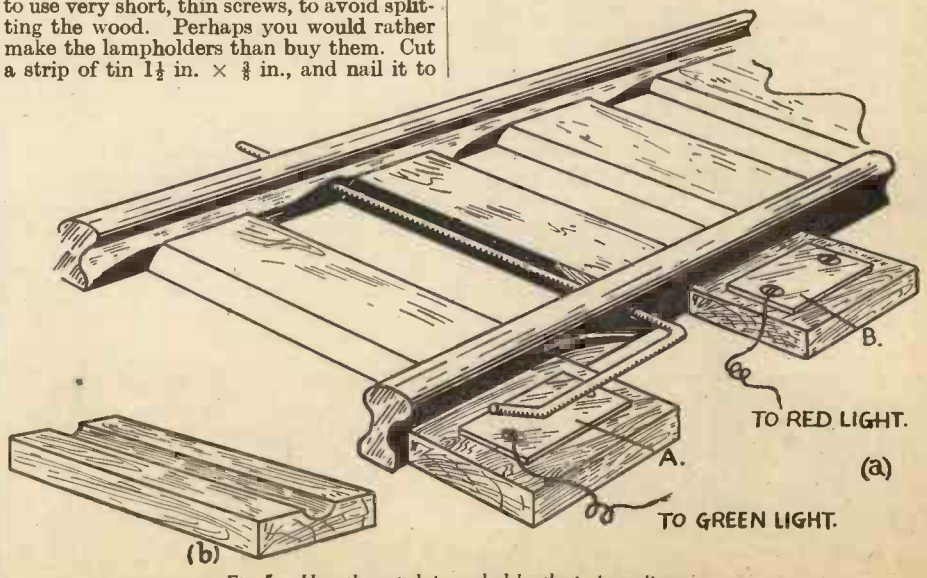


Fig. 5.—How the switch is worked by the train as it passes.

The Connections

The method of connecting up the apparatus is shown in Fig. 4. An ordinary pocket battery is sufficient to work these lamps. A wire connects one contact of the battery to the switch arm. The two switch contacts must be connected to the side-screws of the bulb-holders, and the bottom screws to the other battery contact. Use insulated bell wire for the connections, which should be soldered, but remember to scrape off a little insulation before connecting. Wires running alongside each other should be twisted together for the sake of tidiness, but see that bare parts of two wires do not touch, otherwise you will have a "short-circuit," which will ruin your battery and prevent the model from working.

The Automatic Switch

Some readers may wish to make an automatic switch so that the train on entering a stretch of line, switches the signal to danger. This is not difficult, and Fig. 5 shows the construction. Drill two holes through the sides of the rails to take the lever, which is a piece of iron wire or stout copper wire. This forms the switch arm. Another method is to obtain a piece of wood which will just fit beneath the rails, and to cut a groove in it as shown in Fig. 5. This will hold the lever in place if you cannot drill holes through the rails. For the contacts, use pieces of tin nailed to small wooden blocks. Solder or screw two of the connecting wires to the pieces of tin, and one wire to the lever or to the rail, since the latter makes contact with the lever. The connections are exactly as before. Bend a short portion at the end of the lever, so that it will catch a projection on the engine. A piece of iron wire twisted on the front of the engine, can easily be arranged to catch the lever and switch it over. If the arrangement is not satisfactory at first, bend the lever and alter the height of the projection on your engine until the lever turns without putting too much of a check on the train.

RECORDING EARTHQUAKES

(*Continued from page* 450)

Forecasting Earthquakes

Many attempts have been made to discover regularities in the time of the occurrence of earthquakes with a view to finding some means of predicting the shock, but the results have not been satisfactory and it is feared that no satisfactory method of forecasting will ever be found.

Sometimes a warning is given by the almost insignificant "fore-shocks" which occasionally precede a large earthquake. These preliminary shocks sometimes cover a period of several days, the number per day increasing to a maximum just before the main shock, but although these fore-shocks give a warning that a serious earthquake is to be expected, they give little information about the probable time of the shock.

The actual movement of the ground in even a severe earthquake is surprisingly small. Vibrations with an amplitude of only one-hundredth of a millimeter can actually be felt. In a small shock, such as the Hereford earthquake of 1926, the maximum amplitude recorded was considerably less than half a millimetre while in the case of a serious Japanese earthquake, the amplitude is only of the order or 4 or 6 in. The amount of damage, however, is not necessarily only determined by the magnitude of the oscillations, but depends very largely on their regularity, for if they are continuous and regular, quite a small shock may cause immense destruction and damage to buildings.

MEASURING CANDLE-POWER

(*Continued from page* 460)

sults. Suppose that the results obtained are 40 in. for one lamp and 20 in. for the other when the shadows or sides of the grease spot are illuminated with the same intensity. Call the lamps A and B, then by the law of inverse squares :

Intensity due to A at 40 in. $= \frac{A}{20^2}$ in.-candles.

Intensity due to B at 20 in. $= \frac{B}{40^2}$ in.-candles.

But these intensities are equal,

$$i.e.\ \frac{A}{40^2} = \frac{B}{20^2}$$

$$\therefore \frac{A}{B} = \frac{40^2}{20^2} = \frac{1,600}{400} = 4$$

$$A = 4B \text{ or } B = \tfrac{1}{4}A.$$

One lamp is four times as bright as the other, so that if one is known in candle-power, the other can soon be found. Note that inches and inch-candles are used above. This is only because inches are more convenient for measuring. The distances could equally well be measured in feet, giving foot-candles, or centimetres giving centimetre-candles ; but the final result would be the same.

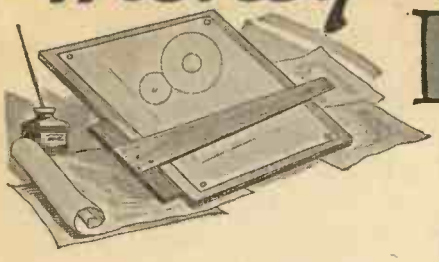
SHARPENING AND SETTING WOODWORKING TOOLS

(*Continued from page* 488)

there is no difficulty in grinding to the correct angle, and all that is necessary is to see that the stone is constantly fed with water. This can be done by making a shelf over the stone upon which is placed an old can with a small tap soldered into it. The tap can be set so that there is a constant drip of water, without the stone being flooded. Until the correct grinding angle can be judged by sight it is a good plan to make a cardboard template, as shown in Fig. 10, by cutting a V the angle of which is just 25 degrees. While grinding the tool can occasionally be checked by inserting the edge into the V cut.

After grinding the tool must be sharpened on the oilstone before it is suitable for use, and the process described above should be followed.

Money Making IDEAS



Advice by our Patents Expert

A SELF-TIGHTENING PLUG AND SOCKET

"ENCLOSED you will find a rough sketch of a device which I have worked out, and I would be greatly obliged if you could advise me as to its novelty and commercial practicability.

"It is, in brief, a self-tightening plug and socket to be used for electrical connections. The size is relatively immaterial, since the plug itself could be made from ⅛ in. to ½ in. or more in diameter. Its principal use would be, I think, on test beds and benches where fairly large currents are handled, necessitating bolted connections to ensure good contact. This plug makes as tight a connection as a bolted one and can be released or tightened in two or three seconds.

"The design is not perfect in any way and the method of connecting the cable to the plug possibly leaves much to be desired; the principle, however, would remain the same.

"The socket may be of hard brass and is screwed or bolted to the panel. The plug is in two parts; the main piece is a sliding fit in the socket and is bored axially to within a short distance of the tip, this hole ending in a taper of 30° to 40°. It is also screwed internally for a short way from the top, and that part which enters the socket is split by saw cuts to give it a certain degree of flexibility. The external top portion is screwed to take the nut for fastening the cable.

"The other portion of the plug consists of a knurled head and shaft which is an easy fit in the central hole of the first portion and threaded at the top to screw into the latter.

"To assemble, a steel ball is dropped into the hole in the body of the plug and the head and shaft screwed in.

"If the plug now be placed in the socket, it is obvious that, by screwing down the knurled head, the shaft affixed to the latter will force the steel ball up the taper and so expand the plug against the walls of the socket and render it immovable until the pressure on the steel ball is released." (J. H., London, N.W.2.)

THE improved plug-and-socket connection for electrical purposes is fit subject matter for protection by Patent and is, we think, from personal knowledge, to be novel, but this can only be definitely ascertained by making a search amongst prior Patent Specifications dealing with the subject matter.

The invention is ingenious and should be commercially practicable, and if properly marketed should have a commercial value.

We would advise you to protect your invention by filing an Application for Patent with a Provisional Specification, which will give you about twelve months' protection, during which time you should be able to ascertain the commercial possibilities of your invention without incurring very great expense. You are advised to employ professional assistance in applying for your patent, and the Editor will be pleased to put you him in touch with a reliable Patent Agent.

A NOVEL WIRELESS RECEIVER

"I ENCLOSE a copy of a Provisional Specification relating to an idea for obtaining two programmes simultaneously from one wireless receiver. I have made sufficient experiments to satisfy myself that the idea is workable, but unfortunately a lot of time has been lost since the provisional was taken out, with the result that a Patent Agent will have to be instructed without delay to apply for the complete Patent. I cannot afford to spend any more money on the invention and I shall be glad to know whether you or your periodical would be sufficiently interested to take the matter up. Failing that, perhaps you could advise me of some person or firm that would be interested.

"I shall be glad to receive a reply at your earliest convenience, for which purpose I enclose a stamped addressed envelope." (S. J. H. S., Surrey.)

YOUR invention relating to "Wireless and Television Apparatus," covered by Provisional Patent Application No. 4075, dated February 8th, 1935, is from personal knowledge thought to be novel, and should be fit subject-matter for protection by Patent. It should have a commercial value if properly marketed.

It is doubtful if it will be possible to lodge the Complete Specification on the 8th proximo, but we would remind you that it is possible to obtain one month's extension of time for doing this. It is not within either the province of PRACTICAL MECHANICS or a Patent Agent to take a financial interest in an invention, for obvious reasons. You have already had practically a year in which to put the invention before firms likely to be interested, and it is unlikely that any firm would agree to become interested and pay for completing the Application without first experimenting, which would probably take more than a month.

A WATER TAP ADAPTER

"WOULD you be kind enough to inform me of the value or otherwise of the idea I have just roughly sketched.

"It is purely and simply an adapter for a water tap.

"The sketch I think is self-explanatory. There would be two models, if placed on the market, but you will observe that they are interchangeable." (M.S., Manchester.)

1. THE improved adapter for a water tap is not thought to have sufficient subject-matter or invention over known devices to support a Patent. Provided the invention be novel a certain measure of protection may be obtained by registration as a Design. The cost of registering a Design for fifteen years, with taxes paid for the first five years, if applied for through a reputable Patent Agent, which is the course advised, is approximately £3 3*s*.

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.

Woman's Devices

A WOMAN has recently invented a device which provides a means of illumination under the running-board of a motor car, shedding light both beneath and beside the car. This will be especially useful in the case of a breakdown on the road by night, enabling repairs to be executed underneath the car with convenience. It will also make conspicuous any person standing or working on the off-side of a car, thereby protecting him from injury by passing vehicles.

To prove the versatility of women as inventors, it is necessary only to mention a few of their recent devices. These include a spray nozzle for use in fire extinguishing; an inner oven for gas ovens to prevent fumes from contaminating the food; a method of storing eggs to ensure the eggs retaining the gases which are naturally present in them; an improved gas mask; and a syphon discharge to prevent waste of water in cisterns.

A Comprehensive Clock

AN ingenious citizen of the United States has designed a clock which makes itself generally useful. First it performs the duty of an ordinary clock, whose office is—or should be—to tell the time. Below the dial is a space in which you are informed the date. Beneath that is an arrangement which could be utilized for a running advertisement. The last-mentioned could be used to exhibit words of wisdom, such as one sees at the foot of a tear-off calendar. The words could be made to change at predetermined intervals.

An Umbrella with a Window

EVERYONE who carries an umbrella has experienced the inconvenience of facing a head wind and a driving shower of rain. Compelled to hold the "gamp" in front of one's face, it is impossible to see who is coming. The inevitable consequence is that one collides with a number of people. To meet this contingency, some years ago an inventor devised an umbrella with a window in it. This device does not seem to have been generally adopted. I have lived for many years in the frequently moist climate which is a characteristic of our happy land, but I have never seen in our streets an umbrella with a window in it.

How it Shuts Up

ANOTHER inventor has recently thought fit to improve upon the previous device. The difficulty in designing an umbrella with a window is to make the umbrella close with ease. The first inventor appears to have arranged the window in two halves with a hinge at one of the ribs. The later invention has a window also in two halves with a hinge between them, but the window is in one of the panels. This, it is contended, makes for a more convenient shutting up of the umbrella. It is hardly necessary to add that the window is not made of glass, but consists of some light transparent material. It occurs to me that even with such a window one's view is still likely to be obscured through the window becoming blurred by the rain. I imagine a wiper would be necessary to ensure the visibility not being low.

Individual Restaurant Wardrobes

IT is the practice in public places where people eat and drink for the management to furnish hat-and-coat stands for the headgear and garments of more or less quick lunchers. As these stands are not always near the tables at which the customers sit, it is not easy for the latter to detect the removal inadvertently—to use a charitable phrase—of their property by some person who is not the owner. I myself have been the victim of an exchange of umbrellas in which the umbrella left was not the better of the two. To guard against this danger, an inventor has conceived the idea of a combined seat and wardrobe. Beneath the seat is a container for the small belongings of the customer. This is open at the front and the legs of the sitter act as two sentinels to guard his property. In addition, there can be fixed a garment hanger which also forms a back rest for the seat.

A Generally Useful Seat

ANOTHER convenient feature of this seat, which, if desired, may work on a swivel, is that it is adjustable in a fore and aft direction in relation to a table or counter, so that it can be made to suit people of different stature and proportions—the tall, the short, the stout, and the slim.

Improved Hairdresser's Chair

TO the same family of ideas as the above-mentioned belongs a recently contrived hairdresser's chair, which should be of special interest to the ladies, who spend many hours in the cubicle of the hairdressing saloon. The chair in question has a capacious pocket on either side, in which can be safely held their handbags, gloves, etc., while the fair are subjected to the mysterious rites of the "perm."

Artificial Waves

SPEAKING of permanent waves, I am moved to refer to other waves, also artificial. As the weather becomes warmer, the swimming-pool will engross those of us who undertake the rôle of the merman and the water nymph. A new method of creating artificial waves will appeal to these aquatic folk. A characteristic feature of the appliance that troubles the water is that, although it is under the surface, it is easily accessible for oiling.

Toy Talkie Machine

THE inventor does not limit his activity to the production of articles of utility; he also provides amusement devices. Among recent inventions of this kind is a toy talkie machine. There are in existence several toy projectors for silent films, but the new invention incorporates both picture and sound. Another interesting amusement device is a gun which projects toy aeroplanes.

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.

ETCHING INITIALS ON GLASS

"1. I HAVE been using the following method for etching initials on glass.

"By measure.

"5. Sodium Fluoride.

"1. Zinc Chloride.

"1. Potassium Sulphate.

"Mix to a paste with water and prepare for use with hydrochloric acid.

"The results have been very weak and poor, the stencilled initial being barely visible.

"Can you please offer a suggestion for improvement?

"2. Can you please give me a formula for obtaining a 'frosted' finish for the same type of work?" (B. T., N.W.4.)

1. THE best, and, incidentally, the cheapest, material for etching initials on glass is hydrofluoric acid. This, however, is only sold by manufacturing chemists in special rubberoid containers.

As an alternative, you might try a paste made of powdered fluorspar (or sodium fluoride) and concentrated sulphuric acid.

The glass-etching paste you mention is not much good.

2. Many "frosted" finishes on glass are produced by the process of sandblasting, whereby the glass is subjected to a bombardment of sand particles. This process, however, requires special appliances. The best chemical for giving a frosted appearance to glass is dilute hydrofluoric acid, or, as a milder alternative, the etching paste above mentioned. With either of these you ought to obtain immediate success with your experiments.

ELECTROLYTE FOR ACCUMULATORS

"I HAVE been experimenting with an electrolyte for use in accumulators. Would there have been many such electrolytes patented since, say, 1920, and how could I get specifications of any to see if mine is sufficiently different to make it worth while going further in the matter?" S. J., Essex.)

THE only way of ascertaining whether the improved electrolyte for accumulators has been previously patented, is by making a search amongst prior patent specifications dealing with the subject. A search can be expedited by consulting the abridgments of patents, which may be consulted at the Patent Office Library, 25 Southampton Buildings, London, E.C.4. The abridgment Class 53, Galvanic Batteries, should cover the subject matter up to 1930, since when a new classification came into force, and under such classification, Group XXXVI must be consulted. Unless the inventor has had experience in searching, he is advised to employ professional assistance.

AMATEUR CINÉ WORK

"I WISH to make a small range-finder for amateur ciné work, but I am not quite sure how the optical parts would be arranged. The maximum range I need is 40 ft. —minimum 2 ft. Are lenses necessary, and if so, what kind and where?" (G. N. H., Holt.)

JUDGING by the details of the sketch which you supply, we are of the opinion that no optical parts in the form of lenses will be required for your range-finder. An eye-piece lens, as, for instance, a low-power eye-piece of a microscope, might be a refinement, but this would require to be mounted in a focusing jacket, an arrangement which you would find difficult or impossible to construct. Provided your worm gear for range indication was carefully cut and mounted and, also, that the calibration of the indicator of the instrument was well carried out, the range-finder as as you describe it should function without trouble.

It is possible to make a 20-volt accumulator capable of giving 10 amps., but you would find such a cell expensive and difficult to construct satisfactorily. Plain "gridded" plates would be best for such a purpose, and they would require to be of large size. Also, nearly all commercial accumulators contain pastes made up in accordance with secret formulæ. You would be well advised, therefore, to give up the idea of making such an accumulator yourself and to procure one of the commercial cells instead.

FREEZING MIXTURE

"CAN you please give me any information about the freezing material in refrigerators?

"I have heard of one method, whereby something of this sort is sold in blocks, and my idea is for keeping the pantries cool.

"Also how is it made?" (C. D., Yorkshire.)

THE refrigerating material in commercial refrigerators is usually ammonia gas which is compressed and expanded automatically and which, during its expansion, produces the desired degree of cold.

The freezing material which you are referring to is probably "Drikold," which is solidified carbon-dioxide gas. It is made by compressing carbon-dioxide gas until it liquefies. The pressure is then removed and the consequent rapid vaporisation of the liquefied gas produces such a degree of cold that the liquid freezes to a hard white solid, which is sometimes known as "carbonic snow."

"Drikold" is manufactured by Imperial Chemical Industries, Ltd., Millbank, London, S.W.1, from which company you can obtain all particulars upon application.

REPLIES in BRIEF

J. F. (Hull).—It is not possible to give all the constructional details for a mains transformer in this column, but we refer you to the article on this subject which appeared in the January 1934 issue of this Magazine. All the necessary information is given in this article.

A. B. T. (Kircardineshire).—Compressed air will be unsuitable since the power required to compress the air could be used to drive the dynamo direct. You do not mention what is the type of the dynamo, so it is impossible to tell you what power is required. You also do not mention the bore and stroke of the steam engine. If you multiply the voltage rating by the current the answer will equal wattage of the dynamo. There are 746 watts to an electrical h.p. If, for example, the output is 200 watts, which is equivalent to ¼ h.p., you will require a ½ h.p. engine to allow for losses.

R. F. W. (Sevenoaks).—For details of the engine to which you refer apply to the Model Aircraft Stores, Ltd., Prestwich. Dry-Ice is obtainable from Imperial Chemical Industries, Ltd., Millbank, S.W.1. Have you seen Mr. F. J. Camm's two small handbooks, *Power Driven Model Aircraft, Model Aeroplanes and Airships*, which can be sent to you for 1*s.* 2*d.* each?

B. J. A. C. (Leicester).—We can let you have a file copy of an issue describing the making of a self-acting fountain for 6*d.*, by post. You did not enclose a stamped addressed envelope.

J. T. H. (London, W.2.)—The blanks you require are probably obtainable from Messrs. Musikon, Ltd., 19, Lisle Street, London, W.C.2.

D. C. T. (Newhaven).—You omitted to enclose a stamped addressed envelope and a query coupon. The engine you have is quite satisfactory. Blue prints will cost 10*s.* 6*d.* a set when ready.

J. J. R. (Dublin).—You omitted to enclose a query coupon and a stamped addressed envelope. A design for a boat such as you require is intended for early publication. The address required is Messrs. Pearl & Moore, 168 Strand, London, W.C.2. We recommend you to obtain a copy of our Fifty Tested Wireless Circuits. It can be obtained for 2*s.* 10*d.*, post paid.

V. S. (Morley).—You could make a transformer of the type you require by using 16 turns per volt for both primary and secondary. The primary may consist of 38-gauge enamelled wire and the secondary of 24-gauge D.C.C.

P. R. (No Address).—We would advise you to get into touch with the General Electric Co., Magnet House, Kingsway, London, W.C.2, for further particulars of the Electric Heater. You omitted to enclose a query coupon and stamped addressed envelope.

R. P. (London, N.1).—The reply to your query which was returned in your own stamped and addressed envelope has been returned to us, "Not known". We give the reply herewith: There is no such metal which responds to the radiations you mention.

P. S. (Cornwall).—The width of the 0 gauge track is 1¼ in., 00 gauge track is 4 mm. between running rails and HO gauge is ⅝ in. (3½ mm.). Gauge O is, of course, 7 mm. or 1¼ in.

BUY, EXCHANGE OR SELL

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

CINEMATOGRAPHY

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

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

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

"FILMCRAFT."—Here is a fascinating series of authoritative textbooks for everyone interested in the Cinema as the newest of the arts. The Filmcraft series, each 3s. 6d. net, includes volumes by Pudovkin, Adrien Brunel, G. E. Kendall, D. Charles Otley, Percy W. Harris. Each 3s. 9d. post free from George Newnes, Ltd., 8–11 Southampton Street, Strand, London, W.C.2.

ELECTRICAL

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

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

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

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

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

ENGINEERING

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

ENGINES

ENGINES. Build Butler's Practical Model Petrol Engine, ¼-h.p., castings, 9/9. Interesting Catalogue 3d. Charging Dynamos, Boat Propellers, Sterntubes, Shafting Blocks.—Write Butler's Profit-sharing Works, Wade Street, Littleover, Derby.

LITERATURE

AMERICAN MAGAZINES. Science. Inventions. Mechanics. Aeroplanes, Models, Radio, Science Fiction. Everything. Samples 1/2. State interests. Lists free. —G. A. Final, 15 Nashleigh Hill, Chesham, Bucks.

WALKING TOURS AND HOSTELS OF BRITAIN, by Sydney Moorhouse. Foolscap 8vo, with maps, 3s. 6d. net. The first comprehensive book covering 14 best districts of Britain with maps and information about routes, stopping places, etc. Officially recognized by the Youth Hostel Association. Ready this spring.—Country Life, Ltd., 20 Tavistock Street, London, W.C.2.

LITERATURE *(continued)*

GARDENS OF ENGLAND AND WALES. Crown 8vo., 148 pp., 1s. net. New edition for 1936, illustrated and indexed list of gardens open to the public under the Queen's Institute Scheme.—Country Life, Ltd., 20 Tavistock Street, London, W.C.2.

"SUNG BEFORE SIX," by Oliver Linden. Illustrated by Treyer Evans, 3s. 6d. net.—"This is a delightful book of verses, constituting the candid criticisms of a child on his parents, relatives, and those about him, and on life in general. They touch a very human chord, and are always amusing."—"Yorkshire Observer." Obtainable at all Booksellers and Newsagents.—George Newnes, Ltd., 8–11 Southampton Street, Strand, London, W.C.2.

HAPPY WEEK-ENDS IN THE COUNTRY

Caravanning! The ideal, inexpensive holiday. If you've a small car, you too can luxuriate in a free-and-easy caravan vacation this summer. It's cheaper to build your caravan—and we can show you how. Write to-day for our interesting catalogue of home-constructors' blueprints, kits and parts.

Holland Coachcraft Ltd., 95 Bath Street, Glasgow, C.2

Make More Money

£3 to £6 weekly can be earned at home in a wonderful business of your own. No matter where you live you can commence to make money in your spare or whole time. No risk, canvassing or experience required. A wonderful opportunity for anyone wishing to add pounds to their income. Particulars, stamp.

BALLARD, 71 Graces Rd., London, S.E.5

MISCELLANEOUS

A REAL HE-MAN'S CANOE! Build your own at negligible cost. Only a few simple tools required. Blueprints and full instructions 3/6 post free. Illustrated list of parts and kits on request.— Holland Coachcraft, Ltd., 95 Bath Street, Glasgow, C.2.

"HOME TOYMAKING," just published, 180 illustrations, 1s. 2d. (below).

"DIE-CASTING IN LEAD," a handbook on lead toymaking, with catalogue of moulds, 1s. 2d.— Industries, 13 Gordon Avenue, Twickenham.

STOP SMOKING.—Send 2/6 for complete treatment; immediate results guaranteed.—"Peacock," 752D Bury Road, Bolton.

5,000 Spring Motors, 4s. 6d.; Gramophones, 15s.; Electric pick-up motors, 38s.; for radiograms, plusagrams, pedestal anexagrams, £5. Soundboxes, horns, tonearms, cabinets, accessories, repairs, needles. Cheapest wholesale-retail. Catalogues free.—REGENTPRAC, 120 Old Street, London, E.C.1.

MODELS

INVENTORS' MODELS, Experimental Work, Drawings. Patterns.—Bland, 105a Crawford Street, London, W.1.

STEEL TUBING, Seamless, ⅛ in. to 4½ in., ⅛ in. to ½ in. thick. Please say lengths you cut to.—Cotes, Church Walk, Brentford, Mddx.

EVERYTHING FOR electrical rewinds and repairs. Screws, nuts, and washers for model engineers. Lists free.—Lumen Electric Co., Litherland, Liverpool, 21.

MODELS *(continued)*

OO GAUGE CORRECT SECTION BRASS TRACK AND POINTS ON BRASS SLEEPERS, ⅜ in. apart, any radius or straight in 3 ft. lengths or less, 10d. per foot, supplied by return, Post Free. Send for List and Free Sample. Rail of Sleepers separately.—T. & M. Products, 1 West Street, Leigh-on-Sea, Essex.

MONEY-MAKING

EXCELLENT MONEY-MAKING OPPORTUNITIES constantly occurring, strongly recommended. Send stamped addressed envelope for free particulars.—Messrs. Green, 17 Church Lane, Hull.

MOTORING

THREE WHEELER CHASSIS, 9 h.p., W.C., J.A.P. twin. 3 speed, reverse, carb., mag., dynamo, interchangeable wheels, EXCELLENT tyres. £6. Offers.—2166 Coventry Road, Sheldon, Birmingham.

COMPLETE ENGINE, gearbox, detachable wheels, etc. Mounted in gully sprung tubular steel frame for three wheeler, £5.—"Lavinia," Aircraft, Lavington, Wilts.

A GREAT OPPORTUNITY FOR READERS OF "PRACTICAL MECHANICS."—ALL PARTS AVAILABLE FOR MR. F. J. CAMMS' £20 CAR

A special department, supervised by a qualified engineer, has been created to make and supply all parts and equipment for the £20 Car, from a complete kit down to the smallest bolt, all conforming accurately to specification.

TIMBER AND PLYWOOD.—Selected prime ash and deal planed to width and thickness supplied cut to suitable lengths.

Specially graded Venesta Birch Plywood cut to approximate dimensions.

N.B.—Use our special waterproof glue—Plyglue.

This adhesive overcomes all the difficulties of making a good joint with birch plywood which has an inherent greasy nature.

METAL PARTS.—All necessary metal can be supplied cut ready for drilling.

Engines, gearboxes, wheels, etc.

A good selection, all carefully examined, is available.

MISCELLANEOUS PARTS.—Whatever you haven't got handy we can supply promptly.

We invite readers of "Practical Mechanics" to write to us for our comprehensive list, which details a complete schedule of parts, or to request quotations for any special parts—an immediate reply will be given and orders speedily executed.

Please note that we cater expressedly for readers of "Practical Mechanics" and that we can supply any apparatus, part or tool described in "Practical Mechanics." Our prices are reasonable and we despatch promptly.

IF YOU CANNOT CALL, CUT OUT AND SEND THIS COUPON AT ONCE

To: Richardson & Whitaker,
4–10 Lamb Walk,
BERMONDSEY, S.E.1.

Tele.: HOP 1206 (Private Exchange).

"PRACTICAL MECHANICS" CAR DEPARTMENT

Please send, free of cost, detailed price list for the £20 Car.

BLOCK LETTERS, PLEASE

Name .....

No. and Road .....

Town .....

County .....

BUY, EXCHANGE OR SELL

MUSICAL INSTRUMENTS

OWN A GENUINE HAWAIIAN GUITAR for only 4/6 weekly. DOBRO the best in the world. Write for 3-Day Free Trial offer and booklet to HESSY'S LTD. (Dept. P.M.), 18–20 Manchester Street, Liverpool.

PLAY A FAMOUS ITALIAN PIANO ACCORDEON for 5/- weekly. Wonderful tone, made by craftsmen. Write for 3-Day FREE TRIAL and colour folder. HESSY'S LTD. (Dept. P.M.), Manchester Street, Liverpool.

PIANO ACCORDEONS. New 25 key, 12 Bass. Beautiful finish. 45s.—Importer, 397 Killinghall Road, Bradford.

BAND GUIDE. Hints on the Bugle, Drum, Flute, Staff Parade formation, etc. Free, post paid.—Potter's (Manufacturers), West Street, London, W.C.2.

PATENTS

REGINALD W. BARKER & CO. (Established 1886), 56 Ludgate Hill, London, E.C.4. Patent and Trade Mark Booklets Gratis.

PHOTOGRAPHY

"PANTOGRAPHS" make large accurate drawings from small photographs, printed drawings, etc., easily. 1s., post free.—Cooke, 33 Hawthorn Road, Levenshulme, Manchester.

£500 worth good, cheap Photo Material, Films, Plates, Cards, Papers, Chemicals. Catalogue and 4 Samples Free.—Hackett's Works, July Road, Liverpool 6.

DON'T TAKE RISKS. Good developers mean good results. Our reliable stock developers keep twelve months after mixing. Satisfaction certain to amateurs and professionals. Best developer ever put on the market. Makes two pints strong developer. 6d. each, 6 for 2/3, 12 for 4/-. Post free.—Hackett's Works, July Road, Liverpool 6.

PHOTOGRAPHIC MATERIALS. Plates, Films, Postcards, Mounts, Folders, Chemicals, etc. I specialize in 6d. packets. Interesting lists free. "Kimber's," 61 Grand Parade, Brighton.

PRINTING

"PHOTO-ENGRAVING." A practical handbook with complete set of materials for engraving printing blocks, 4s. 6d.—Industries, 13 Gordon Avenue, Twickenham.

ADANA PRINTING MACHINE. Perfect, cost over £3. OFFERS.—Stubbs, 15 Windmill Street, Tunstall, Staffs.

SITUATIONS VACANT

AN ASSURED FUTURE. Our New Engineering Guide shows how you can command £10 and upwards per week. It describes numerous "better-pay" courses and qualifications in Electrical; Auto and Aero Engineering: Radio; Television; Talkie Picture Work; Draughtsmanship; Building, etc., and shows how to secure well-paid, permanent posts in Government and Municipal Service. Write to-day for FREE copy of this authoritative publication and details of SUCCESS—OR MONEY BACK GUARANTEE.—National Institute of Engineering (Dept. 5), Staple Inn Buildings, High Holborn, W.C.1.

POST OFFICE ENGINEERING. Good positions open to youths and men, age 17 to 30. Start £4 weekly at age 17. FREE details of vacancies from N.T.O. (Dept. 307), 335 High Holborn, W.C.1.

SITUATIONS VACANT *(continued)*

RADIO MEN WANTED.

Messrs. Marconis anticipate requiring 200 Marine Wireless Operators in the next few months.
TRAINING PERIOD 8/12 MONTHS.
APPOINTMENTS GUARANTEED.
TRAINING FEE CAN BE PAID AFTER SECURING AN APPOINTMENT IF DESIRED.
BRITAIN'S LEADING WIRELESS TRAINING CENTRE.
COLLEGE ON SEA FRONT. BOARDERS ACCEPTED.
WRITE FOR FULL PARTICULARS:
WIRELESS COLLEGE, COLWYN BAY,
Or London Representative, 4 WINTON AVENUE, N.11.

STAMPS

FREE!! Twenty Unused Colonials, "Neurope," 1½d. Fifty for 9d.—G. H. Barnett, Limington, Somerset.

TOOLS

GRAYSON'S Glass-boring Outfits and Tube Cutters avoid risk.—Below.

EXPANDING REAMERS, Files, Woodrasps, HSS hardened toolholder Bits, Drills, Taps, Cold Chisels, centre and hollow Punches.—Grayson & Company, 300 Campo Lane, Sheffield.

THE IDEAL JUNIOR 3-IN. LATHE. S C B G Comp Rest. Quick return to Saddle. Full divided Nut to apron. Illustrated List.—Willimott, Neville's Factory, Chilwell, Notts.

Our Popular 1s. 9d. Bargain Lots, any four lots, 6s.; Lot 1, Gross Whit. Screws, ¼" to ½"; Lot 2, 1 Gross Bright Steel Chamfered Washers, ⅛" to ⅜"; Lot 3, Two Bundles Emery Cloth Strips, weight 2 lb., fine, medium, coarse; Lot 4, Three B.S.F. Taper Taps, ⅛", 3/16", ¼"; Lot 5, 1 Doz. Small Files to 6"; Lot 6, Six Files to 12"; Lot 7, 6 Doz. Assorted Springs, good variety; Lot 8, ⅜" Square Shank Tool Holder, complete with H.S. Turning Tool; Lot 9, Three No. 1 Morse Taper Shank Twist Drills, 3/32" to ¼"; Lot 10, ⅜" B.S.F. Taper and Plug Taps; Lot 11, 1¼" Whit. Taper or Plug Tap; Lot 12, Six Assorted Shapes Norton Grinding Wheels, 1¼" dia., ¼" hole.—Below.

Clearance of Large Taps, Whit. and Gas only, 1½" to 2" Whit., and 1¼" to 4" Gas, all new, best makes, eight assorted, £1; one tap alone worth the money. We will do our best to supply to customers' requirements, but do not guarantee to do this. Carriage forward.—Below.

3 Tons Best Sheffield Files, Flats, Half Rounds, Square, Rounds, in rough and second cut sizes, 6", 8", 10", 12"; this is a very special bargain offer, wonderful value, three dozen assorted, 10s.; also large files, 14", 16", 18", dozen assorted, 8s. 6d., carriage forward.—Below.

250 Bundles Bright Drawn Mild Steel, approx. 5' length each piece, sizes ⅛", 5/32", 3/16", 7/32", ¼", 5/16", 3/8", 7/16", ½" round, 5s. 6d. per bundle of 50'; also Square Bright Steel, sizes ⅛", 5/32", ¼", 5/16", ⅜", 7/16", ½", 5' lengths, 6s. bundle.—Below.

5,000 Small Slitting Saws, ¾" dia., 1/32" thick, clear at 2s. per doz.—Below.

2,000 Slitting Saws, 2¼" dia., 1" hole, 1/16" to ⅛" thick, six assorted, 3s. 6d.—Below.

1,300 Sets Hexagon Die-Nuts, Sheffield made, Whitworth, B.S.F., also American thread, U.S.S. and S.A.E. suitable for Ford and other American cars, ¼", 5/16", ⅜", 7/16", ½", worth 7s. set, our clearing price, 2s. 9d. set; all the above four sets, 10s. lot.—Below.

120 Bundles Best Quality Silver Steel, round, 1/16" to ⅜", 16 standard sizes, 4s. per bundle.—Below.

500 High Speed Tap Fluting Cutters, cuts taps ¼" to ⅜", dia. of cutters 1¼", ⅜" hole, 1s. 3d. each; three assorted, 3s. 3d., worth 6s. each; also larger Cutters, 2½" dia., ⅜" hole, cut taps ½" to 1", 1s. 9d. each; three assorted, 4s. 6d.—Below

TOOLS *(continued)*

250 Sets Feeler Gauges, 10 blades, long taper, 1½ to 25 thous., a very useful bargain, 1s. 9d. each.—Below.

300 Drill Chucks, takes to ½", three jaws. No. 1 Morse taper shank or ½" straight shank, 2s. 9d. each.—Below.

500 Gross Tungsten Steel Hacksaw Blades, 8", 9", 10", 12", 1s. 3d. per doz.; 12s. per gross; also Machine Blades, 12" × 1", 2s. doz., 20s. gross; 14" × 1", 3s. doz.—Below.

1,000 Sets Hexagon Die-Nuts, C.E.I. Cycle Thread, 5/16", ⅜", 7/16", ½", usual price 5s. 9d. set, clear at 2s. 3d. set.—Below.

1,200 Best Quality Straight Shank End Mills, standard sizes, ⅛" 1s. 3d.; 5/16" 1s. 4d.; ⅜" 1s. 6d.; 7/16" 1s. 9d.; ½" 2s. each. All right-hand, suitable for use in lathe—Below.

800 Sets 1" Circular Dies. Screwing ¼", 5/16", ⅜", 7/16", ½", Whitworth and B.S.F. Clearing at 2s. 9d. per set. Both sets 5s. Die Stocks to suit, 1s. 9d. each.—Below.

100 Boxes of Assorted Springs, approx. weight 3 lbs. From 300 to 600 springs. 3s. 6d. per box.—Below.

5,000 Tins Reliable Case-hardening Mixture, for use with ordinary fire, very effective, as used in several large Sheffield works, sample 1 lb. tins 1s. 3d.; 2 lbs. 2s. 6d.; simple to use and guaranteed to give a glass-hard surface to steel or iron; cash refunded if it fails to more than satisfy.—Below.

350 Boring Tool Holders, ½" Square Shank, fitted with ⅜" round boring bar, complete with high-speed tool. These are a very good bargain. Actually worth 8s. 6d. each. Clearing at 3s. 9d. each.—Below.

60 Only, Genuine Norton Grinding Wheels, suitable for general shop use, 9" dia., 1" wide, 1" hole, 4s. 9d. each; also few 1½" wide, 5s. 9d. each.—Below.

1,000 Fine Emery Wheels, 2" to 4" dia., ⅜" hole, ⅛" to ¼" thick, slightly used, but quite serviceable, 1s. 6d. per doz.—Below.

5,000 Genuine Norton Grinding Wheels, 2½" dia., ⅛" to ¾" wide; ¾" hole, three assorted 1s.

10s. Orders Carriage Paid except where stated otherwise, steel bars and files carriage extra.—J. Burke, 30 Trippet Lane, Sheffield.

WIRELESS

HIGH TENSION FROM 2-VOLT ACCUMULATOR. Cost only 5/- to make. Instructions 2/6—Johnson, 6 Fordcroft Road, St. Mary Cray, Orpington, Kent.

FIFTY TESTED WIRELESS CIRCUITS, by F. J. Camm, 2s. 6d.—This handbook contains every modern circuit, complete with instructions for assembling, component values, and notes on operation. 2s. 9d. post free from George Newnes, Ltd., 8–11 Southampton Street, Strand, London, W.C.2.

"THE MATHEMATICS OF WIRELESS," by Ralph Stranger.—This book is essential to the amateur who wants to gain a further knowledge of the subject without loss of time—or temper! Fully illustrated, 256 pages. 5s. 3d. post free from George Newnes, Ltd., 8–11 Southampton Street, Strand, London, W.C.2.

WOODWORK

TIMBER AND PLYWOOD, ex dock prices from direct importer, Hardwoods and Softwoods machined to size. Pine, P.A.R., 3 in. × 2 in. 7/6, 4 in. × 2 in. 8/-, 100 ft. Estimates against cutting list. Goods forwarded F.O.R.—John McKenna, Dept. 5, Timber and Plywood Importer, Oxton Road, Birkenhead.

CABINET HARDWOODS, Oak, Mahogany, Ash. Whitewood, Ply-woods, etc. Lowest Prices. Send Cutting lists. Planing free. Speciality prime Jap Oak, all thicknesses.—Wilfred Parr & Co., March Works, Lancaster Road, Leytonstone, E.11.

FREE SERVICE FOR READERS

READERS requiring information concerning goods or services advertised in *PRACTICAL MECHANICS* should give names of Advertisers from whom particulars are desired. Any number of names may be included and we will obtain for you catalogues, lists, and any other information you may be wanting. THERE IS NO CHARGE FOR THIS SERVICE.

Readers desiring particulars from a number of Advertisers will, by this method, save time and postage. Halfpenny stamp only is required if your envelope is left unsealed. If any Advertiser stipulates that stamps or postal orders are necessary before samples or catalogues are sent, please enclose the necessary amount with your instructions. You are cordially invited to make full use of this Service.

Post this to

ADVERT. SERVICE DEPT.,
PRACTICAL MECHANICS,
8-11 SOUTHAMPTON STREET, STRAND, W.C.2

Please obtain and send to me particulars from the Advertisers in your May issue whose names I give on list attached.

Advertiser	Page No.	Information Required

Attach sheet of paper, with particulars, and your name and address (written in **BLOCK** *letters), with date, to this announcement.*

FREE ADVICE BUREAU
COUPON

This coupon is available until May 31st, 1936, and must be attached to all letters containing queries.

PRACTICAL MECHANICS, MAY, 1936

Published about the 30th of each month by GEORGE NEWNES, LIMITED, 8-11 Southampton Street, Strand, London, W.C.2, and Printed in Great Britain by HAZELL, WATSON & VINEY, LTD., London and Aylesbury. Sole Agents for Australia and New Zealand—Gordon & Gotch Ltd. Sole Agents for South Africa—Central News Agency Ltd. Subscription Rates: Inland and Abroad, 7s. 6d. per annum; Canada, 7s. per annum.