Building the "P.M." MODEL PETROL PLANE! CASH and other PRIZES

NEWNES

PRACTICAL MECHANICS

APRIL 37

6D

Great National Contest!

Full Details Inside!

YOU HAVE BEEN WARNED BY RADIO

Professor Hilton on November 19th, 1936, from the B.B.C. broadcast a warning. The warning was to the effect that while there are many really good and reliable Colleges teaching by correspondence, there are many others which are colleges by name only. He said some so-called colleges rented a couple of rooms in a large building in a well-known street. Some made great promises which they did not intend to fulfil. Some claimed successes they could not prove. In some cases the names of prominent men were quoted who were in no way connected with the working of the College.

NOW BE ADVISED BY ME

The big name of a College is no proof of its national standing. The Bennett College has been established over 30 years and our entire building is devoted to Bennett College work. No other business of any kind is either on or attached to The Bennett College. We have seating accommodation for over 10,000. We have a permanent staff of over 190 people on the College premises. Our Professional Staff have all passed their examinations, and our tutors are all experts in their own specialised work. We do not send out any homework to be corrected by tired, spare-time tutors. All students' homework is corrected on the College premises the same day that it arrives, and is returned by evening post. This College is Technical, Scientific, General and Commercial, thus enabling us to cater for all requirements ; this is important to Cost and Works Accountants and all who have to deal with rate-fixing, machining-allowance, and it is also of great importance in many of the Civil Service Examinations. This is an entirely British College. Most of our textbooks are written on the College premises by our own professional staff, especially for tutorial purposes. Our tutors specialise in teaching students for the examinations they themselves have already passed.

THERE IS NO OTHER COLLEGE IN THIS KINGDOM THAT CAN CLAIM ALL THE ABOVE ADVANTAGES

It is not necessary for students to attend the College ; we can send exactly the same tuition to you by post for a reasonable fee payable monthly. Anyone who reads the journals knows that there are many things advertised that one can study, and any kind of study is good. It is training for the brain, but the best thing to study, surely, is a course specially prepared to teach you your own vocation, or prepare you for the examination which you have in view. Knowing that you are master of your job gives you self-confidence and personality, but a Diploma from a College is absolute proof of your efficiency. We have agencies in all English-speaking corners of the world. The nature of our business makes us keep in touch with employment requirements in all parts of the world, therefore we specialise in preparing students for the good positions which we know exist, and for all the worth-while examinations.

THE ABOVE VAST ORGANISATION CAN HAVE BEEN CREATED ONLY BY THE SUCCESS OF OUR STUDENTS

There is a tide in the affairs of man which, if taken at the flood, leads on to fortune and success. There are three things which come not back—the sped arrow, the spoken word, and the lost opportunity—this is your opportunity. If it is your desire to make progress and establish yourself in a good career, write to us for free particulars on any subject which interests you, or if your career is not decided, write and tell us of your likes and dislikes, and we will give you practical advice as to the possibilities of a vocation and how to succeed in it. You will be under no obligation whatever. It is our pleasure to help. We never take students for courses unless we feel satisfied they are suitable. Do not forget that success is not the prerogative of the brilliant. Our experience of over 30 years proves that *the will to succeed* achieves more than outstanding brilliancy.

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Let me tell you how to make a success of your career.
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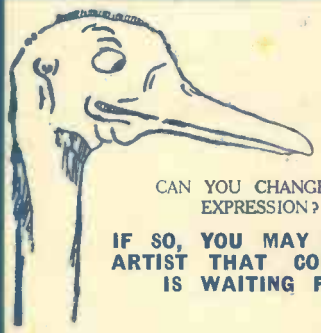
I want to help, and it will cost you nothing to get my help ; you will be under no obligation whatever.

We are prepared to produce, on demand, over 10,000 unsolicited testimonials from successful students, or in default we will hand over £100 to charity.



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- Radio Communication
- Road-making and Maintenance
- Salesmanship, I.S.M.A.
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The Machine that "MAKES" MONEY

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SENSATIONAL New Money-Making Opportunities are opened up by the placing on the market of this NEW ADANA FULL QUARTO SIZE PRINTING MACHINE!

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From a VISITING CARD to a

FULL QUARTO SIZE POSTER

Think of the possibilities now open to you! Think of the printing that is needed every day in your district—**CIRCULARS, LETTERHEADS, DANCE** and **MEETING POSTERS, NOTICES, PROGRAMMES, TRADESMEN'S BILLHEADS, HANDBILLS, CLUB** and **CHURCH PRINTING, etc.,** apart from the veritable host of smaller things such as **Invitation Cards, Admission Tickets, Price Tickets, Labels, Menus, etc., etc.**

SOMEBODY has to meet the demand!

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YOU can make POUNDS from PRINT! There is literally **no end** to the scope of work—**simply waiting to be done!**

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GREAT OFFER

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Messrs. Archibald Turner & Co., Ltd.
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It's called "POUNDS FROM PRINT" because that's the only way to describe the almost unlimited possibilities it discloses! Page after page is packed with the wonderful experiences of people who are making regular incomes in their own homes. Every line of it will fire the imagination of every ambitious man and woman. Send the coupon on the right NOW!

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a *MAMMOTH* machine at a *MINIATURE* Price!

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Why not add those extra inches with one box of Challoner's Famous Formula.

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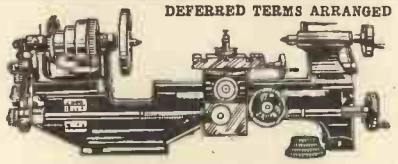

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Send a stamp to pay postage, and you will learn how to rid yourself of such a terrible affliction free of charge.

Address in confidence—
P. TEMPLE, Specialist
"Palace House," 128 Shaftesbury Avenue, W.1
(Est. 30 years.)

Boasted Jones at the Club t'other night,
"Every job that I do is done right!"
Said a pal, "Well I never,
Now isn't that clever,
But 'who put you on to Fluxite?"

See that FLUXITE is always by you—in the house—garage—workshop—wherever speedy soldering is needed. Used for 30 years in government works and by leading engineers and manufacturers. Of Ironmongers—in tins, 4d., 8d., 1/4 and 2/8. Ask to see the FLUXITE SMALL-SPACE SOLDERING SET—compact but substantial—complete with full instructions, 7/6.

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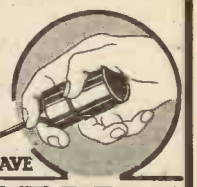
is always ready to put Fluxite on the soldering job instantly. A little pressure places the right quantity on the right spot and one charging lasts for ages. Price 1/6.



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is one of our well-known stand or hand telescopes for look-out and astronomical use. A 25x erecting day eyepiece and a 50x astro eyepiece with Sun-cap are provided, also tripod stand with ball-and-socket joint.

Price £3 10 0
Delivery free.

Send for lists of new and secondhand Telescopes, Microscopes and Binoculars.

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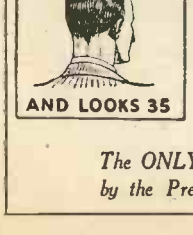
Telescope House, 63 Farringdon Rd., London, E.C.1.



BALDNESS BARS PROMOTION

A MODERN MIRACLE

MEDICAL Science has at last discovered a simple method whereby the dormant hair follicles can be restored to VIGOROUS LIFE, enabling them to produce new and naturally coloured hair.

One delighted Client of 89½ who was bald for over 30 years reported that the "C.L.L." treatment produced a FINE GROWTH OF NEW HAIR. The ages of other equally grateful Clients range from 22 to 81. MEDICALLY RECOMMENDED, £1,000 for denial.

Write to-day for a copy of our Illustrated Book entitled "HOW TO ACQUIRE PERFECT HAIR GROWTH." Post free privately from:—

THE LABORATORIES (P.M.),
37 New Bond Street, London, W.1.

The ONLY cure in the world for Baldness endorsed by the Press and the MEDICAL PROFESSION.

AMAZING CYCLE OFFER

ROADSTERS OR RACERS

47/6

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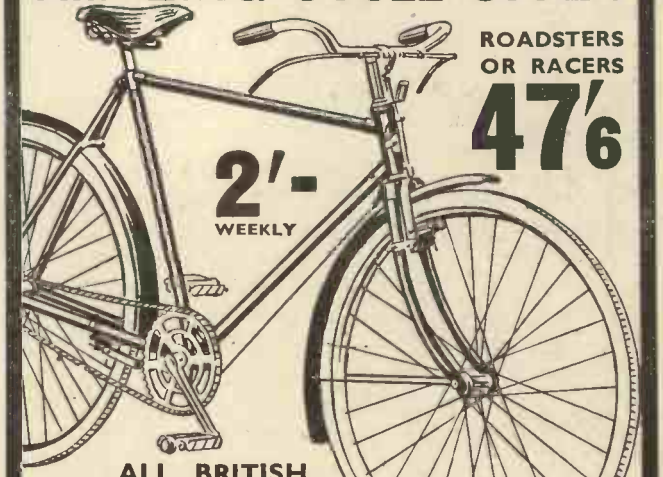
WEEKLY



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JAGROSE ROADSTER. Built by a firm with 60 years' cycle experience. Est. 1876. Beats all agents and stores. Dunlop Rims, British Goodrich Tyres, Perry Chain, Dunlop Saddle, British Hubs and Pedals, Ball-bearing Freewheel. Frame coslettised to prevent rust, four coats Best Enamel, lined Red. Bright Parts Heavily Plated. Fully Guaranteed. Worth £3.15.0. Don't Delay. Take advantage *now* of this wonderful offer.

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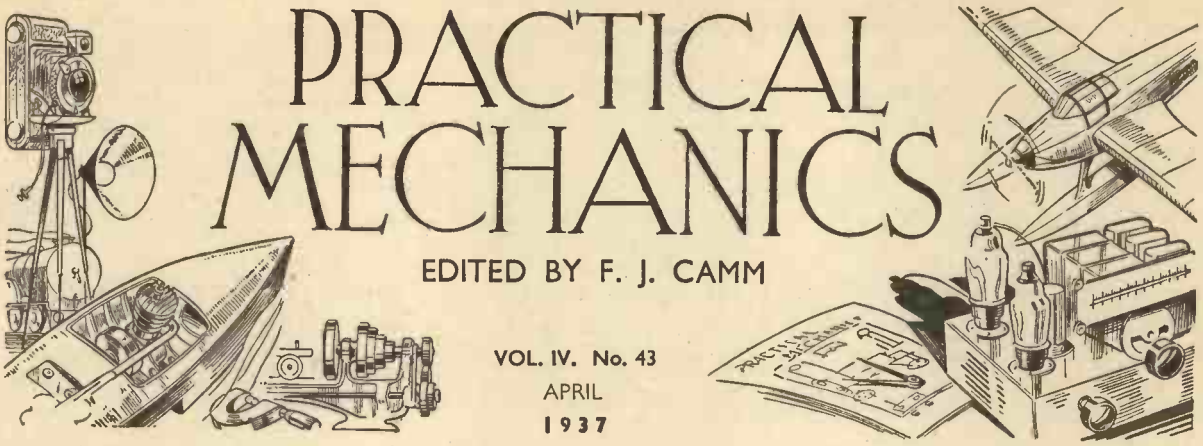
Illustrated List of Roadsters, Racers and Tandems from 47/6

NAME.....

ADDRESS..... M.3.

JAMES GROSE LTD., 379 EUSTON RD., N.W.1



PRACTICAL MECHANICS

EDITED BY F. J. CAMM

VOL. IV. No. 43
APRIL
1937

Testing Metal by Sound Waves

A DEFECTOSCOPE for the testing of metal up to 1 metre in thickness has been invented by the Soviet scientist, Professor S. Y. Sokolov. With the aid of the instrument it will be possible to determine the quality of metal with absolute precision before it has been put to use. The appliance is based on the ability of sound to pass through metal.

Lloyd's Register Scholarships

A SCHOLARSHIP, value £100 a year for three years, and intended to assist marine engineering students to take an advanced course of instruction in engineering subjects, is being offered by the general committee of Lloyd's Register of Shipping. It will be awarded on results of the Studentship Examination of the Institute in June. The age limit is 18 to 23 years.

Stamps Available

THE Postmaster-General announces that King Edward VIII 2½*d.* postage stamps are generally available at every Post Office in the kingdom, and will be supplied to any purchaser who asks for them. If the stock at any office is temporarily exhausted, it will be replenished without delay. King George V 2½*d.* stamps will continue to be supplied to purchasers who express no special preference.

Decimal Coinage

MANY prominent leaders in industry and public life throughout Great Britain are co-operating in an effort to secure the adoption of decimal coinage.

Electric Insulating Materials

THE building of a plant for the production of electric insulating material has been commenced in the vicinity of Khotkovo Station, near Moscow. The plant is designed for an annual output of goods to the value of 100 million roubles. The first two shops will be put into operation next year.

First Aerial Beacon

THE first aerial beacon to be erected in New Zealand is being installed at Hamilton. It will be of 3,000,000 candle-power, and will be visible in clear weather at a distance of 25 miles.

Aviation in Southern Rhodesia

THE Prime Minister of Southern Rhodesia is setting up a committee to decide how best to expend the gift of £3,500 by Sir Abe Bailey for the assistance of civil aviation in the colony.

NOTES, NEWS, AND VIEWS

The Periscope Hat

A HAT fitted with mirrors, and known as the periscope hat, has been designed for use at race meetings, etc.

Glass Discs for Records

GLASS dics are used in an ingenious manner by a Weston-super-Mare man to make his own gramophone records. After much experimenting, he found a preparation with which to coat the surface of glass, and it is in this that the sound track is made.

Turn to page 366

New French Liner

THE liner now being built to replace the *Atlantique*, which was burnt in the Channel in 1933, is to be named *Pasteur*.

A New Radio Station

THE Czechoslovak Telegraph Administration has placed a contract with Marconi's Wireless Telegraph Co., Ltd., for a high-power broadcasting station to be installed near Brno.

Synthetic Silk

IN Hungary, chemists have succeeded in making synthetic silk from the bark of mulberry trees.

Soviet Turbine of 100,000 kwt.

IT is reported in a recent issue of a Soviet paper that the Stalin metallurgical works in Leningrad is making a powerful turbine of 100,000 kwt. with 3,000 revolutions per minute. Mr. M. O. Grinberg, the director of the plant, has stated that there is no turbine of equal capacity in Europe. The new turbine is expected to be ready in July next.

SUBSCRIPTION RATES

Inland and Abroad, 7s. 6d. per annum

Canada - - 7s. per annum

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'Phone: Temple Bar 4363.
Telegrams: Newnes, Rand, London.

Registered at the G.P.O. for transmission by Canadian Magazine Post

A New Type of Seat

RAILWAY cars that are being built under the London Passenger Transport Board's £40,0000,000 scheme, are to be fitted with a new type of seat with a curve to suit the passenger's back.

A Pedalless Bicycle

AT the recent B.I.F. in London was shown a cycle known as the "Gee Byke." It is a pedalless machine propelled by upward and downward motion of the saddle.

The "Bicycle-Canoe"

A COMBINED bicycle and canoe has made its appearance in France. The bicycle, which has very small wheels, draws a trailer containing the canoe. The canoe, which is in three sections, can be taken to pieces for carriage. The bicycle may also be taken to pieces to carry in the canoe.

A Ship-to-Shore Telephone

A RADIO telephone has now been installed to link up the Hull and Humber ports with ships operating off the coast. A ship-to-shore telephone service is thus available at all times for trawlers, coasting craft, and other vessels within a range of 200 miles of the coast.

Our £20 Car

A READER, Mr. F. A. Halsey, has completed the chassis of the £20 car, including engine, gearbox, back wheel, etc. He has taken the car out and it is quite successful, although the body is not yet completed. Circumstances have arisen which will prevent him from doing so. He says that it would cost about £2 to complete it. He will accept £7 for it, the car going to the first remittance received. Letters will be forwarded, and unsuccessful applications will be returned.

Air Mail Between Cities

SIR Archdale Parkhill, Minister of Defence, announced in Australia recently that letter mails will, by the middle of next year, be carried by air between capital cities in Australia at ordinary rates without any form of surcharge. A surcharge would, it was explained, be maintained temporarily for other services.

Photographs

WILL readers please note that when sending photographs for publication they should write their full name and address on the back of each photograph, as well as a description of the model.

GREAT NATIONAL MODEL AIRCRAFT CONTEST!

1st PRIZE: £50

Many other Valuable PRIZES

NO ENTRANCE FEE!

START BUILDING THE "PETREL" NOW!

Full Constructional Details of this Fine Petrol-driven Model, and Rules of this Important Contest.

PRACTICAL MECHANICS takes great pleasure in announcing an important National Model Aircraft Contest, entrance to which is free to every regular reader, and for which a first prize of £50 will be awarded, as well as the numerous other prizes to be announced later.

The Competition is for petrol-driven models constructed from the plans published here; but in order that every reader may be given a fair chance the design will be modified to suit most of the small petrol engines ranging from 2 c.c. to 9 c.c. which are available.

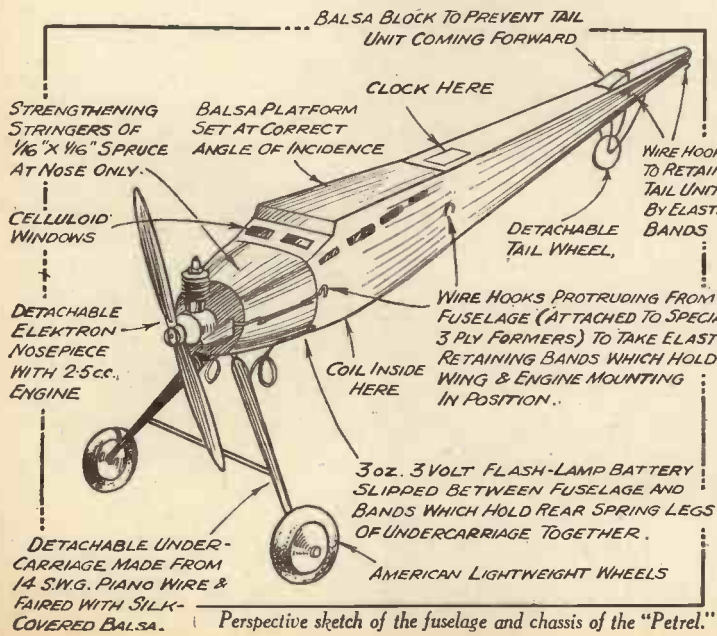
Model Aircraft is making enormous strides, particularly in America, Canada, Australia, and Germany, and whilst interest in this country has been rapidly developing during the past two years, we are in some respects still far behind those countries. This is an unsatisfactory state of affairs when we remember the pioneer work of early English experimenters such as Stringfellow and others who made the early work of the Wright Brothers possible.

The Advance of Miniature Petrol Engines

Our Competition, with its large and valuable prize list, is specially planned to give this fascinating scientific hobby the fillip which it deserves. There are hundreds of model aircraft clubs in this country, and the numbers grow week by week. The hobby is progressing from the rubber-driven model originally introduced by the Frenchman Penaud as far back as 1871, to models propelled by miniature engines driven by compressed air, steam, and petrol. The two former types of engine have not been found very satisfactory, **but there is a large number of entirely satisfactory miniature petrol engines on the market which develop sufficient power to fly models weighing up to 12 lbs., although the engines themselves weigh only from 6 oz. to 16 oz.**

Models which Fly for over One Hour!

It is a somewhat surprising fact that the original record for petrol-driven models of 51 secs. created by D. Stanger many years before the War held until recently, when Captain Bowden broke it with a flight of 12 mins. 48 secs. out of sight. **Actually the length of flight of a petrol-driven model is limited only by the amount of petrol carried, for these little engines will run for indefinite periods at speeds of about 6,000 revolutions per minute.** They are extremely reliable, and cheap. They thus make possible the construction of a realistic model, and one which simulates to a remarkable degree of fidelity the proportions, the appearance, and the performance of a full-size machine. It is one of the most fascinating experiences to watch one of these tiny models take off like a real aeroplane, and ascend to an enormous height, with a crackle from the exhaust almost as loud as that which issues from the full-size machine.



Perspective sketch of the fuselage and chassis of the "Petrel."

COMPONENTS and MATERIALS REQUIRED

ENGINE MOUNT.—Elektron, as described.

UNDERCARRIAGE.—8 ft. 14 S.W.G. wire and 2 reels of florist's wire; 2 pneumatic wheels; 1 length ½-in. sheet balsa for fairing of undercarriage legs; strip of silk for binding fairing.

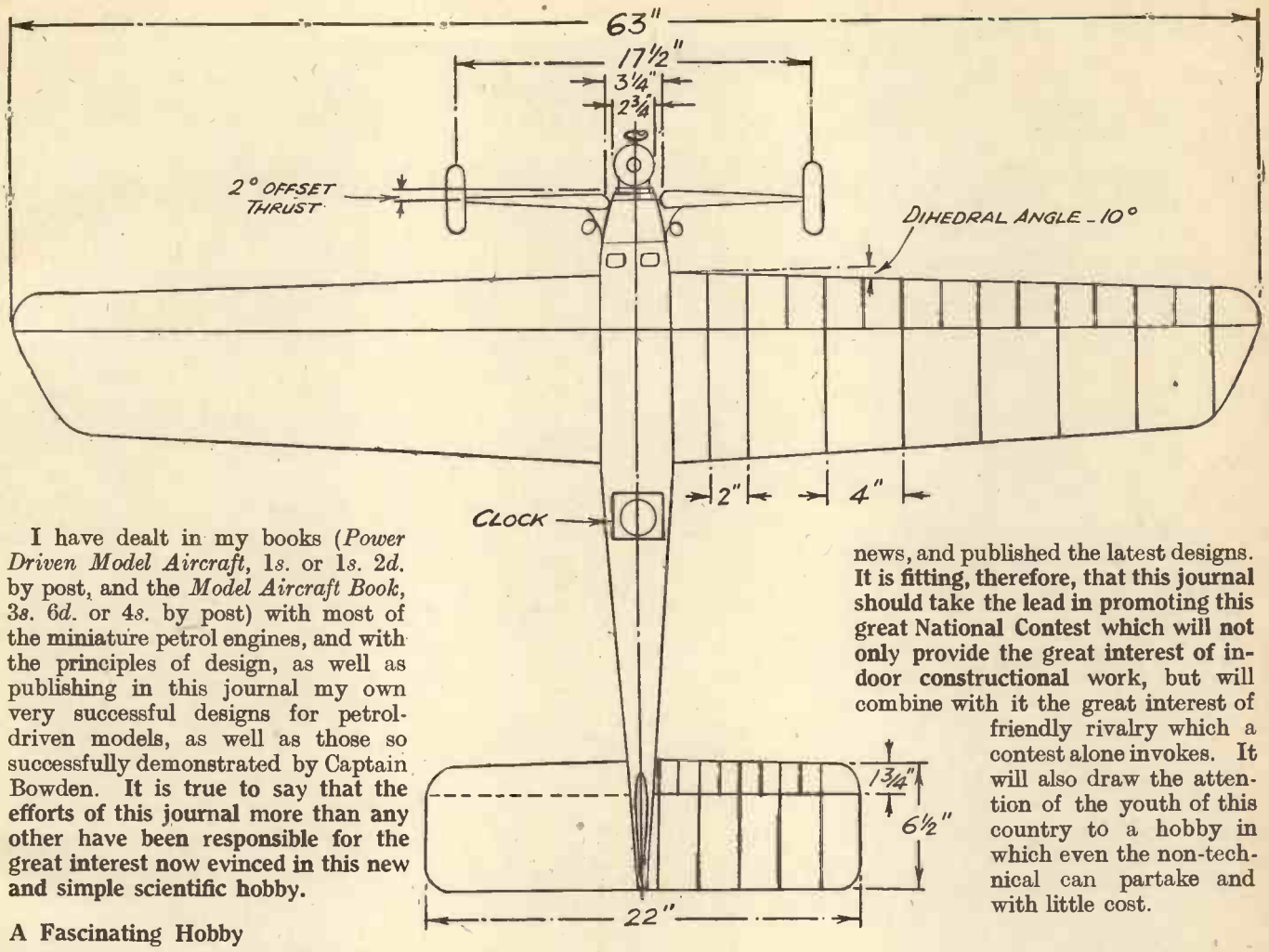
FUSELAGE.—1 large tin of photopaste adhesive for silk covering; 1 pint of clear glider dope (full-strength); 1 pint of coloured dope; four 3-ft. lengths ⅛ in. × ⅛ in. birch or spruce for longerons; three 3-ft. lengths ⅛ in. × ⅛ in. balsa for uprights and crosspieces; 12 in. × 4 in. of ⅛-in. three-ply for special formers; 4 in. × 4 in. × ¼ in. three-ply for circular nosepiece; small tube plastic wood for reinforcement; 12 in. × 3 in. × 1 m.m. three-ply for fuselage floor (forward); four sheets of 3 ft. × 6 in. × 1/16 in. balsa sheet for side, top and bottom covering of fuselage; 12 in. of duralumin or brass tube to take 14 S.W.G. wire for undercarriage anchorage in fuselage; 6-in. brass tube for tail wheel anchorage, to take 20 S.W.G. wire; 1 light tail wheel; 5 in. aluminium tubing, and cycle tubing to connect tank in wing; 6 in. × 4 in. thin celluloid for cabin windows; 6 in. × 1½ in. balsa block to make stops for mainplane and tailplane; 36 in. × 20 in. silk for covering fuselage; 9 in. × 5 in. green baize to make anti-slip platform coverings for wing and tail unit; 2 reels binding thread; 3 ft. 18 S.W.G. wire for hooks.

MAINPLANE.—Four lengths of 3 ft. × ½ in. × ⅛ in. spruce for mainspars; four lengths 3 ft. × 3 in. × ⅛ in. balsa sheet for ribs and riblets; two pieces 1/16-in. three-ply for central ribs; 18 S.W.G. piano wire strengtheners at dihedral angle, fin, and undercarriage hooks; four lengths hard balsa 3 ft. × ½ in. × ⅛ in. for leading and trailing edges; 2 ft. round cane ⅛ in. diameter for wing tips; two solid balsa wing tip inserts, 3 in. × 6 in. × 1 in.; four pieces of jap silk 35 in. × 10 in. to cover wing.

TAILPLANE.—One sheet balsa 3 ft. × 6 in. × 1/16 in., and one sheet 3 ft. × ⅛ in. balsa for ribs and riblets; one length spruce ⅛ in. × ⅛ in. for mainspars; two lengths ⅛ in. × ⅛ in. balsa for leading and trailing edges; two pieces of silk 23 in. × 7 in. to cover tailplane, and two pieces silk 7 in. × 8 in. to cover fin.

ODDMENTS.—Insulating tape; ignition wire; rubber bands; two wireless terminal clips; valve tubing for petrol connections; two wireless plugs and sockets; glasspaper; cellulose aero glue (six large tubes).

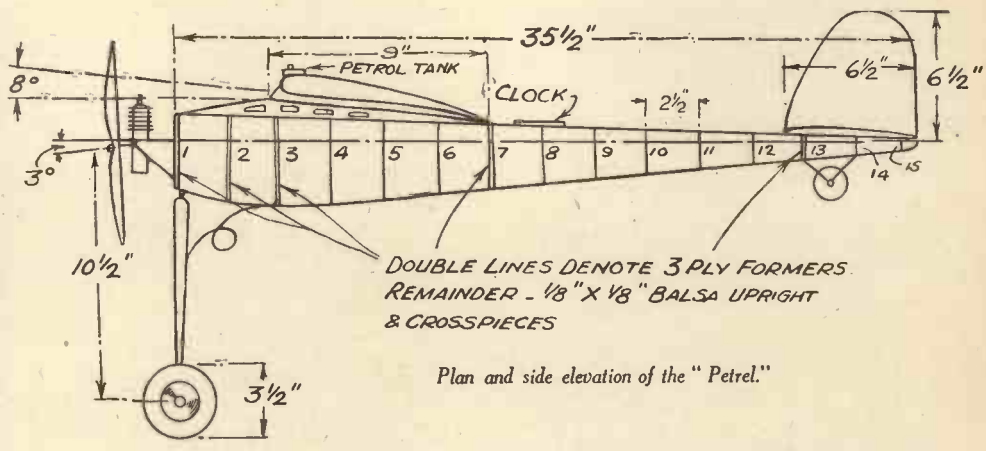
ENGINE.—See text.



I have dealt in my books (*Power Driven Model Aircraft*, 1*s*. or 1*s*. 2*d*. by post, and the *Model Aircraft Book*, 3*s*. 6*d*. or 4*s*. by post) with most of the miniature petrol engines, and with the principles of design, as well as publishing in this journal my own very successful designs for petrol-driven models, as well as those so successfully demonstrated by Captain Bowden. **It is true to say that the efforts of this journal more than any other have been responsible for the great interest now evinced in this new and simple scientific hobby.**

A Fascinating Hobby

This is a scientific age and more and more will aircraft play its part in the commercial and civil life of the country. The aircraft industry is full of opportunities for those who know the principles of flight. There is no more certain way of acquiring this knowledge than by means of the building and flying of model aeroplanes. In this and other journals of which I am the Editor I have regularly for more than twenty years dealt with model aircraft. I have scoured the world for news, and published the latest designs. **It is fitting, therefore, that this journal should take the lead in promoting this great National Contest which will not only provide the great interest of indoor constructional work, but will combine with it the great interest of** friendly rivalry which a contest alone invokes. It will also draw the attention of the youth of this country to a hobby in which even the non-technical can partake and with little cost.



Plan and side elevation of the "Petrel."

RULES

(Competition Rules to be given next month)

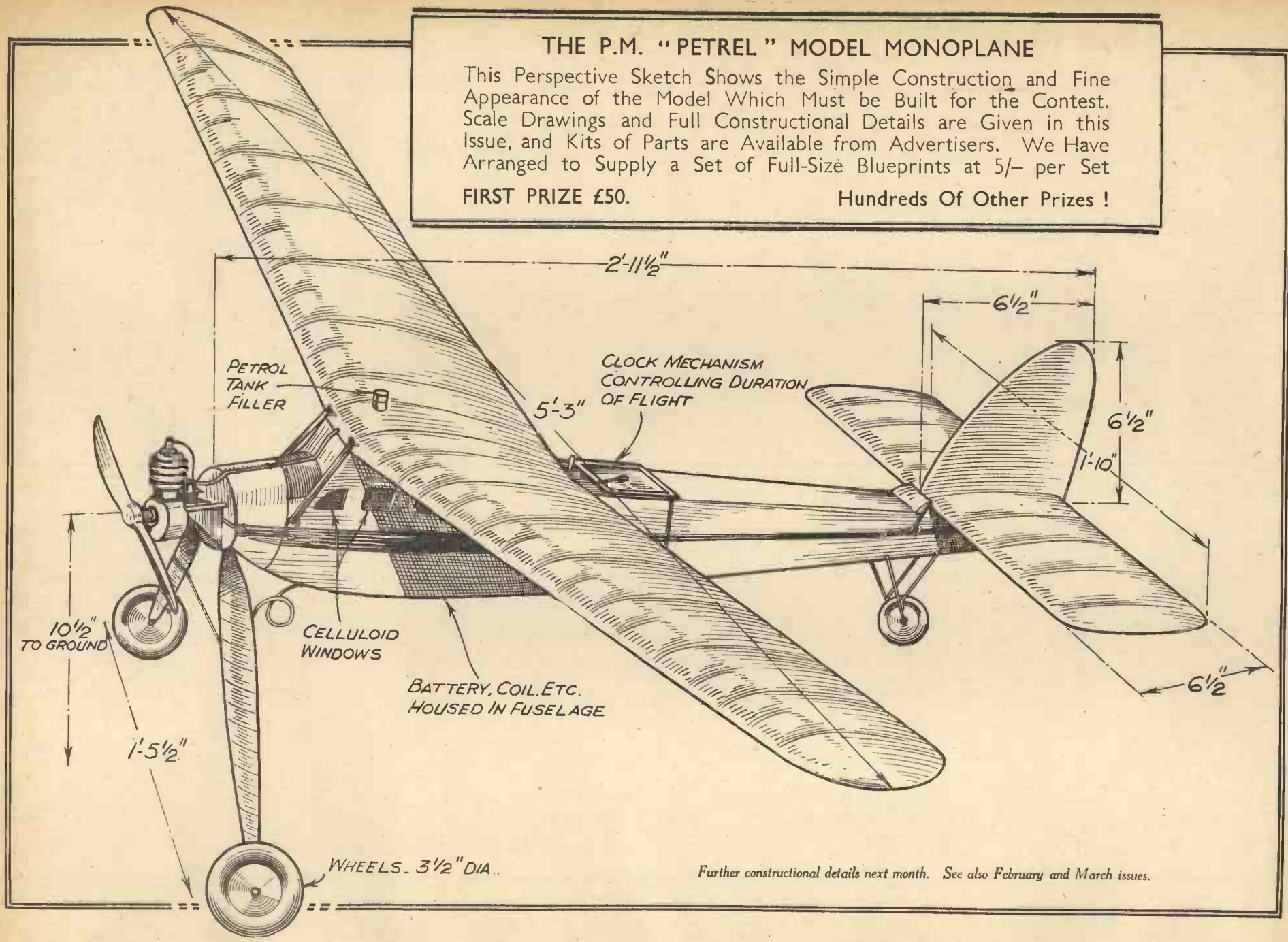
1. *Only models built according to the designs and specifications here given are eligible.*
2. *Notification of intention to compete must be sent on a postcard, so that a register of competitors can be compiled. Address postcards to The Editor, Practical Mechanics, George Newnes, Ltd., Tower House, Southampton St., Strand, London, W.C.2, to reach us not later than April 30th, 1937.*
3. *The Editor reserves the right to refuse an entry without assigning a reason.*
4. *Professional model-makers, those engaged in the making of models for profit, or as a livelihood, are excluded from this competition.*
5. *Models must be the unaided work of the competitor, but they are allowed to purchase the usual finished parts —airscrew, ribs, wheels, engine, etc.*
6. *The competition is open only to regular readers, and competitors must, at a later date, send us the query coupons, as evidence of purchase, cut from the April, May and June issues of this journal.*
7. *The Editor of this journal, in conjunction with the S.M.A.E., will frame the competition rules (to be announced in the next issue) and will act as judges. Their decision is final and legally binding.*
8. *Each competitor may enter only one model.*
9. *Any variation in the design may entail disqualification, within the discretion of the judges.*
10. *Those competitors who will be unable to attend to fly the models themselves may appoint a delegate, approved by the judges, to do so.*
11. *The competition will be for time-controlled flight, marks being awarded for take-off, stability, duration of flight, and landing. The model with a quick take off may thus score points.*
12. *Other prizes will be awarded for workmanship and finish.*
13. *The date of the competition, which will take place at one of the large aerodromes, will be announced later.*

Full-Size Blueprints Available—See Page 368

THE P.M. "PETREL" MODEL MONOPLANE

This Perspective Sketch Shows the Simple Construction and Fine Appearance of the Model Which Must be Built for the Contest. Scale Drawings and Full Constructional Details are Given in this Issue, and Kits of Parts are Available from Advertisers. We Have Arranged to Supply a Set of Full-Size Blueprints at 5/– per Set

FIRST PRIZE £50. **Hundreds Of Other Prizes !**



Further constructional details next month. See also February and March issues.

START BUILDING THE "PETREL" TO-DAY ! FIRST PRIZE £50 !

Rear view of the model.

View of the engine mounting.

The S.M.A.E. to Assist

The governing body of model aeronautics in this country is the Society of Model Aeronautical Engineers, who have kindly consented to act with us in framing the rules and judging the competition.

The Contest will be held in July at one of the great Aerodromes of this country, so that every reader has ample time to build his model and to perfect it. Arrangements will be made so that those readers who cannot attend to fly the models themselves may appoint a delegate approved by the S.M.A.E. to do so. Thus, every reader will be given an equal opportunity and distance will not confer a disadvantage. The competition will not be for duration. It is quite easy for anyone to make a petrol-driven model which will fly for an hour or more. There are many instances of models which have flown and landed over 60 miles away, having ascended to an altitude of over 3,000 feet.

Details of the Competition

Quite obviously a competition for duration would be difficult, if not almost impossible to judge, for under the rules of the S.M.A.E. the timekeepers are not allowed to follow the model and the time is taken until the model disappears from the sight of the timekeeper. If the competition were for duration there would be an enormous number of lost models, a large number of ties, and the competitors would be penalised according to the light at the time the flight was made.

So it is proposed to make the competition for time-controlled flight: the model will be required to take off and land within a specified time. This is possible by means of the simple time-control switches, constructional details of which are given. Marks will be awarded for a good take-off and a good landing, as well as for the stability of the model in flight; but the time of flight will also be taken into consideration.

Other prizes will be awarded for workmanship in a *concours d'elegance*. We shall award hundreds of consolation prizes. **In order that we may make the necessary arrangements it is important that every reader who wishes to enter the competition should write a postcard addressed to the Editor, "Practical Mechanics," George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2, stating that fact.**

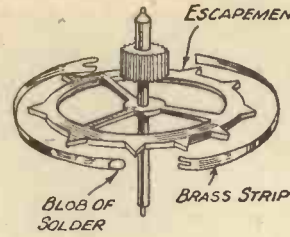
The "Petrel"

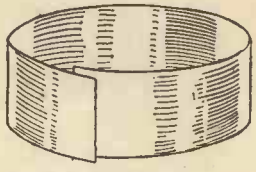
A suitable design for the competition is the "Petrel" illustrated here. This has been specially designed for models up to 3 c.c., but we shall publish details of the modifications (very minor) necessary to convert the model for 6 c.c. and 9 c.c. engines. The model must be constructed according to the specifications here given, so that all competitors are operating under similar conditions. We cannot permit to be entered in the competition models of the competitor's own design. This would be unfair to those competitors who have not yet constructed a petrol-driven model, for many model-makers already possess petrol-driven models; and under no circumstances can we permit variations of design, or specifications.

The model here shown has formed the subject of articles in the two previous issues of PRACTICAL MECHANICS, but the drawings are repro-

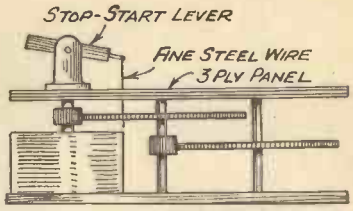
This photograph shows the "Petrel" in flight. It is a fine flier.

The diagrams to the left show the timing mechanism which presets the length of flight. Below is shown the electrical circuit for ignition.

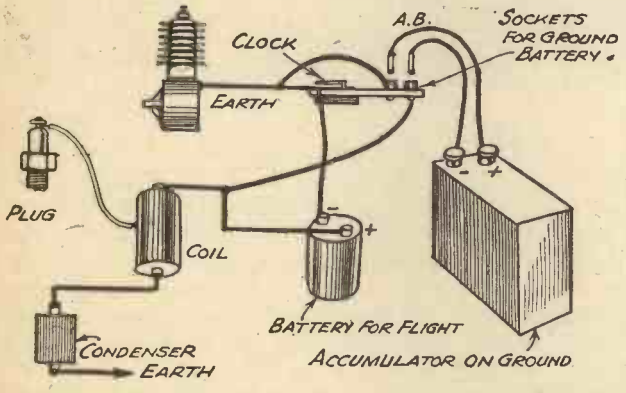


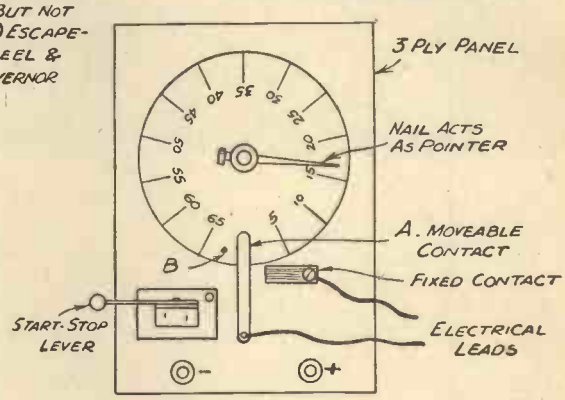


TIN DRUM TO FIT ROUND (BUT NOT TO TOUCH) ESCAPEMENT WHEEL & FORM GOVERNOR



DRUM WITH GOVERNOR INSIDE

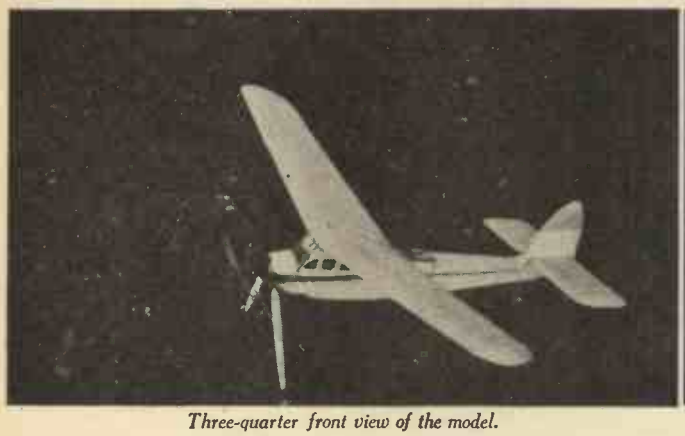




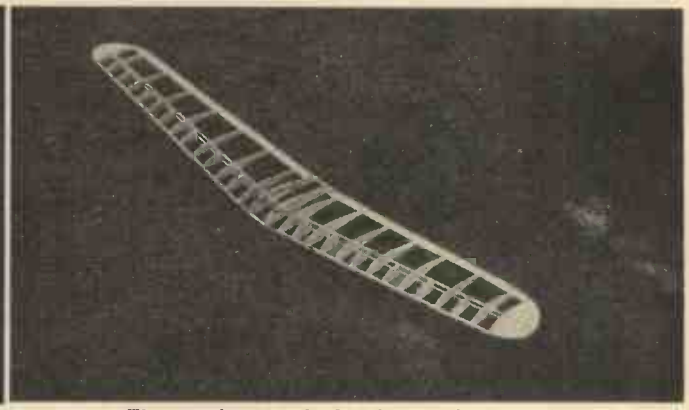
duced here again for the benefit of intending competitors; they should, however, consult those two issues.

All of the materials are obtainable from advertisers in this journal, and it is particularly important to order the engines first. Each supplier will then have ample time to tune up the engines for competitors, and save them a lot of work. Make up your mind now to enter this great national contest for petrol-driven models.

We can also supply a set of blueprints, showing important parts full-size, for 5*s*. Read the Rules carefully, and study the designs carefully before commencing construction.



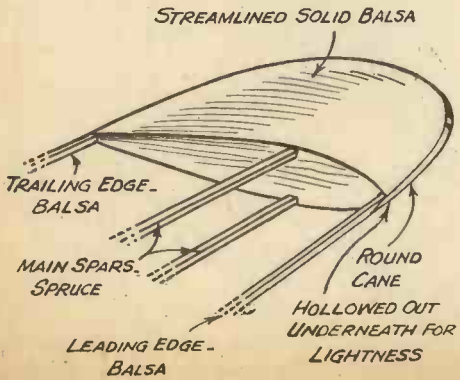
Three-quarter front view of the model.



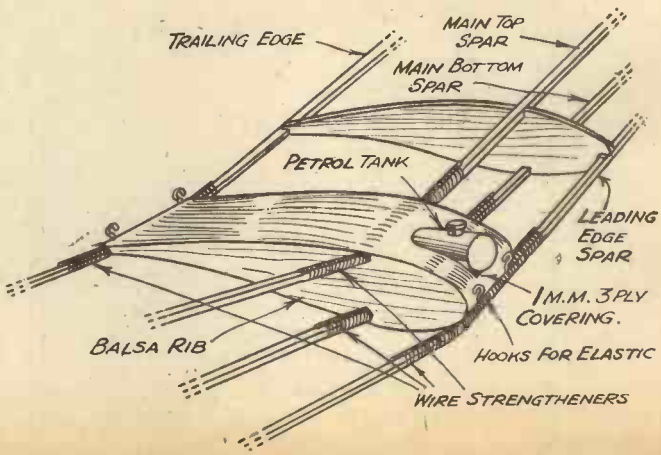
The mainplane completed and ready for covering.

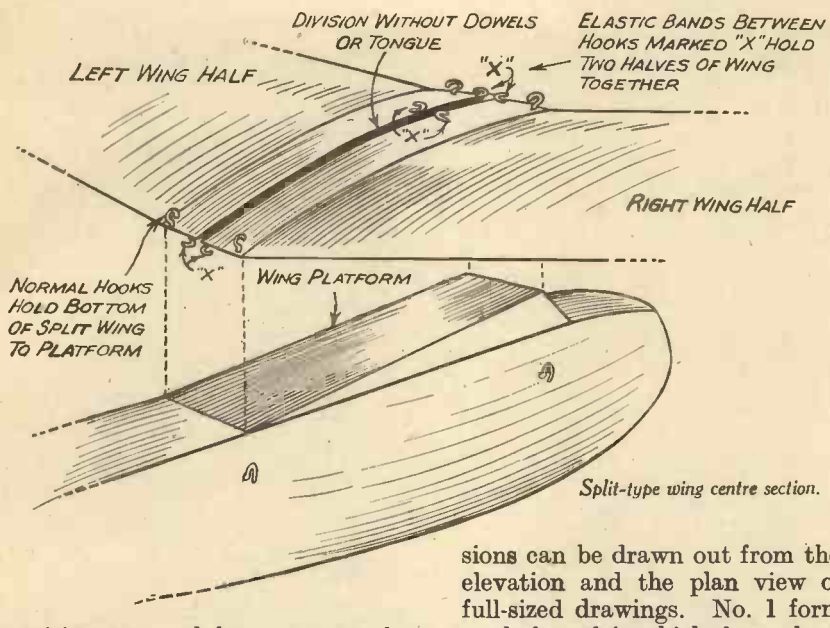
The Fuselage

This is almost entirely made from balsa wood, but, due to its construction, is very strong. It is of rectangular form in order that it shall be simple to construct for the newcomer to model work. The top and bottom longerons are of $\frac{1}{8}$-in. by $\frac{1}{8}$-in. square "medium" balsa wood. These longerons are laid along the longeron lines on the drawing and are kept in place by means of small pins on either side. Two longerons are placed in

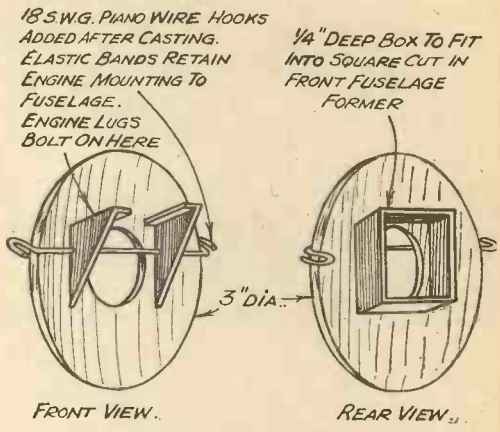


Left: wing-tip construction and, right: centre section details.





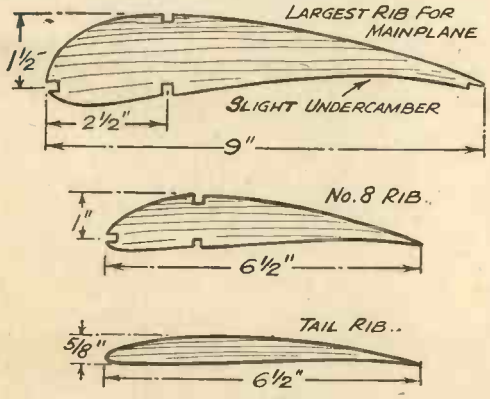
Split-type wing centre section.



The detachable engine mounting.

position top and bottom, one above the other, so that both sides of the fuselage are made simultaneously.

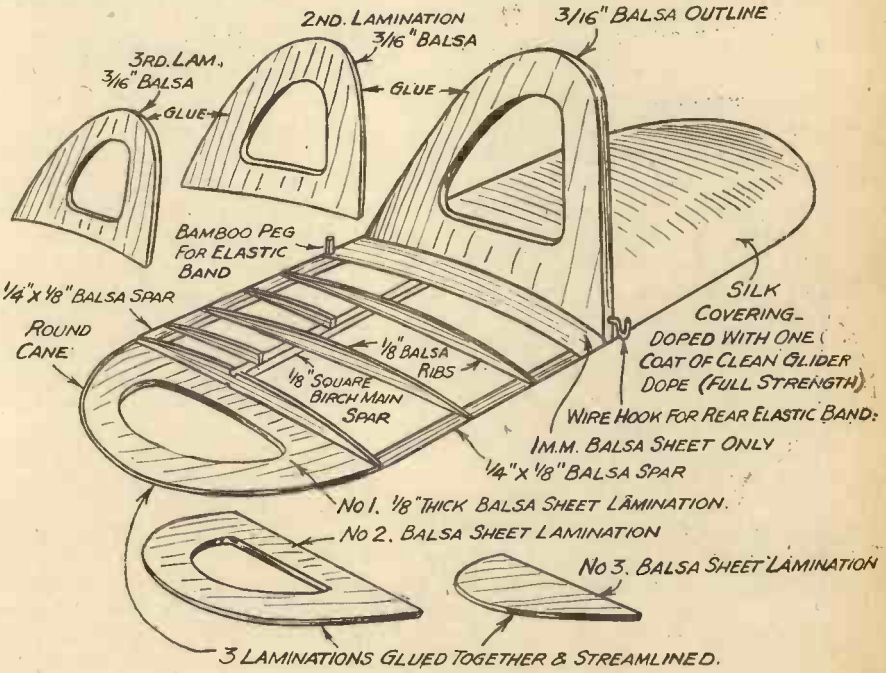
Now $\frac{1}{8}$-in. by $\frac{1}{8}$-in. balsa uprights are glued in position everywhere except at No. 1, 3, 7, and 13 formers (see diagram). At these special positions three-



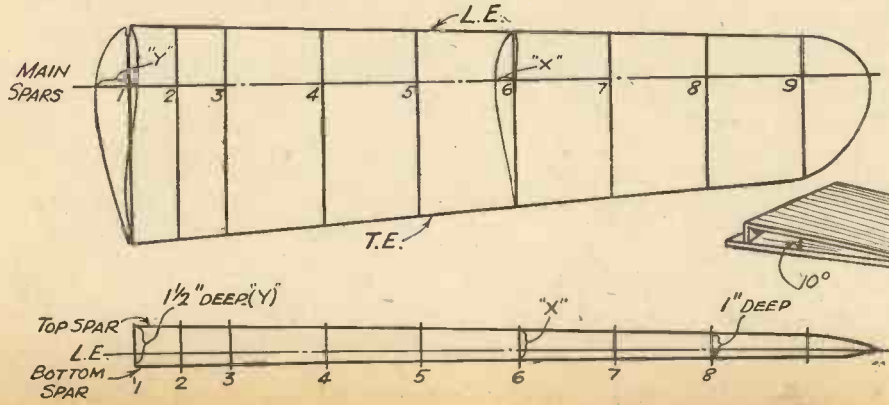
Rib forms for wing and tail.

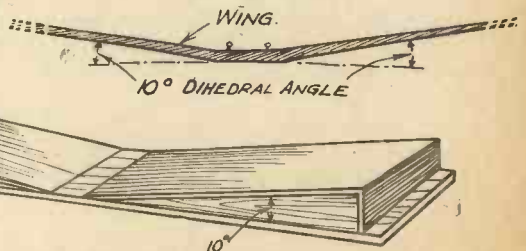
ply wood formers are placed because these are the points where wire fittings and strains occur. These three-ply formers, except No. 1, are all cut from $\frac{1}{16}$ in. thick three-ply and well fretted out in the centre for lightness. They are of rectangular shape and their dimensions can be drawn out from the side elevation and the plan view of the full-sized drawings. No. 1 former is made from $\frac{1}{4}$-in. thick three-ply as it is the nosepiece and has to withstand extra strain.

Before fitting these three-ply formers, all the uprights must be glued in and the glue set hard. To keep the bottom set of uprights from sticking to the top through any excess of glue, little slips of greaseproof paper are pushed between the bottom and top longerons where the uprights meet the longerons *after* the bottom set of uprights are glued into position.



The tail unit. This weighs complete 2½ ozs.





These diagrams show the method of laying out the wings, and (above) the wooden jig for building in the dihedral angle.

(To be continued)

Fair Comment

What is a Unit of Value?

WHEN you compare the price of an article with the amount of material and workmanship involved in making it you form a conclusion as to whether the article is worth the price asked. You say that the article is cheap or dear, that it is worth the price asked, or that it is not. If you were asked to explain why you thought the article was good value or bad, you would find it difficult to substantiate your opinion. When you buy a pint of milk or a gallon of petrol, you have as a unit of value the imperial pint measure, and the imperial gallon measure which are checked by Government officials. When comparing one lathe with another or one watch with another watch, one car with another car, one make of wireless set with another, you can only form an opinion as to relative value. There is no unit of value by which to measure values, and so it is customary to consider some previous purchase which you have made and mentally compare it with the purchase in prospect. The critical buyer takes everything into consideration—that indefinable something known as style, the quality of the material, the quantity of the material, the amount of work necessary to make it, the probable demand for the article, as well as making a comparison with the general appearance against the competitive products.

Comparison

SOME purchasers take as their unit of value some item purchased at a cheap store. Others take as their unit a medium class article, whilst for the cognoscenti only the best can be used for comparative purposes. A thing remains good or best only whilst there is nothing as good or better with which to compare it. No one has yet devised a formula for value. On one side you may have a greedy manufacturer who seeks to make an unconscionable profit on an article which is greatly in demand. Another manufacturer seeks to improve his sales by cutting his profits. Here a direct comparison can be made, for obviously the latter will be giving better value per unit of money spent.

However badly, or well, an article is made the demand for it will affect the selling price, for the cost of the tools and the cost of marketing and advertising must necessarily be covered on the entire output and each item will bear a correspondingly large or small chunk of it. Once the tools are made that cost stands, irrespective of the quantities run off, with perhaps a small allowance for the upkeep of the tools.

Camouflage

NOWADAYS the art of camouflage—of making a thing appeal to the eye only—has somewhat destroyed our sense of relative values. Take watches; you can purchase two watches which look absolutely identical, and yet they are of different quality. The dials are probably made by the same firm and so are the cases, but not the movements. The public, however, to-day picks a watch according to the appearance of its dial; if the dial does not appeal the jeweller appeals in vain on the high quality of the movement. With cameras, it is much the same, and it certainly is with motor cars which to-day are purchased because of the preference of a particular colour scheme, or a particular shape of body, on the part of the fair passenger who will accompany the driver.

It is so with periodicals. You cannot measure the value. If you are a regular reader you spend 6*s*. per year in buying PRACTICAL MECHANICS. If the periodical is of use to you only once in that period the subscription has been worth it. Compare the value of a technical journal and its costly production, costly illustrations, costly blocks, costly articles, costly distribution, and costly advertising, with the cost of similar technical advice in other fields.

Technical Advice

YOU have a pain, and a doctor will charge you anything from 5*s*. to 7*s*. 6*d*. to tell you that it is a muscular pain. He does not cure it, however. No! He invites you to take a prescription to the chemist and spend another 2*s*. 6*d*. in medicine. If you have an aching tooth, a dentist will charge you at least 5*s*. to extract it. If you consult a lawyer, it will cost you anything from £1 1*s*. upwards. In a technical periodical you obtain for a few coppers a month the technical services of highly skilled people in various technical and scientific fields; experts whose education and training and experience have cost far more than that of a doctor, or lawyer, or dentist. This point cannot be too strongly stressed. Just think of the variety of subjects which this journal alone deals with in the course of a year. Reflect upon the remarkable Free Service we give in answering readers' queries on almost every subject under the sun. Although we publish only a tithe of them you will gauge the extent of this valuable

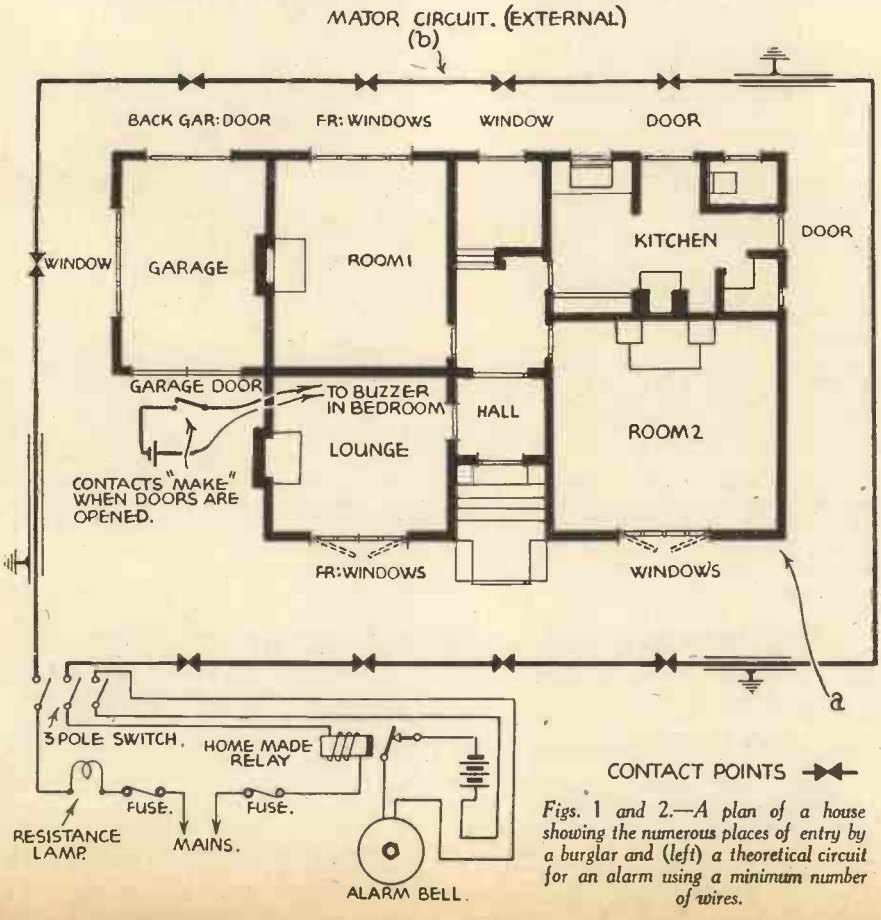
(*Continued on page* 422)

BURGLARS

AND HOW TO FOIL THEM

ADEQUATE protection against burglary usually necessitates quite a considerable expenditure on the part of the householder, and even an insurance policy does not make allowances for the sentimental aspect of various losses, thus it is that the writer has effected a series of interesting designs and fitments which are simple to follow, economical, and possess a degree of efficiency which should meet the average demands.

The house offers many points of easy access to the burglar. In considering Fig. 1 it will be apparent that full precautions would presumably require a system, whereby the entry by force or by easily opened doors or windows, etc., would cause the alarm to operate over independent circuits, and here then arises the question of economy and security, since obviously the employment of individual alarm circuits at each vulnerable point of entry would mean a large outlay in money to cover extensive wiring. The theoretical circuit Fig. 2 shows one method of minimising the number of wires in the circuit, and yet maintaining a consistency throughout. Now from this circuit it will be seen that a breach of continuity at any point will cause a cessation of current to the relay, which will release the armature, and the two back contacts will engage and complete an alarm circuit. One suitable release system is shown theoretically in Fig. 3, and in utilising this method, the relay shown in the anode circuit of the power valve must be so designed, as to give definite operation to the armature which should remain held the whole time the anode current is flowing. There are a number of anode circuit relays on the market, and the employment of one in preference to a home made relay, would be well worth while, if the efficiency of the whole system is definitely to be assured. However, a serviceable relay may be constructed with the bobbins from old headphones, or cone speaker, but as the adjustment of this type of relay is so critical, it is not to be recommended.



Figs. 1 and 2.—A plan of a house showing the numerous places of entry by a burglar and (left) a theoretical circuit for an alarm using a minimum number of wires.

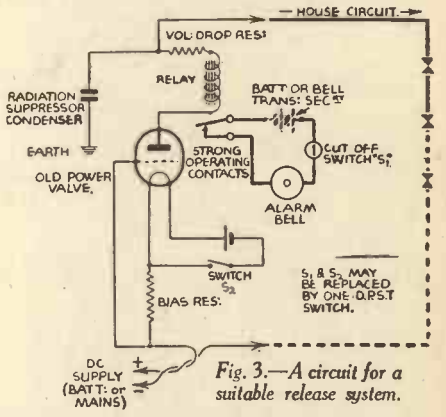


Fig. 3.—A circuit for a suitable release system.

Another Method

Another method which may be employed, is that using the D.C. mains in con-

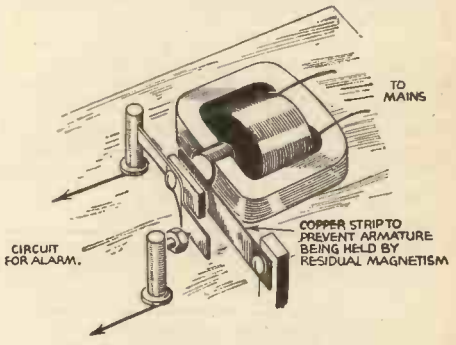


Fig. 4.—Details of a simple relay.

junction with an old "energised type" moving coil speaker, and Fig. 4 shows how this may be accomplished. The wiring employed, however, must be capable of carrying the mains voltage, and if externally erected, should be lead covered or threaded through conduit, the covering in either case being earthed at more than one point.

Now owing to the numerous types of windows and door designs, the measurements are left to the constructor; however, the principal details are outlined in order

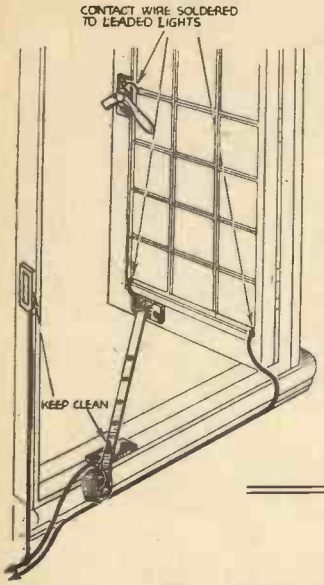


Fig. 5. — A system whereby a window can be left partly open yet be well protected against entry by a burglar.

that they may be of assistance, and a happy medium is taken with regard to the design of the premises.

A Partly Open Window

In certain cases a system is necessary which permits a window to be left partly open, and Fig. 5 shows one method of maintaining continuity throughout the whole alarm circuit, at the same time guarding against entry by this window in like manner to those which are closed.

Yet one or two difficulties arise which makes this secondary inclusion lacking in guaranteed efficiency; for example, the window being open, the contact points are liable to be impaired by rust and deterioration through being exposed to the weather. Again, unless a low-voltage circuit is to be employed, the house personnel will be liable to shocks whilst handling the fittings, but its inclusion in this article is deemed quite useful since a step-down transformer may be used in conjunction with the mains, and a supply of the low order of 6 to 12 volts employed, together with bell type bobbins acting as relay and cut: the (battery) principle of which is shown in Fig. 4. Vaseline applied to the contact points is advisable for protection against corrosion, etc.

Fig. 6 shows a simple window fitment constructed of brass, and necessitating little skill in assembly; the more accurate the work is carried out, the more lasting and ensured security; by this is meant the neat concealment of the wiring, etc., since a "snip" with wire cutters will render the whole alarm system useless.

Having neatly wired the most important fitments in the above manner, one must next pay attention to doors, and Figs. 7 and 8 show "invisible" fitments which can be relied upon to give very satisfactory operation. Here again the metal used is brass since this is soft and easily "worked."

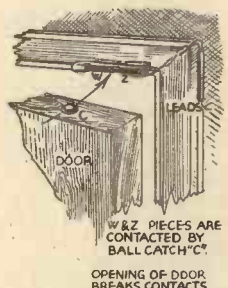
French Windows

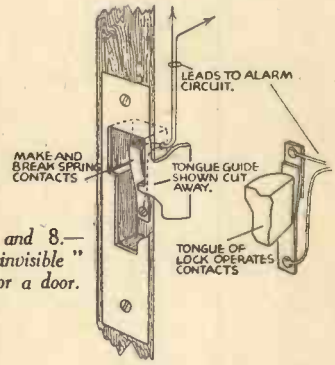
Another important feature of establishing an efficient system ,is that which arises from the question of French windows, and Fig. 9 shows a precautionary fitment against the unbolting of these types of doors by breaking the glass and inserting the hand.

Consider now another system which does not necessitate the wiring of all the windows and doors, but necessitates floor contacts. Here one has a neat system which is employed to quite a great extent, the only drawback being that the contact points might be missed by the burglar when he has made his entry. Thus it would seem that very large surface plates, or a number of floor buttons would have to be fitted to cope with this eventually, and in these circumstances it would preferable to compromise between the two systems, namely, "window catch" and the "floor operated" type, and Fig. 10 shows a simple method employing a mechanically held relay.

The alarm is set first of all, by the operation of the push button, and a circuit is immediately completed for the relay "R,"

Fig. 6.—A simple window fitment.





Figs. 7 and 8.— Two "invisible" fitments for a door.

scaled a wall or entered by any way other than by the gate, this system would prove itself of value.

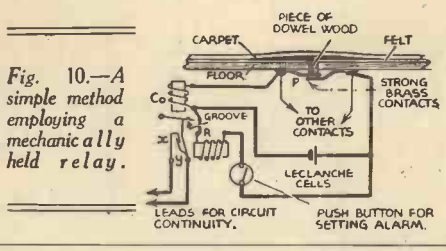


Fig. 10.—A simple method employing a mechanically held relay.

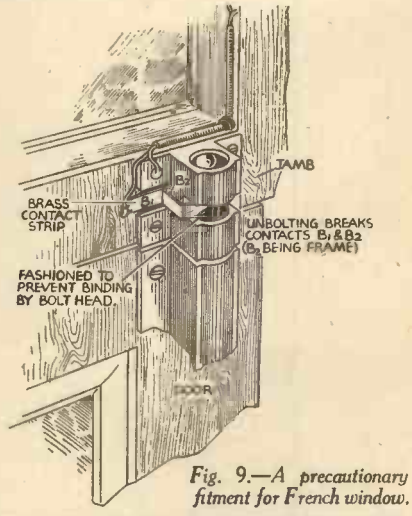


Fig. 9.—A precautionary fitment for French window.

ANTI-GAS AND AIR RAID EQUIPMENT.

FILTERS for eliminating poison gas in houses and shelters are shortly to be manufactured in this country on a large scale.

Hitherto equipment of this type has been very costly, but from a British firm which has been making extensive experiments, we understand that the price will be only an eighth of the cost of continental filters and which are at present the chief source of supply. Production has already been commenced in the factory of Andre (Components) Ltd., of Putney.

This new filter, which removes all traces of poison gas from the atmosphere, involves entirely new principles and it is operated by an electric motor or by turning a small handle.

A further device, which has been developed secretly, is to atomise a liquid antidote so that rooms already filled with poison gas are rendered innocuous. The phantomyste, as it is called, so finely reduces the liquid antidote, that it stays suspended in the air for several hours and has proved effective in disinfecting gas masks.

AERO ENGINEERING.

THE production of aeroplanes and aero engines requires a highly-specialised type of craftmanship. The present rapid expansion of the industry however, is drawing into its ranks many men who hitherto have been employed in other branches of engineering or associated trades. It is for such men that a new weekly part publication *Aero Engineering* has been produced. It is published by George Newnes Ltd., and will be completed in about thirty-two parts: the price is 1*s.* a copy. The first appeared on March 10th.

One of the primary objects of this work is to provide a comprehensive work of reference on aircraft construction, production, maintenance and overhaul. The information is contributed by men closely associated with production work in some of the largest aeroplane and engine factories in this country.

This work is very well illustrated by drawings and photographs, whilst an interesting feature is the data sheets covering the most important types of 'plane.

A modern cinematograph projector for silent films made by Ross, Ltd.

MASTERS OF MECHANICS

No. 20.—An Inventor who Disappeared

The Strange Story of Augustin Le Prince, a Pioneer of the Cinematograph

THE lot of the pioneer and inventor is traditionally a hard one. Many, indeed, have been the inventors who, in the pursuit of anticipated success, have been reduced to hardship and sometimes to the direst poverty. No inventor, however, has suffered a harder fate than did Augustin Le Prince, artist, engineer, mechanical genius, and one of the early pioneers of the cinematograph and the moving-picture camera. Le Prince at the very height of his powers was, by some mysterious agency, whipped suddenly into an oblivion from which he never returned. The disappearance of Le Prince has never been accounted for. To this day it remains, as it seems likely always to remain, one of the strangest occurrences in the annals of invention.

More than one inventor has been credited with the origination of the cinematograph, but there is no doubt of the fact that Augustin Le Prince was the cinematograph's real creator, for he was the first to take moving pictures from life with a single-lens camera and to project them on to a screen by means of an arc light.

Born in France

Louis Aimé Augustin Le Prince, to give the inventor his full name, was born at Metz, in France, on August 28th, 1842. His father was a French army officer, and it is rather significant to note that Le Prince *père* was a personal friend of the great Louis J. M. Daguerre, one of the originators of photography and the inventor of the very successful daguerreotype process. It is on record that Daguerre gave young Le Prince some lessons in the photographic art and that he aroused in the growing lad an enthusiasm for photography and its applications which, later on in his life, enabled him to devote his energies to the creation of the first successful cinema camera and projector.

Le Prince received a good general and technical education. He even went so far as to do research work in chemistry at the University of Leipzig. But besides being a trained scientist, Le Prince happened to have been born an artist, and ultimately, after a period of indecision, he determined to devote his career to the practical application of Art.

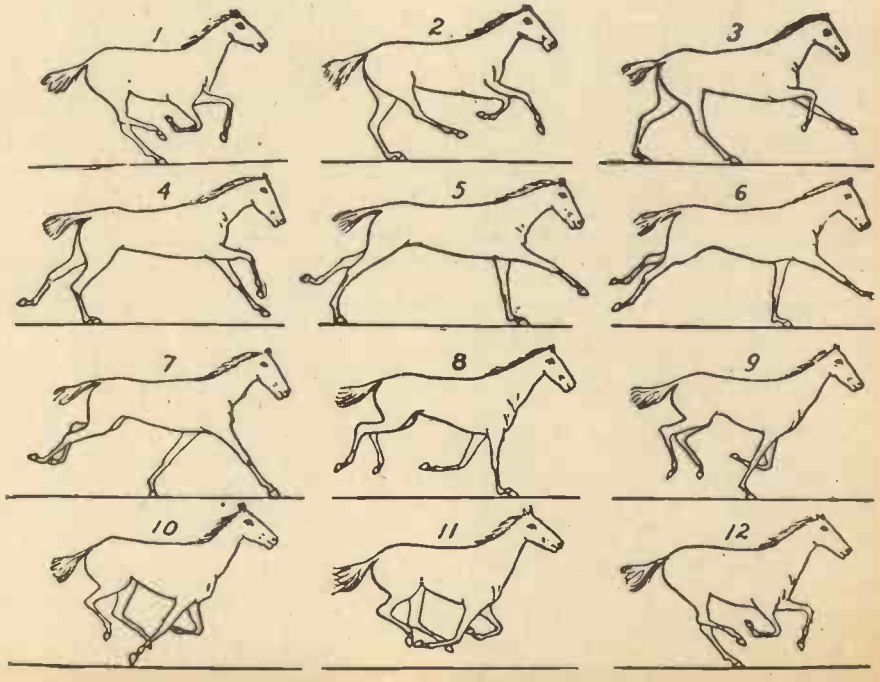
After a period of artistic training in Paris, Le Prince started as a painter of portraits and also as a maker of art pottery.

J. R. Whitley

It was during these early days that Le Prince met the man who was destined to influence his entire career. This individual was John R. Whitley, son of a brassfounder and engineer, of Leeds. Whitley had a sister studying painting at Paris, and this lady, too, exerted a great influence upon the future career of Le Prince, for, ultimately, she became his wife and assisted him greatly in his creative and inventive work.

The father of Le Prince's wife was Joseph Whitley, founder of the firm of Whitley Partners, brassfounders, of Leeds. This Joseph Whitley was quite an inventive individual in his way, and, among other things, he devised the first commercial process of "spinning" molten metal for the production of what are termed "spun castings." Le Prince, in 1866 visited Leeds and, owing to his friendship with John R. Whitley, was given a position on the staff of Whitley Partners, in which firm he became a designer. Le Prince married Miss Whitley in 1869, and during the Franco-Prussian war of 1870 he served as an officer in the French army, going through the siege of Paris unharmed.

On the cessation of hostilities Le Prince returned to Leeds, where, with his wife, he founded a "School of Applied Art." In addition to running this school, Le Prince specialised in the production of art pottery and coloured photographs in enamel. The venture was a successful one. Le Prince and his wife worked together in the closest harmony and they received commissions from members of the Royal Family. Portraits of Queen Victoria and of the



A series of motion photographs of a galloping horse obtained by Eadweard Muybridge. They constitute some of the first motion photographs ever obtained.

renowned Mr. Gladstone executed by the Le Princes were placed, it is said, in the foundation stone of Cleopatra's Needle on the Thames Embankment, along with other contemporary records of the period.

"Living Pictures"

Le Prince's attention was first turned to the possibility of creating "living pictures" by the work of a certain Eadweard Muybridge, a native of Kingston-on-Thames, who was then engaged in photographic survey work in California. Muybridge had managed to take a series of instantaneous photographs of a running horse and also of other moving objects by means of a battery of two dozen cameras, the shutters of which were released automatically by the consecutive movements of the animal. Subsequently printing his series of photographs, Muybridge succeeded in reproducing the original movements of the objects by means of a simple viewing device.

There is no doubt that Eadweard Muybridge is entitled to be called the "first father" of the cinematograph, for it was he who first photographed movement and then, in some manner, reproduced it. Muybridge, however, stuck in one groove all through his life, and as his particular groove happened to be the wrong one he did not get very far with his work, despite the fact that he appears to have made a comfortable income out of his moving images.

Le Prince became fascinated by the idea of reproducing movement by means of photography. He made a few preliminary experiments on the subject in his Leeds studio, but, at this juncture, he became associated with a new commercial decorative process which had been devised by his brother-in-law, and he went over to America to assist in the introduction of the process in that country. Afterwards, on the sale of the American rights of the process, he acted as the manager of a concern in New York which produced large stage panoramas and similar canvases. His wife, at this time, had obtained a post as a teacher of Applied Art at an institute for the deaf in New York.

He Resumes his Studies

Being friendly with the principal of this institution, Le Prince was given permission to use certain mechanical workshops belonging to the institution, and he continued here the work on the photography of motion which he had begun at Leeds. As a result, he developed a crude form of motion-picture camera and also a projector with a number of lenses. It was in the workshops of this Deaf Institution that Le Prince first projected moving shadows upon a screen. Later, in 1886, Le Prince took out his first American patent covering the invention of a moving-picture camera and a projector, or "deliverer," as he termed it.

Not long afterwards, Le Prince returned to Leeds and, establishing a workshop in that town, he gave himself up in earnest to the construction of a moving-picture camera and projector.

Le Prince's first cameras were of the multi-lens type. Within them, two bands of sensitive paper or gelatine film were stretched side by side. The shutter-releases of the lenses were actuated by electro-magnets, the latter being connected up to a battery and a rotary switch, which was turned by a handle. As the latter was moved, the bands of film were exposed in consecutive parts. The paper or film negatives thus produced were printed as glass positives and these were fixed upon a band-like structure and passed through the projector.

A Single-lens Camera and Projector

Having arrived at Leeds again, Le Prince commenced the construction of a single-lens camera and projector. Within a year he had made two machines, in which the sensitive film was exposed at the rate of 12 to 16 pictures per second. Reproductions of two of the earliest of Le Prince's films of this period have survived. The first, taken in October 1888, shows some of Le Prince's relatives in a garden at Leeds. The other shows a portion of the traffic of the period passing over Leeds bridge, being taken from a window overlooking the bridge.

Le Prince's great trouble at this time was the unsuitable nature of the sensitive material which he had to use, for celluloid as a film base came later. For the taking of the above-mentioned pictures Le Prince employed sensitised paper bands. He also experimented with gelatine films, glass strips, and with other materials, but it was only after he had been able to procure sensitised celluloid sheets of reasonably transparent properties that the crowning success came to his work. At first, the sensitive

An early cinematograph constructed by Le Prince. It employed a roll of sensitised paper.

celluloid used by Le Prince was only obtainable in sheets of considerable size, which had to be cut up into strips laboriously by hand and subsequently joined together. Eventually, however, sensitised celluloid in rolls—the progenitor of our modern roll films—came along and aided Le Prince enormously in his development of the cinema camera and projector.

Le Prince's cinematograph projector gave him far more trouble in its design and construction than did his early cameras. The inventor found it necessary to modify the design of his projector continually, adding improvement after improvement, gradually, thereby arriving at his desired result.

Commercialising his Invention

At last the inventor managed to construct a projector which satisfied him for the time being. The coming of celluloid as a base for sensitive film had removed the major part of his photographic difficulties, and Le Prince now felt that the time was ripe for the commercialisation of his invention.

Accordingly, in the spring of 1890, he decided to return to New York and to take his improved camera and projector with him. He ordered special cases to be made for the safe transport of his instruments, and arranged to sail for America in the autumn of the same year.

Before embarking for New York, Le Prince took it into his head to make a hurried visit to France for the purpose of attending to some patent affairs in that country. Alas, however, a more ill-fated decision could hardly ever have been made. Le Prince duly arrived in France and paid a brief visit to his brother, an engineer and architect, of Dijon. Le Prince appears to have been in high spirits at the time, and on September 16th, 1890, he was seen off at the railway station at Dijon by his brother in a train bound for Paris.

His Disappearance

Le Prince, in stepping into that Paris-bound train at Dijon, strode, virtually, out of human ken. He was never seen again. Whether he ever reached Paris or not is a matter for conjecture, as is also the mode of his lamentably tragic and altogether uncanny disappearance. Despite the fact that Le Prince had with him on the train a considerable amount of personal luggage and important papers connected with his inventions, these, too, disappeared as completely as the man himself, and were never recovered.

The case of Le Prince's disappearance was taken up by the French authorities and an intensive search was carried out all over the country. Nothing ever came of it, however, and, to this day, the extraordinary circumstances of Le Prince's disappearance remain a quite unsolved and, apparently, an ever insoluble mystery.

Mrs. Le Prince and others with her have averred that the inventor met a tragic fate in secret at the instigation of some individuals interested in the commercial possibilities of the cinematograph who wished to remove the master-inventor from the sphere of operations. By English law, Mrs. Le Prince had to wait for the elapse of the statutory seven years before her husband could be "presumed dead" and before she could secure control of his patents. By this time, however, other workers had entered the field of cinematography. Hence, so far as any financial results were concerned, the whole of Le Prince's pioneer work in the creation of the cinematograph was lost to his family.

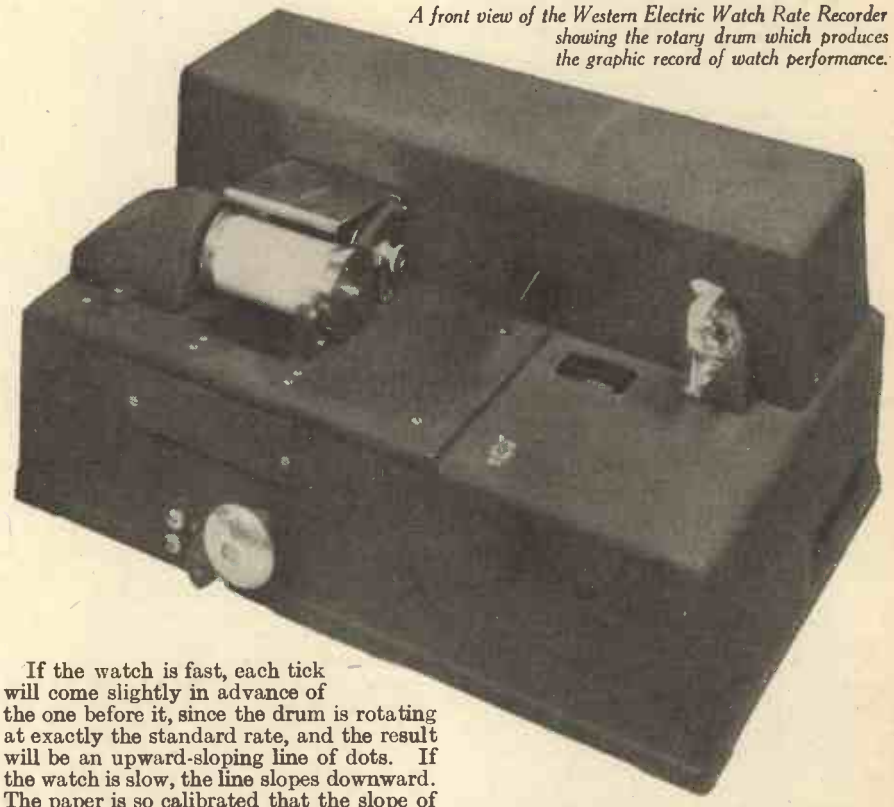
In July 1930, owing to the activities of Mr. E. Kilburn Scott, consulting engineer, of London, who, in 1889, had assisted Le Prince with the electrical equipment of his cinematograph projectors, a bronze tablet was placed upon the front of the Leeds building—150 Woodhouse Lane—where the ill-fated inventor had his workshop. The commemorative tablet was unveiled by the Lord Mayor of Leeds in the presence of the wife of Le Prince, who had come specially from New York for the occasion, and in that of a number of distinguished engineers, scientists, and other interested individuals.

Recognition as a Pioneer

Louis Aimé Augustin Le Prince thereby, if somewhat belatedly, obtained recognition as a pioneer of cinematography. Other inventors there were who improved upon and commercialised his work. These, indeed, for the most part, reaped the benefits of success. Yet, without a doubt, much of the primary honour for the creation of the cinema is Le Prince's.

A Watch Rate Recorder

A Scientific Tool Which Eliminates Guesswork and Enables the Repair Man to accurately Set the Rate of a Watch



A front view of the Western Electric Watch Rate Recorder showing the rotary drum which produces the graphic record of watch performance.

THE Recorder consists of two units: the Recorder, which gives the written record of watch performance; and the frequency generator, which produces a standard frequency precise to one part in 100,000, or a continuous accuracy of less than one second per day deviation.

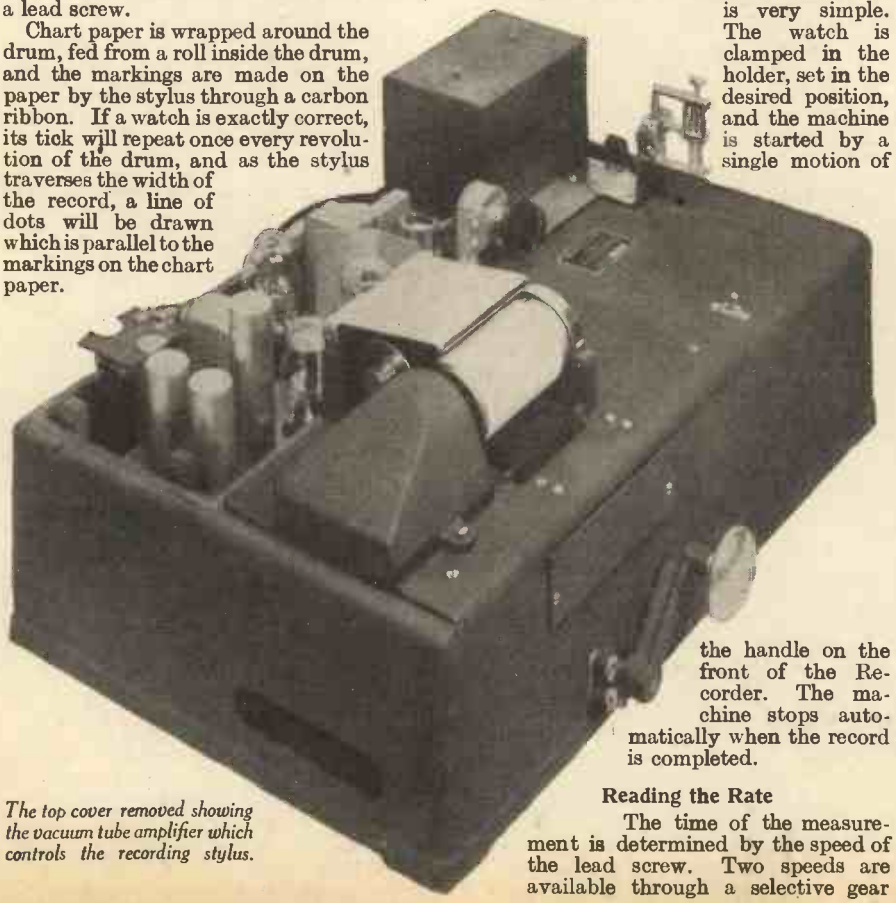
How the Recorder Works

The standard frequency output of the generator drives a synchronous motor which rotates the drum of the Recorder at a uniform rate of one revolution per beat of a correct five-beat watch. The watch to be tested is clamped in a spring mounting which can be rotated to give readings of the watch in various positions. The mechanical vibration in the case, due to the escapement impact, is transmitted through a special pick-up and amplifier, and the amplified tick of the watch operates a recording stylus. This stylus is mounted under the drum, and travels the length of the drum actuated by a lead screw.

Chart paper is wrapped around the drum, fed from a roll inside the drum, and the markings are made on the paper by the stylus through a carbon ribbon. If a watch is exactly correct, its tick will repeat once every revolution of the drum, and as the stylus traverses the width of the record, a line of dots will be drawn which is parallel to the markings on the chart paper.

If the watch is fast, each tick will come slightly in advance of the one before it, since the drum is rotating at exactly the standard rate, and the result will be an upward-sloping line of dots. If the watch is slow, the line slopes downward. The paper is so calibrated that the slope of the record can be read in seconds per day.

The operation of making a measurement is very simple. The watch is clamped in the holder, set in the desired position, and the machine is started by a single motion of the handle on the front of the Recorder. The machine stops automatically when the record is completed.



The top cover removed showing the vacuum tube amplifier which controls the recording stylus.

Reading the Rate

The time of the measurement is determined by the speed of the lead screw. Two speeds are available through a selective gear shift. Either a five-second or a thirty-second measurement may be made. The five-second record, for rough timing, gives a readable accuracy of fifteen seconds per day. The thirty-second record, being six times as long, shows a greater cumulative error in the watch, hence it is readable to two seconds per day.

The machine makes an extremely flexible tool in the repair shop. Its major task is analysis of watch performance. Only short experience is required to become proficient in the simple procedure. Position error, isochronous error, and general average rate can be determined by the machine. In addition, such faults as banking, low-motion effect, loose pallet jewels, escape wheel eccentricity or tooth roughness, and other escapement troubles, draw distinctive records which immediately identify them.

When the fault is corrected, the machine permits a quick verification of the repair, and complete regulation within a few minutes.

Although the machine is designed primarily for five-beat watches, it will also measure the rate of any beat train, faster or slower than 18,000 beats per hour. The rating of a 21,600 or 19,800-beat movement is as simple as an 18,000 movement.

Besides rating watches, the Recorder will time alarm clocks, automobile clocks, time recorders and meters, and other quick train movements which are too large to mount on the holder. This is done by simply clipping a wire from the object to be tested to the watch holder of the machine; the sensitivity is such that the vibration transmitted through the wire will operate the machine. Hairsprings may also be vibrated by means of the Recorder. Another feature is a headphone jack which enables the jeweller to hear the amplified tick of the watch. This often proves a valuable aid in locating trouble.

THIS MONTH IN THE SCIENCE AND

Coal-cleaning Robot

IN preparing large coal for the market the coal has to be picked free from lumps of shale and shaly coal. At present this is done by hand picking from a travelling belt. A robot, electrically operated picker has been devised to perform this tedious operation. The coal is spread on to a table and jigged under wires which stroke the coal on the top and sides. The wires carry a small electric current which passes through the lumps of coal or shale under the wires and through to the table. The electrical resistance of the shale is, however, less than that of the coal. The differences of electrical resistance can be magnified through valve relays. The currents thus set flowing by the wires then actuate gates in the path of the coal. If the wires feel that it is coal, the gate is left open and the coal jumps off the table on to a shoot. But if the current corresponds to a lump of shale, a bar rises in its path and it is tripped over so that it falls through a gap at the edge of the table. Very complete separation of coal from dross is in this way secured to a finer degree of selection than is possible on the old hand-picking belt. This is one of the many examples of the finer technique now being used for the preparation of clean coal for the market.

Detecting Fish Shoals

THE automatic sounding machine which has become a standard navigational aid aboard big ships finds a new use as a detector of fish shoals. The principle is to send an electrically-timed sound wave down from the bottom of the ship. When it reaches the sea bed it is reflected back and its sound is caught again by apparatus on the ship's hull which transmits it electrically to a recording chart on the navigation bridge. The time interval between sending out the sound and receiving back its echo gives a measure of the distance of the sea bed below the ship's bottom. In using this apparatus to chart out fishing grounds a ghost echo was sometimes recorded. Observation showed that this ghost emanated from the presence of shoals of herrings and other fish swimming below the surface. The vast numbers of fish in these shoals acted as a dispersed reflector for the sound wave. It is now proposed to apply this discovery to the detection of shoals for fleets of trawlers operating in conjunction with a leader equipped with sounding gear.

THE LARGEST MOBILE DREDGE IN THE WORLD.

The Mourghan Drag Line dredge, said to be the largest mobile dredge in the world. It is shown at work on the 11,000,000 dollar Ballona Channel Control Government project, to carry off rain water from the motion picture city, Culver City, California.

Five Million Volt Generator

A 5,000,000 volt electrostatic generator and accumulator is being installed by the Westinghouse Electric Company in America. The accumulator consists of a large high-pressure steel globe, 50 ft. high and 30 ft. in diameter, mounted on the roof of the specially built laboratory and generator house. Inside the vessel is a 15-ft. diameter spherical electrode mounted on insulated columns. The electrode is insulated from the globe and the dialectric medium between the two is high-pressure air at 120 lb. pressure. These high voltages are generated by the friction of rubber belts over metal rods using exactly the same principle, only on a magnified scale, as that used for generating electrostatic charges in the familiar Whimshurst machine. The plant is meant for the study of the disintegration of the innermost nuclear core of atoms. The high voltages available will enable very high velocity atomic particles to be shot into atomic nuclei in the hope of producing new and more fundamental disintegrations than those which are already known.

Diamond Tooth Cutting Wheels

A STEEL wheel studded with diamonds and diamond dust is the latest contribution of the inventor to the science of toolmaking. The wheel is primarily intended for use in mining gold-bearing quartz, which is so hard that it is at present won by drilling and blasting. But other uses suggest themselves, such as granite quarrying and glass cutting. Even tungsten carbide, which is the material used for manufacture of the hardest of known steel cutting tools, can be shaped and machined with a diamond wheel to the cleanest of cutting edges.

The wheels are made by pressing ground-up diamond dust into a steel matrix already turned up into the shape of a thin-edged wheel. Low-grade diamonds and diamond dust which are useless as precious stones are far cheaper and more readily obtainable than is commonly known. As the diamond is the hardest of all known substances, its efficacy as a cutter can readily be believed.

Boom in Light Alloys

THE national policy of air rearmament is producing a boom in the manufacture of the light magnesium and aluminium alloys used in aeroplane manufacture and aero-engine construction. These alloys contain high percentages of magnesium, which is the lightest metal known to science. The alloy is made up with smaller amounts of aluminium, zinc, and manganese. Electron is one of the best-known examples. Bulk for bulk, it is half the weight of aluminium, and only a third the weight of steel, which it approaches in strength. Factories are being opened for extensive production at Rainham, in Essex, at Manchester and at Avonmouth. The production of the Avonmouth factory is said to be 150 tons a month.

"Grilled" Hay

THE application of artificial drying of grass is now being practised on an extensive experimental scale. The grass is dried in trays by gases from a coke fire cooled down to about 150° Fahrenheit with air. A fan draws these hot gases over the grass and dries a charge in a few hours. The plant is meant for operation over long periods and is to be fed from fields on which the grass is cropped intensively through the summer months, and cut at frequent intervals. The young dried grass obtained in this way is said to form a better cattle food than ordinary hay.

WORLD OF INVENTION

World's Highest Fire Escape

A FIRE-ESCAPE ladder which has recently been constructed is capable of reaching 180 ft. vertically into the air. It has been designed by the Leyland Motor Company for the City of Hull Fire Brigade. The ladder is in six lengths, telescoping into and folding on one another. Full extension can be obtained within half a minute by means of powerful winch gear. Cantilever luffing gear and a rotary turntable enable it to be guided on to its mark by pointer controls from the operating table beneath. The lorry which acts as the anchor base has to be of very heavy construction. With the ladder it weighs twelve tons. Yet by means of special balancing gears this huge machine with heavy top load of ladder is enabled to corner at full speed. The crow's nest at the top, in which the fireman is fastened before the ladder is shot on its mark, has hose-directing gear and a small hoist for lowering rescued persons to the ground. An escape of such dimensions is necessitated by the rise in height line of modern buildings.

The 180 ft. Leyland fire escape, which is the highest in the world.

Use for a Death Ray

FLIES and insects at least can be destroyed by a real death ray. This device has already been explained in the scientific paragraphs of PRACTICAL MECHANICS. Two Danes discovered that ultra-short wireless waves at a short distance from the transmitter would actually kill wasps, flies, and other insects. They passed ultra-short waves between two rods, one on either side of an open window. Insects were tempted into the death-trap by a saucer of honey. They invariably dropped dead as they passed through the window. An American, reading of this discovery, applied it to the bars of special screens round the animal cages of California Zoo. The animals inside the cages were protected thenceforward from all annoyance by flies. If only this sort of thing could be done on a large scale the menace of air attack would disappear, that is until scientists found an anti-death ray.

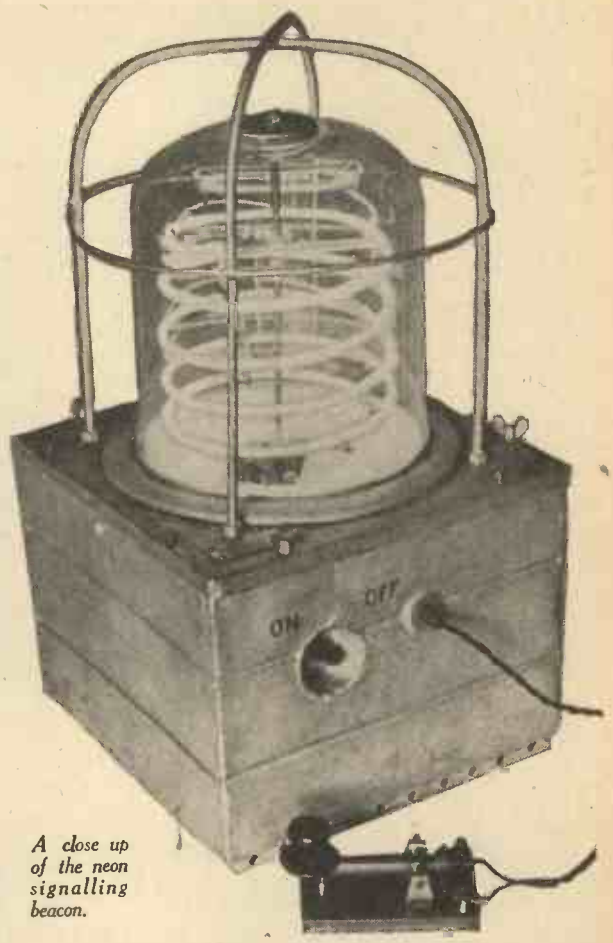
Dewaving the Sea

A RUSSIAN inventor has patented a method of smoothing out sea waves for the purpose of making harbours usable for sea-planes in all weathers. The invention consists of a series of parallel pipes carrying a supply of compressed air thirty feet or so below the surface of the water. The steady release of air from innumerable small holes in these pipes is said to damp out the swell of waves. Waves of four feet in height from crest to hollow have been smoothed out on a small scale at a site in the Black Sea, and it is claimed that a more ambitious installation would smooth out rollers of a considerably bigger size.

The invention may be of use in some of the sea-dromes which are being planned for the Atlantic and Pacific transits. These consist of large horseshoe-shaped steel pontoons moored to copper spheres sunk down into the calmer depths of the ocean. These sea-dromes are to maintain their position by the force of aerial screws.

A Neon Signalling Lamp

MR. R. C. WATKINS, of Merton Park, London, S.W., proprietor of the Super Power Co., Clapham Common, has recently perfected an invention concerning a new kind of neon signalling lamp and beacon which is especially designed for aerodromes in isolated parts of the Empire. Already a dozen of these beacons have been sent to aerodromes in India and proved successful. The glass case with the neon tubing is fixed on to a metal box which contains the main and battery—an easily charged 12-volt battery. The beacon has numerous capabilities, including: It can be used for sending messages from an aerodrome to a 'plane by using morse. A beacon can be placed in each corner of the flying field and used as boundary lights (red neon lighting can be seen 5 or 6 miles away); it is fitted with automatic morse which enables the machine to flash a message continuously.



A close up of the neon signalling beacon.

World's Deepest Mine

A NEW depth record has been established by the sinking of the new South Deep shaft, of the Simmer and Jack's mines in the South African Rand, to 6,600 ft. At this depth a new and rich lode of quartz gold-bearing ore has been discovered. Prevailing high prices for gold make it profitable to work at this great depth. So far down in the earth the temperature rises to almost 100° Fahrenheit, a temperature which is too great for human beings to endure in comfort. To make the workings bearable to the miners, a refrigerating plant cools the ventilating air down to a more reasonable temperature. The depth attained compares with the depth records attained in oil borings which run down to the 10,000-ft. mark or slightly over in some of the American fields.

Gas Masks

THIRTY million gas masks are being made ready by the Government for civilian distribution in the event of national emergency. They consist of a simple rubber visor fitted with transparent cellulose acetate aperture for the eyes. The breathing filters are attached to the visor and contain wool packing to arrest noxious dusts and smokes followed by an absorbent packing of active carbon which gives complete protection from all gaseous poisons.

Development of the St. Gotthard line, near Hassen. *By courtesy of the Swiss Federal Railways.*

THE GREAT ALPINE TUNNELS

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

There are now more than four thousand Railway Tunnels in the world, but the most remarkable are the Great Alpine Borings

TUNNELLING is an exceedingly ancient art, and the methods used continued unchanged through the centuries until quite modern times. There was a wonderful brick-lined subway under the Euphrates River, 12 ft. high and 15 ft. wide, which was built centuries before Christ, and Pliny—the old Roman historian—tells us of another which was made to drain Lake Fucino, which was an amazing work. It was 3½ miles long, 10 ft. high, 6 ft. wide, and passed under Monte Salviano. The work took thirty thousand men eleven years to accomplish.

It was not until the coming of the railways that tunnelling began in real earnest. There are now more than four thousand railway tunnels in the world, but the longest subway is a conduit for water-supply. It is in Greene County, in the State of New York, and is more than 18 miles in length.

The most remarkable tunnels in the world are unquestionably the great Alpine borings, all of which have been constructed in a little more than half a century.

The Mont Cenis Tunnel

The first of these was the Mont Cenis Tunnel, begun in 1857. The rock was so hard, that hand power drilling was exceedingly toilsome and tedious, the distance bored in twenty-four hours being less than eight feet. In 1861 machine drilling began, which increased the speed five-fold, and the tunnel was opened for traffic in 1871. It is a fraction less than eight miles long, and cost £75 per linear foot.

As we study the history of Alpine tunnelling, we shall see what tremendous improvements were made by mechanising much of the work, with the use of electricity, compressed air, etc., so that the cost of tunnelling has been reduced and the speed of the work increased. The Ancients bored their tunnels by hand labour, and moved straight through from one side to the other. The rate of progress has been doubled by modern engineers, by the simple idea of boring the tunnel from both ends at the same time, and meeting in the middle—and in nearly every case the two ends have met exactly—correct to a fraction of an inch.

There is something dramatic in this idea of blasting forwards through the darkness, and the calculations to effect a successful result are intricate and difficult. There has only been one case in the history of railway tunnels where the two ends have failed to meet. This was due to no fault of the engineers, but to the criminal act of a discharged workman, who—for revenge—moved the pegs used for calculations during the night, and so falsified the result.

Courage and Bravery

As against this single act of baseness, we can find many examples of courage and bravery, while few great engineering works have ever been completed without the loss of many brave lives.

The boring of the St. Gotthard Tunnel was the most difficult of the earlier works of this kind. The task was undertaken by Mons. L. Favre, who promised to complete the job in eight years for the sum of two millions sterling. The terms of the contract were very harsh, for every DAY over the ninth year Mons. Favre was to forfeit the sum of £200, and after six months the penalty was doubled.

No engineer had ever undertaken a task of such magnitude. All workmen, tools, and materials had to be conveyed by a single difficult mountain road to the two starting places, Goschenen in the north, and Airolo on the south, the first about 3,640 ft.

above sea level, and the other 3,755, that is higher than the top of the highest mountain in England. The way was impassible in winter, and difficult at all seasons of the year. The actual work was unhealthy and hard, the stifling confined atmosphere told severely on the workmen, who became pale and stooping, and tottered rather than walked, as they returned from their toil at the end of the shift. More than three hundred of them were killed by accident, and nearly a thousand injured before the work was completed. Some were swept away by hidden torrents which suddenly burst from the rock, many were killed by falls of stone. Last of all the gallant Mons. Favre perished. He had been harassed by difficulties of all kinds, financial and political as well as engineering, and though he struggled gamely, the strain was too much for a system enfeebled by hardships, and he died in a fit.

Magnificent Scenery

The tunnel to-day, and the railway to it, form a favourite venue for tourists, owing to the magnificent scenery, as the iron road climbs through the pass, twisting and turning like a serpent at the verge of terrific precipices, and at one point doubling on itself through a spiral tunnel like a figure of eight, so that the bewildered traveller who has noticed a church on entering a dark tunnel, sees it again in a different position after he has passed through. The St. Gotthard Tunnel is 9·3 miles long, and cost £48 a foot, it was begun in 1872 and completed in 1881. The line was electrified throughout in 1914-24.

The greatest of all mountain tunnels is the mighty Simplon, which is 12·3 miles in length, and took from 1898 to 1905 to build. The maximum depth below surface of this tremendous boring is 7,005 ft., and as a result the heat was tremendous in the workings, and formed a great barrier to success, as the workmen were in danger of being stifled. So a new and novel idea was adopted. Instead of a single tunnel, two galleries were pierced, 56 ft. apart, and connected by lateral borings every 660 ft., which enabled a satisfactory degree of ventilation to be obtained. When the work was completed one of these galleries became the actual tunnel 19½ ft. high and 16½ ft. wide, the other was left as it was until the period of the Great War, when it was enlarged and made into a second trackway, which was opened for traffic in 1922. The tunnel is ventilated by electric fans, and the trains are drawn through by electric locomotives in 25 minutes.

Kerstelenbach Viaduct, St. Gotthard. *By courtesy of the Swiss Federal Railways.*

The Simplon line at Brigue, southern end of tunnel. *By courtesy of the Swiss Federal Railways.*

Showing the remarkable spirals on the Gotthard. *By courtesy of the Swiss Federal Railways.*

The Simplon Tunnel.

Probably no other tunnel has been bored in face of such natural obstacles, but owing to the advance in mechanical and engineering skill, all were overcome. The hero of the Simplon was Alfred Brandt, inventor of the rock-drill which bears his name. The tool is operated by water-pressure working at about 15,000 lbs. per sq. in. It ploughs its way through the hard rock by a rotary movement, like a carpenter's augur through wood. The wastage of drills is tremendous, however, so they are quickly scrapped and replaced. The boring began at Iselle, and after progressing about 2½ miles, the "Great Spring" of cold water was encountered. It burst from the rock in a raging torrent with a pressure of 600 lbs. to the square inch, and an average volume of more than ten thousand gallons per minute, which amount was almost doubled at times. Great rocks were hurled aside like chips of wood, and the workmen fled

for their lives. Ultimately the water was controlled by conduits, but the next trouble was a hot spring. It burst from the rock scalding hot, at tremendous pressure, and with a flow of 4,330 gallons per minute. The temperature was 113° F. This also held up work for some time, but was ultimately tamed. The brave Brandt did not live to see the completion of the work, as he was killed by a fall of rocks in the tunnel, while superintending his workmen. The cost of the Simplon was £49 7*s.* per foot. The line is now electrified, using locomotives of 1,800 h.p. for passenger trains and 2,400 h.p. for goods trains.

A Recent Tunnel

The Loetschberg Tunnel affords a striking example of the unknown and unpredictable risks which the engineer has to face. It is one of the most recent of all great mountain borings, having been constructed between 1906 and 1911. The original plan was for a double track tunnel 8½ miles in length, but after they had penetrated the first two miles into the heart of the mountain a frightful catastrophe occurred. The shift were busy working on the rock face with a battery of power drills when there was a roar like thunder, and the whole "solid" cliff face caved in, as a mass of more than eight thousand cubic yards of water, sand, and boulders swept into the tunnel burying machines and workmen for ever. Twenty-five brave men lost their lives, and none of the tools could be recovered. Anxious research by the engineers disclosed the alarming fact that the mountain was not solid as had been supposed, but the very centre of it was cut through by the gorge of a prehistoric river, which had filled up with sand, boulders, and rocks, and so was invisible at the surface and could not have been discovered by the surveyors. To drill through it was impossible, but its exact course was ascertained, and the fault in the tunnel was blocked by huge bulkheads.

Then a new boring was made below the fault, and the line was bent to avoid it, thus adding more than half a mile to the expected length.

A Striking Example

Perhaps the most striking example of the value of mechanised rock drills is that of the Arlberg Tunnel, six and a half miles in length, which was bored in three years. This is only one mile less than the length of the Mont Cenis Tunnel, which took thirteen years to complete. The Arlberg tunnel is 26 ft. by 25 ft., and is situated in one of the most scenic sections of the Austrian Tyrol railway.

Having myself travelled through all these tunnels, I would mention that we are not only impressed by the skill and daring of the engineers in boring the tunnels, but also by the amazing skill with which they have carried the railway lines to these dizzy heights. The line clings to the side of lofty cliffs, crosses innumerable bridges at a great height, and twists and bends among gigantic crags which almost make one dizzy to see.

No tourist who has the opportunity should miss the chance of traversing one of these magnificent routes.

OUR BUSY INVENTORS

The following information is specially supplied to "Practical Mechanics," by Messrs. Hughes & Young (Est. 1829), 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.

Ferric Furniture

A CRITIC of the design of male dress once complained that it consisted principally of tubes ; man wore tubes on his arms, tubes on his legs, and a tube on his head—the top hat. He might now add that some of our furniture is composed of metal tubes. An inventor has recently devoted his energies to the improvement of this tubular furniture. Impressed with the fact that an iron chair is not a light weight, he has devised one in which the wall of the tube is not of uniform thickness. He places lengths of tube inside the frame to strengthen it at the points subject to the greatest strain. Part of the frame is made of tubing of greater diameter than the remaining portion, and the ends of the latter are inserted into the former, providing double thickness. The inventor contends that an additional advantage of this contrivance is that when, in the course of construction, the tubes are bent, the inner tube does not shift.

This equipment for the home may be termed re-inforced ferric furniture.

Door and Raft

NUMEROUS devices have been invented for the benefit of those "in peril on the sea." Many of these appliances are on the lines of that improvised by the Swiss Family Robinson. One of the latest is a door which is convertible into a raft. The special feature of this floatable door is that it has a flange and a groove, providing a gripping means for the shipwrecked person, who, like the door, is unhinged.

A Hidden Advertisement

INVISIBLE writing which reveals itself when heated has been in existence for many years. The principle of this kind of writing has now been applied to the match. We are all familiar with the behaviour of the ordinary match. It begins life straight. Upon being burnt, it sometimes writhes like a martyr at the stake, after which it looks very black, or should do so, as I understand that a neon-like incandescence which does not die away quickly, is regarded, in a match, as an imperfection.

An American has taken the tiny wooden splint which eventually becomes a match, and has prepared it in such a way as to minimise distortion, discoloration and reduction to a fragile ash. On this slip of wood there is printed a word or words, which appear only after the match has been burnt.

This device should afford scope to the advertiser. There is hardly room for a slogan, but the name of a proprietary article might become visible. I can see more than one possibility in connection with this device. Apart from its use as a means of publicity, it could be employed as a novelty or a game. A variety of hidden words might be included in a box of matches, giving an opportunity for guessing competitions.

A Spectacle Shield

THE spectacle case is at times somewhat elusive. When one wishes to put away one's glasses, the case is occasionally missing. Consequently, the spectacles have to be placed in the pocket without protection, which imperils the lenses.

In spectacles, as usually made, the side-pieces both fold down across the back of the lenses—the side nearer the eyes when the glasses are being worn. An improved frame has now been invented, in which one of the side-pieces is so connected to the frame that it can be folded down across the front of the lenses. As a result, the glasses are shielded back and front, and though this does not afford a guard equal to the case, it reduces the possibility of damage.

Good News for Cinema Patrons

IN cinemas, considerable inconvenience is caused to patrons already seated by late-comers, who, in order to reach the seats allotted to them by the courteous usherettes, have to pass in front of the people in the same row. As the space between the rows is limited, it is usually necessary for the seated folk to stand to allow the late-comers to pass. This, in turn, obscures the view of persons in seats behind.

To obviate this inconvenience, there has been devised a cinema chair which is so constructed that it allows the sitter to push the seat portion of the chair backward, without rising. The movement is effected by the person seated exerting pressure by means of the feet.

DYNAMO.

CATALOGUES RECEIVED

Multi-Models Ltd.

IN a well-illustrated catalogue issued by Multi-Models Ltd., of 48 Beak Street, Regent Street, London, W.1, several examples of high-class model-making are listed. These range from perfect replicas of various locos and coaches in all gauges from the miniature 00 (or H0) to the large 7½ in. gauges. A particular feature of the products of this firm is the very high standard of finish, due to the inclusion of a considerable amount of hand manufacture. To assist those who make their own rolling stock various spare parts are obtainable, including some very fine miniature name and number plates for locos. These are perfect replicas and may be obtained in all gauges from 00 upwards. A very fine range of brick papers are also available, printed by a special colour process, and cost only 2*d.* per sheet, 18 in. by 12 in. For signal, point, and line control a novel sectional switch assembly is obtainable and this has almost universal application. It is made in various sizes from 00 upwards, and may be assembled to any desired combination. The catalogue costs 4*d.* by post.

A Free Leaflet of New Designs

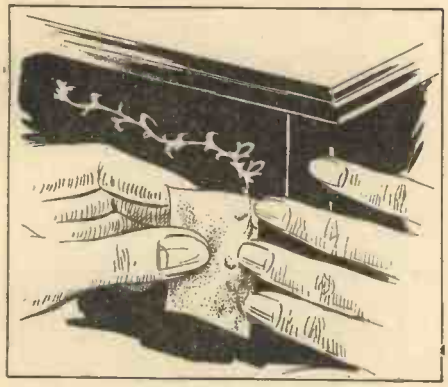
EVERYONE who makes things in wood will be interested to have a new leaflet offered free by the makers of "Casco," the new cold-water glue.

This leaflet is part of a new service—called the "Casco" Project Plan—started by the makers to meet the demand for new designs by homeworkers and schools. The makers advertisement on page 362 in this issue tells you where to send for the leaflet.

Lathe Work for Amateurs

Home Mechanics

Overhauling a Piano



Renewing the gilding on the front of the piano.

Although the Handyman Cannot Hope to Overhaul a Piano as Efficiently as a Piano Repairer, he can at Least Benefit by the Useful Hints given below

THE chief troubles affecting most pianos are dampness, disuse, and misuse; the former, however, is more predominant. In a great measure this is due to the construction of the modern piano, in which metal enters into the construction much more than formerly. People insist on an iron frame, but in the majority of cases, they do not realise that this is apt to encourage dampness. The iron frame of the piano being extremely cold, admission of a warm air will cause condensation on the metal and rust results. A piano does not improve by being left unused for a considerable time. It should be in constant use and then, contrary to popular opinion, tuning is less frequently required. On the other hand misuse, caused by children being allowed to bang on the keys is, of course, to be avoided. A piano is generally most used during holiday seasons, when, possibly, it may receive rougher treatment than at any other time of the year. Consequently, the following weeks are a good time to give it an overhaul and thorough cleaning.

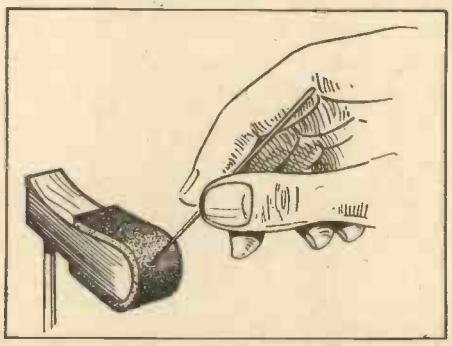
Removing Dust

The first thing to do after opening the front is to remove all dust which may have accumulated inside. It may be discovered then that some rust has made its appearance on parts of the ironwork and steel, even when nickel or chromium plated. The best way to treat this is not to remove it altogether, as this may do more harm than good, especially in the case of the wires. The most satisfactory treatment is to take a piece of coarse cloth, such as felt or tweed from an old coat, dip it in some linseed oil and rub as much of the rust away as possible, at the same time investing the iron with a protective film of the oil to prevent further rusting.

On no account should oil or grease be allowed to get upon the wooden mechanism of the piano as it may interfere with the action by causing swelling of the wood. To assist the smooth working of wooden parts there is nothing better than dusting a little of the finest mica powder between the joints, or any bearings. Black lead was used formerly for this purpose but mica powder, or fine French chalk, is better. Only the bare minimum required should be used—too much only tends to clog and impede action.

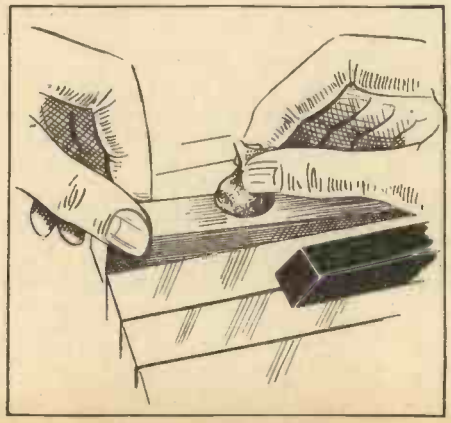
Hardened Felts

Sometimes the tone of a piano has deteriorated through the hardening of the felt on the hammers, more particularly on those in the centre where the most constant wear occurs. An improvement can be effected in this direction by taking a strong needle and pricking the felt pads as this lightens them and lets in the air. This is a matter of patience and the piano repairer uses a special tool for this job, but as it is not usually available for the amateur, he may not accomplish the task so speedily, yet with perseverance he may be successful in greatly improving the tone.

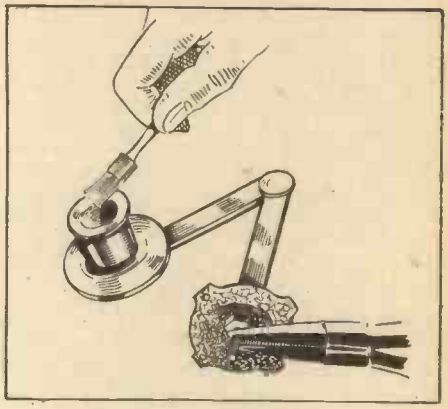


If the tone of the piano deteriorates through the hardening of the felts of the hammers an improvement can be affected by pricking the felts with a needle.

If, on opening the interior of the piano a wire is found to be broken, or other serious damage has arisen it is not advised here that the reader should attempt to rectify it unless possessed of the expert knowledge requisite for a successful result. Piano repairing is highly specialised work but all the hints and advice given here can be carried out by a man of average intelligence, leaving that which may involve more harm than good for the trained workman to carry out.



Cleaning the notes of the piano.



Renovating sconces with lacquer.

Cleaning the Keys

A job that the ordinary reader can accomplish successfully is the cleaning of the keys and the case. Unless the keys are very badly stained and worn it will not be necessary to remove them to effect an improvement. Raise the key from the front, and, holding it firmly with the left hand, use the other hand to briskly rub over the key with a piece of felt dipped in methylated spirit. Each key is taken in turn and served in the same manner when the colour will be greatly improved. If a strong scent of camphor is noticed when the methylated spirit is applied, it indicates that the keys are not covered with ivory but with celluloid.

Renewing Gilding

In cleaning the outside it may be required to renew the gilding, or some of it. If the surface of this has worn uneven it will be necessary to smooth down level with fine glasspaper. After dusting off apply with a camel hair brush a coating of gold size, or white of egg beaten into a liquid state. When this gets tacky apply the gold leaf, pressing in with a velvet pad. When quite dry, the superfluous gold can be removed with a brush. Only the best gold leaf is used on pianos and this is advised here for regilding, especially where only a little is required.

The cleaning of the case is quite simple and usually satisfactory if the proper methods are employed. Some people consider that the application of equal parts of turpentine and sweet oil gives best results, but the writer prefers to use only boiled linseed oil which assists the polish and works easier. Partially soaked in the oil, but not made so oily that there is any drip from it, a piece of felt is briskly rubbed over the surface and a surprisingly rapid improvement takes place. Dirt is quickly removed and the grain of the wood shows up as new.

The only snag that may be found in this process is in cleaning off the oil. To be a

success it is imperative that this be thoroughly done. One, or two soft dusters must be briskly applied, preferably warm, until the case is free from smears. It is wise not to be sparing in the number of clean dusters, as the finishing off can scarcely be overdone.

Sconces

If there are sconces it will be necessary to renovate them. To do this the old lacquer on them must be removed, and the best way of doing this is to soak them in petrol for roughly an hour, away from artificial light and bright sunshine. The lacquer will then brush off, and, after drying, the sconces can be polished with a soft leather. If carefully done they will be found to regain their lustre and can then be lacquered.

When polishing, no grease must be used and even finger marks must be avoided, or the lacquer, when dry, will peel off. To avoid this, handle them carefully. Before applying the lacquer, the sconces must be heated. The correct heat should be too hot to hold with the fingers but not enough to make the lacquer sizzle on the metal. Lacquer being sometimes difficult to obtain in some parts of the country, it is worth remembering that clear white spirit varnish may answer the purpose, but the metal must be only warmed for this, and then it takes some time to dry.

Jingling Noises

Do not decorate the top of the piano with vases of flowers with water in them. Only call in the tuner when imperatively necessary; many pianos are spoilt by too frequent tuning. Jingling noises heard in a piano when played may be due to infrequent use. When not due to this they will, generally, be found to be caused by some loose article on the top of the instrument or near enough to it to set up a vibration when striking one or two particular notes.

During the summer when the piano is rarely used, damage may be done to the felts by moths. This can be prevented by dropping a carbon ball down clear of the mechanism at each end inside the piano.

LOW TEMPERATURE—SOME FURTHER CONSIDERATIONS

By F. W. Britton, D.Sc.

Absolute Zero—So Near Yet So Far.

SCIENTISTS have now reached to within three thousandths of a degree of absolute zero, with the aid of liquid helium and magnetic fields. It would be superfluous to refer again to the wonderful things that can be done through the medium of liquid air, for this has already been fully dealt with by the recent well-illustrated article appearing in this journal (February). But I want to speak about the peculiar features of these excessively low temperatures, because the attention of the public has been drawn to them in the Exhibition held last March at South Kensington.

Difficulties in Low Temperature Research

Absolute zero means, of course, that there is at this point a complete absence of heat altogether; and really, this degree does not seem particularly low—only — 273° C. below the freezing point of water. It is easy to reach a thousand or two degrees ABOVE the freezing point, so why shouldn't we be able to get BELOW it a paltry few hundred degrees? Now just remember how long it took physicists to attain such low temperatures—the problem has been wrestled with for over a hundred years at least. One of the most difficult factors which confronted experimenters was that of suitable means for obtaining high pressures. This came with the advent of modern mechanical inventions, thus making it possible to compress air to the point of liquefaction, then, using this to liquefy hydrogen, which, in turn, can liquefy helium, so that, since this represents the limit of physical liquefaction, we arrive at a degree above the Absolute zero. Ultimately, it is possible to reach to within three-thousandths of a degree of absolute cold as we shall see.

Enormous Pressure Necessary

A good conception of the enormous pressures needed for gas liquefaction is given from that of common carbon dioxide which requires 4,500 lb. per square inch before it condenses to a liquid. On releasing the pressure on liquid CO_2 the gas rushes out and freezes to a white snow, the temperature being — 80° C. As far as the properties of liquid air are concerned, we cannot do better than refer to the article already mentioned, which will tell us all about them. But unfortunately, one very interesting point was not raised although I looked carefully for it.

If a length of copper wire is cooled in liquid air, or better, to several degrees lower, its conductivity increases enormously—as a matter of fact, if you do this at a temperature one or two degrees above absolute zero, the conductivity of the metal itself becomes absolute—in other words its resistance is nil. Thus, an electric current once passed along such a conductor would circulate for ever.

The question is naturally, how to obtain a current of electricity in a closed loop of copper wire; obviously the method is by induction. Consequently, an inductively excited copper conductor would retain its induced charge for an infinite period, provided it was at, or near, the absolute zero. Whether it will ever be possible to make such a conductor, we cannot say, but there is no reason why an alloy may not be produced in the future which will be far and away more conducting at normal temperatures and pressures than those in everyday use.

You can just visualise the great possibilities of a perfect conductor, where the transmission of electric power is concerned. It would be quite unnecessary to resort to high tension in order to overcome resistance, while applied to dynamos and motors, just imagine the increased efficiency. However it is a subject upon which it is premature to speculate—there *are* possibilities, we know, but before they can be realised, untold difficulties must be surmounted. Mention of difficulties should bring to our memory the stupendous job which confronted the pioneer workers in the isolation of rare gases and their liquefaction, and I think we shall do well to consider their task in contrast with the novel method employed in the recent approach to absolute zero.

From Liquid Air to Absolute Zero

On some past occasion, I referred to the preparation of the rare gases, (PRACTICAL MECHANICS, September, 1935) and the manufacture of helium was there shown to be due to the extremely low temperature of liquid air. Now helium was first liquefied by a Dutch chemist, Kammerlingh Onnes, some years ago, after the gas was discovered in CLEIVITE one of the rarer minerals. Dewar, the English chemist of vacuum-flask fame, did much research on the rare gases, but was unsuccessful in his attempts at isolating helium.

Hydrogen was liquefied more than thirty years ago, and this was the last step in the process of the liquefaction of helium, being only 15 degrees above the absolute. But 15 degrees IS 15 degrees and so it has taken some thirty years to come to the stage of helium liquefaction—a wonderful achievement. That stage then, brought us to within 1 degree of the absolute zero and the overcoming of this 1 degree is a terrific and laborious job which may never be achieved, but what has been done is this. The magnetisation of certain crystal structures causes a very slight increase in temperature, conversely, demagnetisation causes a drop in temperature. Hence, if a crystal of this sort (a chrome-alum variety) is subjected to an intense magnetic field and cooled with liquid helium until the temperature is at a minimum, while, at this point the magnetic field is suddenly removed, a temperature three-thousandths of a degree above absolute zero is attained.

Uses of Low Temperature

Perhaps the commonest use of low temperatures is in the preservation of food—solid carbon dioxide being the most usual gas—fruit treated to such cold conditions may be preserved indefinitely, apples especially benefiting. It is the object of the Low Temperature Research Station at Cambridge to produce "new laid" eggs as a commercial proposition with the aid of cold, but only moderately low temperatures are necessary for food storage purposes, around — 40° C. Another important use is that of nitrogen manufacture from the air, a factor so vital in agriculture in the preparation of fertilisers. Many other chemical processes will benefit too.

A more recent use has been put to liquid oxygen. Those elusive particles which accompany the disintegration of atoms due to beta-ray bombardment, the neutrons, are found to acquire far greater activity when cooled with liquid oxygen. Further research will no doubt show whether these neutrons can be profitably used in radiation technique. Liquid air has been used in Medicine for the cure of insect bites, while a very recent therapeutic use to which solid carbon dioxide has been put, is in the cure of leprosy, a report of which comes from Dorpat. The action of these low temperatures on the skin is similar to that of intense heat—fulguration taking place, and it is too, rather difficult to localise any treatment. In the case of leprosy, however, the gas not only destroys the disease along with the surrounding tissues, but enables the essential bodies which counter the disease in the blood—antibodies—to be separated so that they can do their work.

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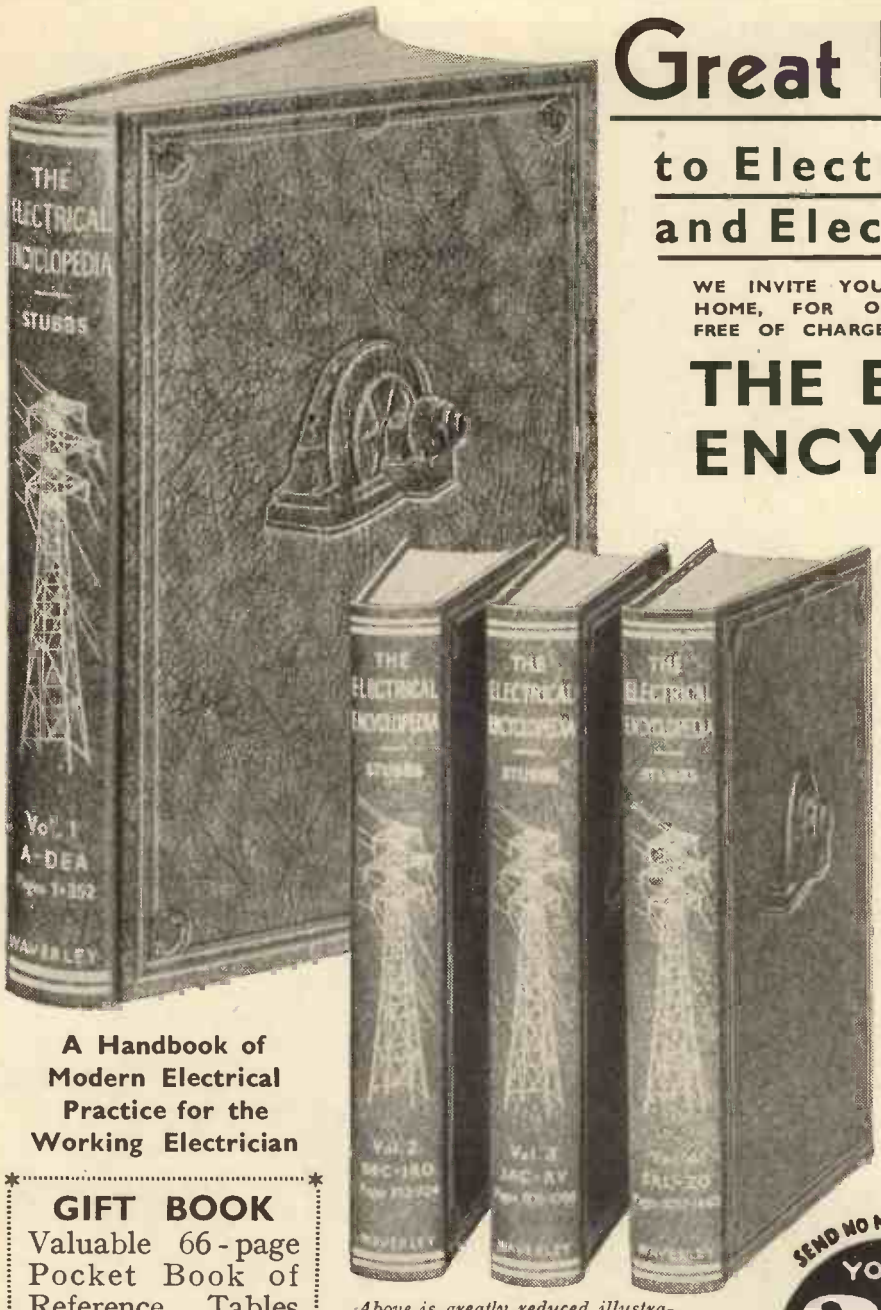

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LAMPS AND LIGHTING METHODS AND FITTINGS.—Modern methods, such as Lay Lighting, Cornice Lighting, Tubular Lighting, Flood-lighting, and new apparatus, as Hot Cathode Lamps, fully dealt with.

MISCELLANEOUS: MATERIALS AND SPECIAL DEPARTMENTS.—Every classification has its miscellany. Here are included the materials used in electro-technology; specialist sections such as electro-chemistry, electro-metallurgy, and other matters.

SUPPLY AND TRANSMISSION.—The apparatus, principles, and methods employed between the power station and the consumers' terminals.

SWITCHGEAR AND SWITCHBOARD.—The immense variety of apparatus used for controlling electric power is covered in principal and detail.

THEORY OF ELECTRICAL PRACTICE.—Put clearly and simply without incursion into higher mathematics.

TRANSFORMERS AND RECTIFIERS.—Includes every variety of transformer, as well as Metal Rectifiers, Mercury Arc Rectifiers, etc.

WIRELESS OR RADIO WORK.—Discussions of theoretical principles and their application in modern radio practice. Instruction is given on repair and maintenance.

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ROLL-FILM DEVELOPMENT MADE EASY

By G. L. Wakefield

An enlargement made from the miniature print in the left-hand corner.

TO the amateur photographer who develops a roll film only occasionally, a developing tank is an unnecessary expense. The job can be carried out quite successfully in a small pudding basin, as shown in the photograph, and the results are as good as those obtained by more complicated methods.

Fast "chrome" or panchromatic films are best desensitised before development, when all the operations can be carried out in the light of a candle, or a bright yellow safelight. The desensitising is done by soaking the film for a minute in a dilute solution of a special aniline dye, which has the property of making the emulsion much less sensitive to light without affecting the latent image.

There are several of such dyes obtainable, and they can be bought, either in tablet form, or in liquid, from any photographic dealer. The use of such a dye removes one of the major difficulties from development; that of seeing when the film has attained sufficient contrast and density.

Development

For development you will need: a dish containing the diluted desensitiser; a small pudding basin containing 6 or 8 ounces of developer; a bowl of clean water; a dish with acid hypo bath.

Here is a suitable developer for all makes of roll film:

Metol	20 grains
Hydroquinone	60 grains
Sodium Sulphite (crystals)	1½ ounces
Sodium Carbonate (crystals)	1½ ounces
Potassium Bromide	16 grains
Water to	20 ounces

For use, dilute one part of developer with one part of water. If you have no facilities for making up your own solutions, a chemist will make up the required quantity for about a shilling. The stock solution will keep for months in a tightly corked bottle.

The acid fixing bath is:

Hypo	4 ounces
Warm water	20 ounces

When the hypo is dissolved, and the solution cool, add 1 ounce of potassium metabisulphite, and shake until dissolved.

Instructions for dissolving or diluting the desensitiser will be found on the bottle or carton. When all the solutions are in their respective dishes, unroll the spool of exposed film in complete darkness. Remove the backing paper, and run the film through the desensitiser, taking care to cover the whole of it. If the film is held by one end only, and raised and lowered in the dish, the free end will wind up and unroll by its natural springiness. After a minute or more in the desensitiser (according to the maker's instructions) transfer the film to the developer in the basin, continuing the up and down movements. The film should not be rinsed between desensitising and development.

Printing

After two or three minutes' develoment, the light can be turned on, either a candle or a yellow safelight, such as is normally used for bromide paper. Although the emulsion is now much less sensitive to light, it should be treated with respect, and not placed nearer than two feet to the light until development is nearly complete.

The density of the film can easily be judged at this distance. From four to five minutes at a temperature of 65 degrees Fahrenheit is sufficient for most films, but some of the ultra fast panchromatic varieties need from five to six minutes at this temperature.

When development is complete, rinse the film for a moment in clean water, and transfer to the fixing bath. Fix for fifteen minutes, keeping the film on the move.

Wash for a least half an hour after fixing. This is best done in a shallow hand bowl; clip the film in a loop with a paper clip, the emulsion side outwards, and let the tap run slowly until washing is finished. As the hypo from the film sinks to the bottom of the bowl, empty the water away every five minutes.

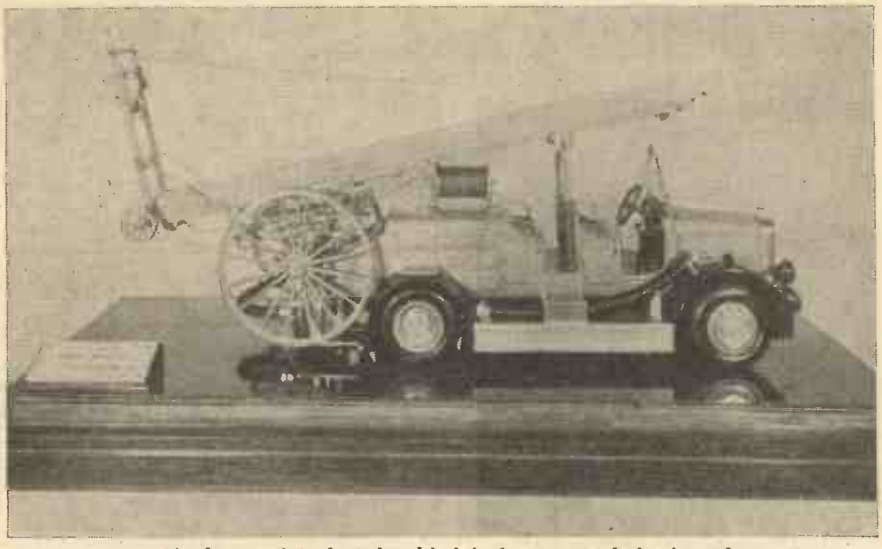
Before hanging the film to dry, wipe the front and back with a piece of soft, wet chamois leather to remove any scum that has collected from the washing water.

(Above) A fine piece of photographic work and (Right) After being desensitised, the film can be handled in the light of a candle, making it easy to see how development is progressing.

Models—Ancient and Modern

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

Some Interesting Models that were on View at the 1937 British Industries Fair held at Olympia



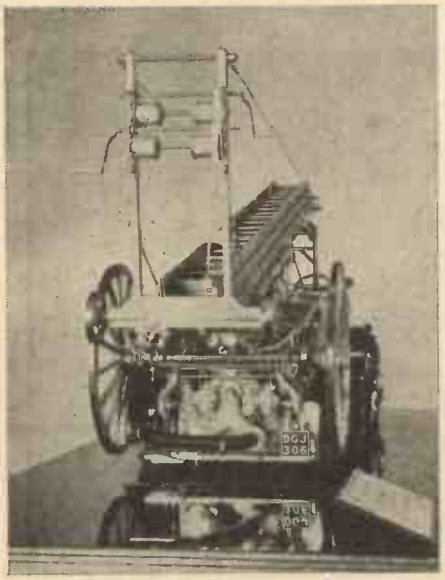
A side view of the finished model of the fire engine ready for the road.

MODELS, ancient and modern, were on view at this popular trade fair in February, and drew much admiration and discussion from the interested visitors to Olympia.

There were three models of particular note made by the well-known model-making firm of Bassett-Lowke Ltd., and exhibited on their stand, which showed most clearly the trend in modern craftsmanship.

The first, an 1½ in. to the foot model of the *Rocket*, was made for the Royal Scottish Museum and standing alongside it was a working model of the L.M.S. express engine *Royal Scot*. Both are to be same scale and thus represent an interesting comparison in a century of railway progress.

The *Rocket*, finished in yellow and black with white chimney, is as originally constructed by George Stephenson in 1829. It is in section and mounted on a piece of track, part of which is a replica of the earlier type with stone sleepers, the remainder showing the later pattern with wooden sleepers.



A view of the finished model showing the suction and outlets of the motor pump.

Amazing Detail

The overall length of the model is 2 ft. 9 in., and it shows the amazing amount of detail of this pioneer model very clearly and attracted much attention at the Fair.

The work of making this museum type model occupied four skilled men over a period of three months. Most of the work was metal work, except the tender, water barrel and boiler lagging, which was made in the wood-working shop. The unusually shaped tender wheels, engine trailing wheels, cylinders and wheel hubs were all made from special patterns, and the front wheels were built up in the metal hub, with wooden spokes and felloes, and a tyre of mild steel.

A Difficult Job

The tender, body and barrel were made from fine grain oak, the wheels of cast iron, and the fire box from copper. This was built by hand and has no less than 85 10 B.A. steel stays in it, a very slow and difficult job as these were all hand-made. The boiler barrel is made from sheet iron, the tubes of copper, and the correct number of copper rivets are in all barrel joints.

A model of the Dennis Dual Purpose fire engine, in the course of construction, showing the escape nearly finished and some of the small parts of the motor in the near foreground.

A 1½-in. scale working steam model o the Royal Scot exhibited at the British Industries Fair.

The smoke box is of copper, beaten by hand, the chimney hand-made in three slightly conical sections, each fitting into each other, and the rods are made by hand from steel. Another very difficult but fascinating job was the making of the left hand cylinder, which was in cast iron, with the ports cast in.

The reversing gear is correctly modelled, giving forward and backward movement with two eccentrics.

All bolts and set screws and nuts on this model are square, and the sectional part of the model shows half the number of fire tubes, the tie rods to straighten the boiler ends, the steam pipe and dome, and also the ferrules in the fire tubes.

A view of the partly finished 1½-in. to the foot scale model of the Rocket and parts, in the course of construction.

An Interesting Feature

An interesting feature on the front of the model is the mercurial pressure gauge used on early railway engines. The corona at the top of the chimney was made in a straight strip from sheet metal, and then rolled and bent into the correct shape. Two safety valves are fitted, one dead-weight and one spring loaded, as specified for the Rainhill Trials in 1829, for which this famous little engine was built.

The second model of the 4–6–0 *Royal Scot*, which became so well known from its trip across America, is about 8 ft. long, fitted with steam brakes, and capable of hauling anything between 10 to 15 passengers on a 7¼ in. gauge Garden Railway.

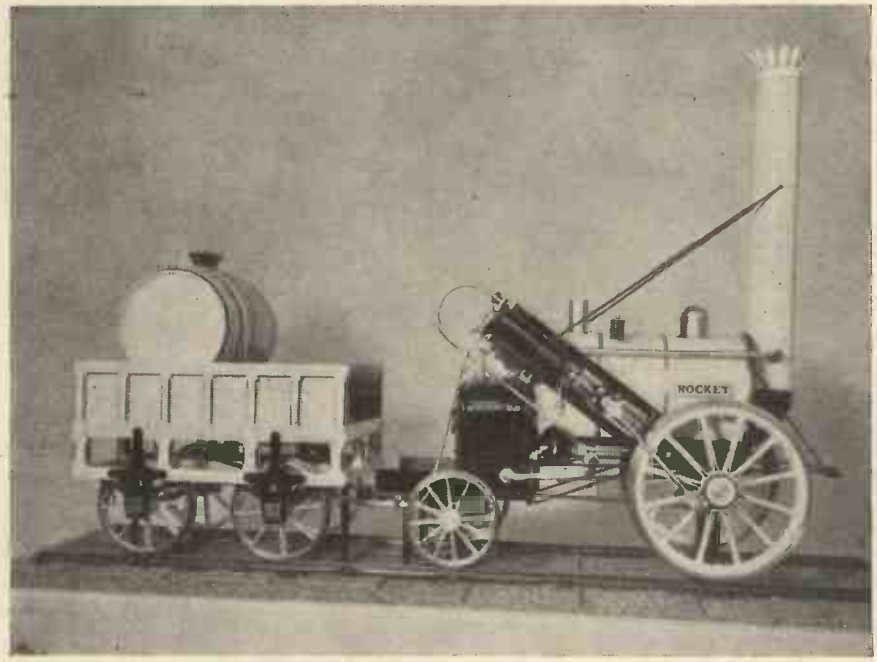
A Traction Engine

Standing in a special place of honour on Bassett-Lowke's stand was a model of the Burrell Traction Engine that has already been described in these pages by Mr. F. J. Camm. This has already become a very popular stock line and is complete with every detail, embodying a regulator for speed control, reverse lever for reversing the model, pressure gauge, water gauge, steering wheel, and has a very fine water-tube boiler capable of maintaining a pressure of 80 lb. to the square inch when working. This is definitely an improvement on any other Traction Engine on the market, either at the price or even more expensive. A novel feature is that it can be used either as a stationary engine or as a traction engine.

Model Fire Engine

Lastly and probably most interesting of all comes the exhibition model shown on Bassett-Lowke's stand of an inch to the foot Dennis Dual Purpose Fire Engine, finished in the vivid red of the L.C.C. London Fire Brigade, and the latest Fire Engine in public service, and the Bassett-Lowke craftsmen were able to show their versatile capabilities in modelling a fire engine.

The chassis was wrought in metal, mostly brass, and the escapes and body constructed in selected wood with all the fitments, either in metal or wood carefully made in the respective departments. The unpainted model was completely assembled for the approval of Messrs. Dennis Bros., and then taken apart again, for plating and painting. The wheels are hand-made in metal with special rubber tyres, and the seats are upholstered with leather spring cushions. The windscreen is of glass, and everything from the tiny detail of the intricate pumps at the rear to the large erecting wheels is in truth "realism in miniature."



A photograph of the finished model of the Rocket showing the side of the engine fully modelled.

Workers in both wood and metal were employed over eight weeks in constructing this model, which contains every detail although it does not actually work.

Model Railway Exhibition

THE Model Railway Club, which two years ago celebrated its Jubilee, will shortly be holding its Annual Exhibition at the Central Hall, Westminster. Easter falling early this year, the Exhibition opens on Tuesday, March 30th, and closes Saturday evening, April 3rd.

All the four Groups of the British Railways will be represented, each Group having a large section to itself. Another large section will be devoted to free-lance models, i.e. while not representing the rolling-stock of any British Group, still conform strictly to Railway practice. There will be working lay-outs in various scales and gauges where trains may be seen in motion, controlled from a central point, and all faithfully carrying out real practice in miniature.

There will also be a section composed of Models of historical railway interest, and another of antiques of railway interest on loan to the Club. Altogether this Exhibition should not be missed, and no one paying the Club a visit will for a moment regret doing so, on the contrary, he will probably be greatly impressed by what can be accomplished by the amateur, and possibly join the ranks, constantly growing, of the model railway maker and builder.

How a Television Screen is Made

By F. Goddard

An Explanation of One of the Most Delicate Operations in the Manufacture of a Television Set

The G.E.C. television receiver, showing the internal construction.

IN the television section of the G.E.C. research laboratories at Wembley, Middlesex, is a room that is probably the most dust-proof in the world.

In this room is conducted one of the most delicate operations in the manufacture of a television set. It is the spraying of fluorescent powder on to the almost flat end of a glass tube which is to form the screen on which the picture is produced.

It is this tube, known as a cathode-ray tube, which is at once the most costly and the most important part of a television set.

The tube is about 28 in. in length; it is cylindrical in shape at the lower end, after which it widens out into a pear shape, the base (which in the finished set is the screen) having a slightly convex surface, although this fact is not obvious to the viewer when watching a transmission.

At the narrow end of the tube is a cathode, from which a stream of electrons is directed on to the screen, which, being coated with fluorescent powder, lights up and thus gives a picture.

Fluorescence

Zinc sulphide is the chemical most commonly used to secure the fluorescence, but there are other compounds mixed with it. The proportions of these must be accurate within one-thousandth of one per cent.

Actually, different mixtures give slightly different tones of colour to the picture. The G.E.C. were experimenting on this point for a considerable time before television transmission became regular. A great many different mixtures were tried out before the exact proportions at present used were decided upon.

The spraying of the fluorescent powder on to the surface of the tube is quite as "finicky" a job as mixing it, for the layer must be absolutely even. It is for this reason that the spraying is conducted in a dust-proof room. The slightest irregularity—even a particle of dust—would distort the picture.

The Dust-proof Room

The dust-proof room in which the spraying is conducted has to be free, not only of the kind of dust that the house-wife sweeps up in the morning, but of dust so minute that only the most powerful scientific instruments can detect it.

The fluorescent powder is made to adhere to the tube by the use of waterglass.

The speed at which the screen is bombarded with electrons is 70,000,000 miles an hour. The cathode-ray tube, being completely evacuated, has to be able to stand terrific strain. In order to combat this strain the shape of the tube is mathematically worked out and each tube is subjected to a water pressure of over two tons before being passed as perfect.

Between the cathode and the screen are several complex electrical devices, including focusing electrodes which act as a lens, and deflectors where the tube widens.

These devices serve to deflect the rays from the cathode in such a way that they will cover the whole screen.

Unlike a newspaper picture, which is composed of a large number of minute dots, a television picture is composed of horizontal lines. These lines are either 240 or 405 in number, according to the system of transmission used, and they are traced at the colossal speed of 7,500 miles an hour. There is some danger of the picture being distorted by electrons re-bounding from the screen after bombarding it. This danger is eliminated by coating the sides of the tube with graphite.

3,980 Parts

The cathode-ray tube is by no means the only costly item in a television set. To give an idea how true this is, the standard 23-valve G.E.C. set contains no fewer than 3,980 parts; the set which incorporates an all-wave radio receiver contains an additional 2,000 parts.

The cathode-ray tube is, however, a very expensive item indeed to manufacture under present conditions, although, for some time before the B.B.C. began giving regular transmissions, the G.E.C. were manufacturing sets on a regular production basis in the same way as the famous G.E.C. wireless sets are made.

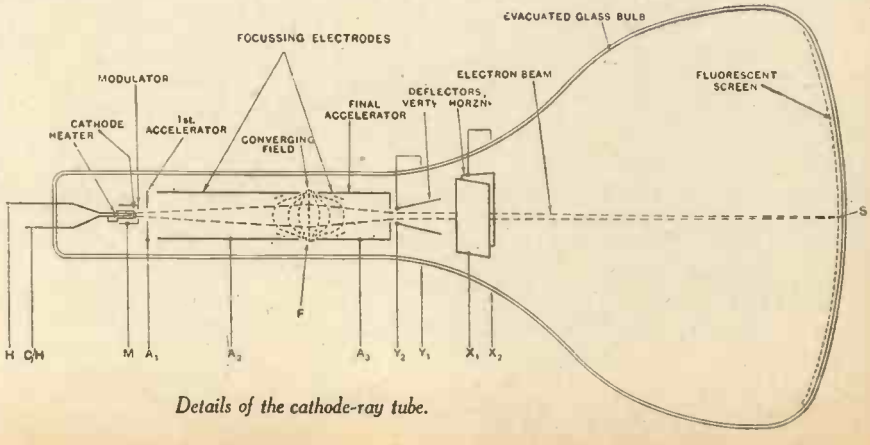
In the Cathode-Ray Tube the following fundamental operations take place (see diagram):

1. EMISSION OF ELECTRONS
This is obtained from an Indirectly Heated Cathode (O), similar in principle to that common with A.C. mains valves.

2. FOCUSING OF BEAM
This is effected by means of an electric field (F) of such shape that it causes the divergent beam of electrons coming from the Cathode to be changed into a convergent beam, in the same way as a beam of light passing through a convex lens. The focusing electrode design has required long research into the subject now known as "electron optics" and has resulted in an exceedingly accurately focused and bright spot.

3. ACCELERATING THE BEAM
An electrode of high positive potential, called "accelerator" (or sometimes "anode") (A_3), is so placed as to give the beam of electrons an exceedingly high velocity (70 million miles per hour). The electrons thus acquire considerable energy, which they give up to the fluorescent screen when they impinge on it, thus producing a bright spot of light (S).

4. DEFLECTION OF THE BEAM
The focused beam of electrons is made to traverse the fluorescent screen in both a horizontal and vertical direction by means of electrodes known as "electric deflectors" (X_1X_2, Y_1Y_2). The focused electron image is displaced horizontally in the range of 6,000 to 10,000 repetitions per second (line frequency), and also vertically in the range of 25 to 50 repetitions per second (image frequency).



Details of the cathode-ray tube.

MYSTERIO

By Norm

(The Well-known Conjurer of

Clever Ideas that Enable Conjurer

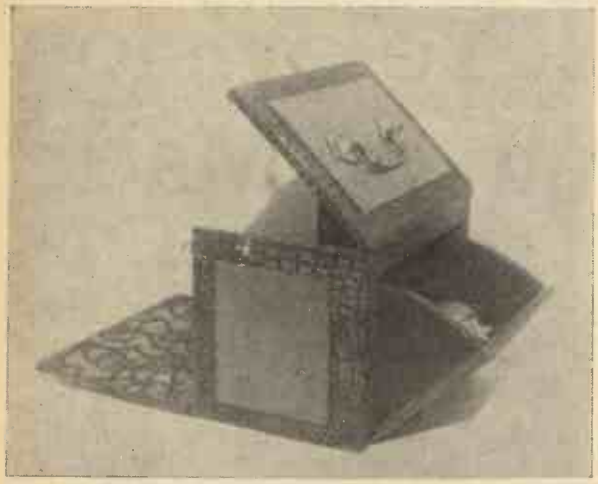


Fig. 1.—An exposed view, showing the secret V-shaped compartment. When the compartment is swung inside the box, the back of it becomes the panel on the back of the box.

PEOPLE frequently talk about "the box trick" as if there were only one trick that could be done with a box. Actually, boxes of one kind or another form one of the most valuable sections of a conjurer's stock in trade. By the use of ingeniously contrived false bottoms, flaps, secret linings, and other devices boxes may be constructed to make articles disappear, change into other articles, multiply, appear, change colour, in fact do almost anything that looks as if it couldn't be done.

For Producing Articles

Fig. 1 shows a view, which the audience naturally are not allowed to see, of a box designed primarily for producing various articles after the spectators have seen that it is empty. Some conjurers use a box of this kind to introduce magically the various things required for their tricks, casually showing the box empty now and again, but always finding in it the particular thing they want for the next trick, such as a handkerchief, ball, pack of cards, and so on.

The box has a let-down front and a hinged lid. The back of the box, when it is shown empty, is actually the front of a V shaped compartment which in the illustration can be seen tilted through the back of the box. When the box is closed, this compartment is tipped inside and the back of the compartment then becomes the panel on the back of the box, as shown in Figs. 8 and 9. The box may now be turned round to show all sides and when the lid is again lifted the articles concealed in the secret compartment are produced.

By reversing the process anything that can be tucked into the compartment while it is within the box can, of course, be made to disappear by tilting the compartment to the back. It should be noted that the compartment is not the full width of the box, a small margin being allowed at each side to prevent the audience seeing round the box and catching a glimpse of the secret receptacle. When performing with an audience very much at the sides, the conjurer holds the box with one hand at each side so that his arms help to mask the presence of the V-shaped compartment.

A Drawer in a Case

Another very simple but effective box is illustrated in Fig. 2. This is simply a drawer in a case. The drawer is pulled out and shown to be empty, closed and opened again, and it is instantly filled with toys, flowers, or anything the conjurer likes to put there.

In this case the secret is just an inner lining to the drawer. The drawer proper has no back and by means of a hole in the bottom of the casing, the lining may either be held within the casing or be pulled out with the drawer.

The box may be constructed of either wood or cardboard. Fig. 10 shows the general principle. By inserting a finger of the hand holding the case through the hole, the inner lining, into which have been packed the things to be produced, is held back and the outer drawer alone comes out. The front of the lining appears to be the back of the drawer. To make all secure the insides of the case, lining and drawer, are painted dead black also the outside of the lining. The drawer having been closed, it is only necessary to remove the retaining finger and pull out the drawer when the lining will come with it, thus filling the drawer. In the illustration the lining is shown half-way out.

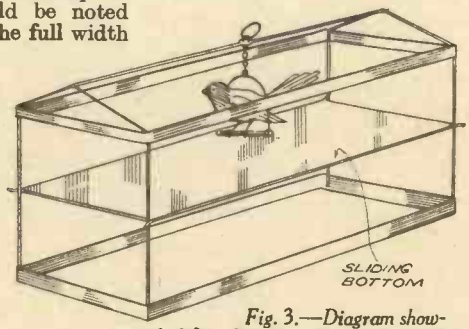


Fig. 3.—Diagram showing operation of sliding bottom. The wires of the cage have been omitted for the sake of clearness.

Fig. 4.—The cage being ren Note the sliding bottom whi the top to show the position is in the box. It drops down

The Lining

The outer casing has a small strip of

Fig. 2.—The lining of the drawer containing the article to be produced, is here shown half-way out. Actually the front of the lining would be close against the front of the drawer. Note the turned over edges of the drawer which hide the edges of the lining.

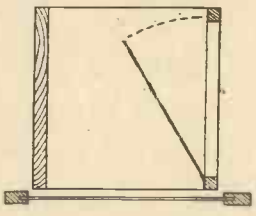


Fig. 6.—End section of box, showing operation of flap.

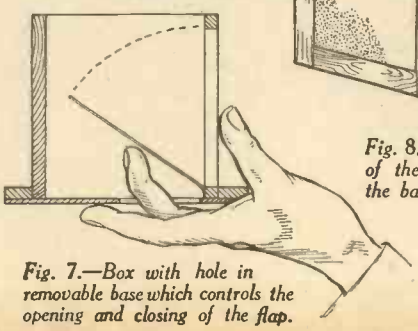


Fig. 7.—Box with hole in removable base which controls the opening and closing of the flap.

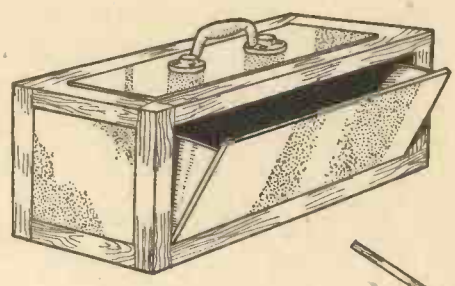


Fig. 9.—(Below) the box, showing compartment s

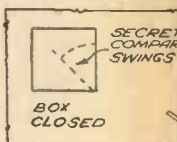


Fig. 8.—(Above) The back of the compartment forms the back panel of the box.

...US BOXES

...an Hunter

("Maskelyne's Mysteries" Fame)

...s to do the Apparently Impossible

wood or cardboard along the inside of the bottom edge at the front, to butt against a similar strip fastened to the under part of the back of the outer drawer. These strips prevent the drawer being accidentally pulled right out.

Such a box will easily produce or vanish anything placed into the lining. All that it is necessary to do is to hold back the lining at the proper time. Small scraps of paper dropped into the outer drawer can be changed to paper lanterns or dolls, or each scrap of paper may be made to fill itself with a sweet. To do this, fill the lining with wrapped sweets, show the drawer empty as described, drop into the outer case a few wrappings taken from similar sweets. Close the drawer, open it again and there are your mysterious sweets. Needless to say, nothing bulky must be placed in the outer drawer or the apparatus cannot be closed or operated properly.

A clever method of increasing the effect produced by this box is to wrap some article, say a gollywog, in a patterned silk handkerchief and conceal it in the lining. Show the drawer empty and place a similar handkerchief into the outer drawer. When the box is closed the empty handkerchief is crushed between the front of the drawer and the lining and the gollywog, appearing in the drawer wrapped, apparently in the same handkerchief as was just put into the box, makes a very puzzling problem indeed.

It should be noted that the top edges of the outer drawer are turned inwards to mask the edges of the lining (see Fig. 11).

...moved from the trick box. ...ch has here been held at ...it occupies while the cage ...n as the cage is lifted out.

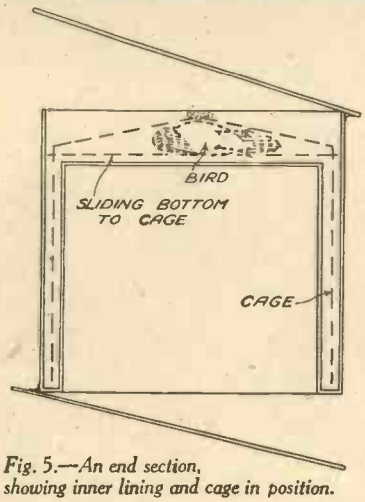


Fig. 5.—An end section, showing inner lining and cage in position.

Of Different Construction

Of totally different construction is the box shown in Figs. 12 and 13. There is no lid and the bottom is removable. The audience are allowed to look through the box, which seems to offer no possibility of concealing anything, yet, when the box is placed on its base, which, by the way, may be of glass set in a narrow wooden frame, an incredible quantity of silk handkerchiefs, flags, and similar articles may be produced from it.

Fig. 13 reveals the secret which is further explained by Fig. 6. One side of the box is hollow and is closed by a metal flap, hinged at the bottom inside the box and held in position by a small turn button. The space thus provided in the thickness of the box accommodates the load and, surprising as it may seem, about twenty handkerchiefs each eighteen inches square, if they are of fine silk, may be packed conveniently into the hollow side of a box measuring about nine inches by six, the sides being half an inch thick.

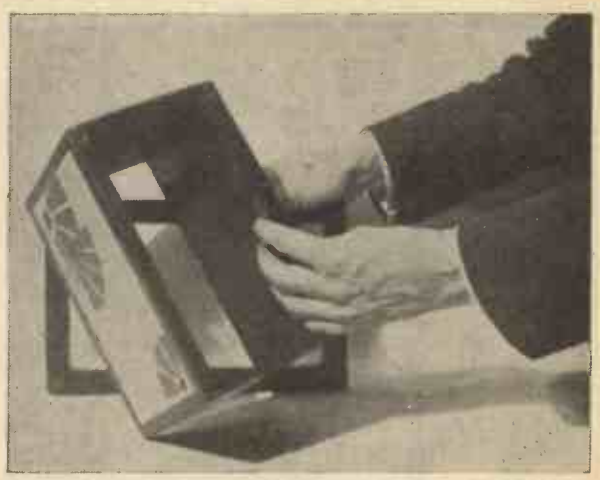


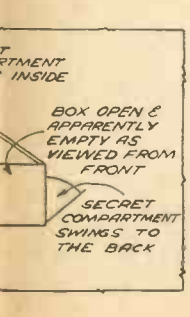
Fig. 12.—A box with a removable glass bottom. The fingers of the hand holding the box are on the catch, ready to push it up and release the secret flap.

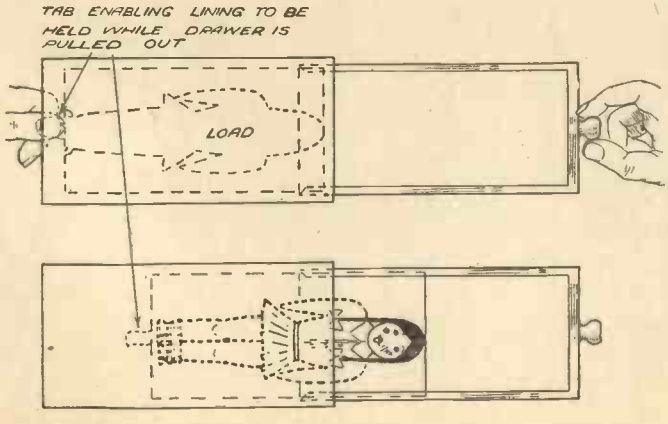
In operation the box is held in one hand and the base in the other. The fingers of the hand holding the box slide the turn button up so that when the box is placed upon its base the flap, forced by the load behind it, drops inwards and renders the articles get-at-able.

The Flaps

The idea is often carried a step further by providing the box with flaps to each of its long sides so that a double load may be produced. Another development is the use of a wooden removable base having a hole in it. A finger of the hand holding the box may be introduced through this hole and close the flap from below as required (Fig. 7.) The box may then be used for a series of bewildering little illusions; a handkerchief is produced from the apparently empty box, vanished and found in the conjurer's pocket (actually a duplicate previously placed there). It is dropped back into the box and changes colour (the original handkerchief being left behind and one already in the secret

...An end section of ...how the V-shaped ...wings in or out.





Figs. 10 and 11.—(Above) The lining left in the case and the drawer pulled out empty. (Below) The lining part of the way out, as shown in Fig. 2.

Fig. 13.—The box fitted to its removable transparent base and the flap released, showing the load ready to be produced.

compartment removed instead). The handkerchief can then be multiplied into half a dozen which in turn may be changed to a flag, which eventually becomes a shower of flower petals. The changes are simple, being effected merely by having the necessary articles packed into the hollow sides and producing them at the right times, leaving the other things in their place.

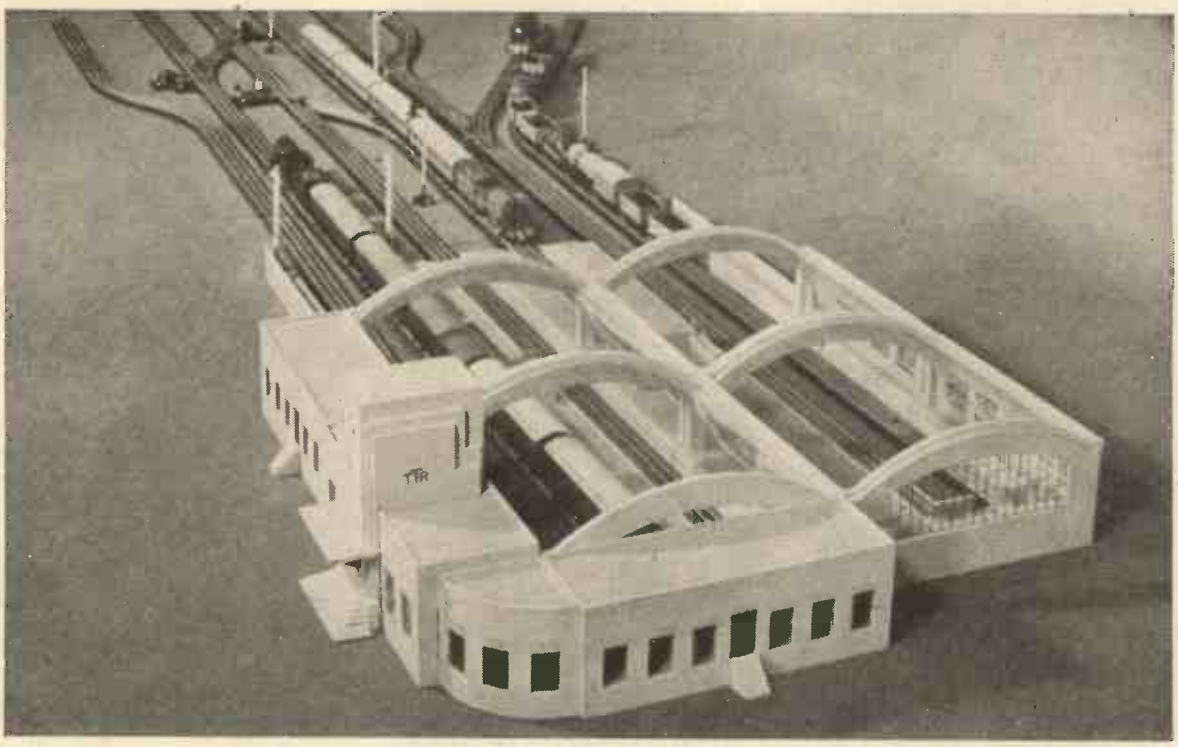
Then there is a large box, about a foot or more square, having a flap in each of its four sides. Such a box is usually made in sections and put together in view of the audience, after which the flaps are released one after the other and the articles behind them are produced.

Producing a Bird Cage

In Fig. 4 can be seen a box constructed to produce a bird cage with a bird in it. The box is shown empty and articles may be placed into it, after which a magic pass suffices to change the contents into the bird cage seen in the photograph.

The box has two lids and is constructed with an inner lining, as shown in Fig. 5. The cage is bottomless and a separate sliding bottom is fitted which can be pushed up to within an inch or so of the top, leaving just room for the imitation bird (Fig. 3). The cage fits over the inner lining of the box, the sides of the cage going between the outer walls of the box and the walls of the lining (see Fig. 5). When the corresponding lid is closed, the box may be shown, from the other end, and appear to be quite empty though actually the audience are looking into the lining. The box having been filled with whatever it has been decided to use, the lid is closed and the box turned completely over in the act of placing it upon a chair. When the box is again opened the now uppermost lid is lifted and the cage taken out. As the cage is removed the bottom sinks down into its proper place and the dummy bird drops down and swings on its perch, being attached to the top of the cage with string. The cage should not be hung up, which might cause the audience to imagine that it was collapsible, but stood on the box, the lid being closed for this purpose. This not only proves the solidity of the cage, but prevents any member of the audience from catching a glimpse of the lining, the closed end of which might now be visible to persons standing or sitting near the performer. For safety's sake the interior of the box at both ends should be painted dead black.

A box like this is frequently used in combination with some other piece of apparatus, the articles placed into the box to start with, or rather duplicates of them, being reproduced from the other trick property.



The New Unit Station development in 00 Gauge.

Latest Developments in Model Railways

AT the British Industries Fair, Messrs. Trix Ltd. were showing on their stand a full range of samples of the new "Many-ways" Station Buildings.

These are made on the unit principle and are very ingeniously built so that they make up practically any form of station, either terminal, through or wayside. The goods depots, warehouses, engine and carriage shed all have an excellent modern appearance. They have been designed by Mr. E. W. Twining on the lines of the modern Southern Railway Stations now being built.

Messrs. Bassett-Lowke Ltd. expect to have these on sale in October next ready for the winter season.

This season, a new method of packing has been introduced. Single trams are now packed in special Celilynd boxes with a space provided for the other train which may be added later. With this innovation, of course, the great advantage is that you can make a trial with one set of rolling stock without incurring the expense of two trains.

We also note that Trix rails are now put up separately in their own boxes in a wide variety of complete formations, enabling anyone to choose with ease the track lay-out he most prefers. A well-illustrated booklet, entitled "The T.T.R. Permanent Way Manual," is also included in each box of rails.

Hambling's

Model railway enthusiasts contemplating the building of a realistic miniature railway would do well to consider the possibilities of the "00" gauge layout, with a track gauge of only $\frac{7}{8}$ in. A comprehensive range of locos, rolling stock, and accessories for this gauge is given in the latest list (No. 52/1937) issued by A. W. Hambling & Co., 10, Cecil Court, London, W.C.2. The miniature locos are electrically operated, and complete electro-motors are listed, and also separate parts of the mechanism. A large number of blue-prints are also listed, giving particulars of various designs of locos, permanent way layouts, and buildings. There is also an interesting range of lineside and station accessories which just give that finishing touch of realism. The list, which runs to 40 pages, is priced at 4*d*.

MODEL AIRCRAFT SUPPLEMENT

PHOTOGRAPHS IN SOOT

A Cheap and Effective Printing Process with which all may Experiment

THE printing process described in this article is, perhaps, not quite the easiest of photographic processes, but it is certainly one of the cheapest, for, by means of it, the image constituting the photograph is built up in ordinary soot or in any other insoluble pigment which the photographer may care to choose. Moreover, almost any variety of paper may be used for printing the photograph on, or, in place of paper, wood, and other smooth surfaces may be employed.

Known as the "gum-bichromate process," this method of photographic printing gives absolutely permanent results, provided, of course, that the pigment used is itself a permanent and unfadable one. Soot, which is merely carbon, is an exceedingly permanent and stable material. Hence, gum-bichromate prints made in soot or carbon are as permanent as the paper or other base upon which they are printed.

Sensitising the paper with bichromate solution.

The gum-bichromate process is based upon the fact that when a mixture of gum or glue and potassium bichromate is acted upon by light, the gum becomes insoluble in water in proportion to the amount of light action which it has received. If an insoluble pigment, such as soot or finely ground carbon, is mixed with the bichromated gum, the pigment will remain on the paper entrapped in the insolubilised gum and will thus form an image.

Line Negatives

The gum-bichromate process works best with "line negatives," that is to say with negatives which contain white lines only and in which there are no half or intermediate tones. If we print an ordinary view or portrait negative in gum-bichromate, some of the finer detail will be lost. At the same time, however, such a print will exhibit many striking and artistic features and, indeed, many photographic workers print in gum-bichromate especially for the purpose of subduing detail and obtaining the peculiar rounded, soft-focus effect which is characteristic of the process when used for the printing of ordinary negatives.

In order to work the gum-bichromate process we must start with the sizing of the paper. Any variety of paper may be selected for printing on, but, for the beginner, ordinary plain white drawing paper will be found the best. This is sized by rubbing over it with a wad of cotton wool saturated with a solution of ordinary cooking gelatine containing a quarter of an ounce of gelatine dissolved in 3 ozs. of hot water. In order to preserve the gelatine solution for further use, a few drops of carbolic acid should be added to it.

Sensitising the Paper

After the paper has been gelatine-sized and allowed to dry, it must be wiped over with a cotton wool wad saturated with a solution of formalin of the strength ½ oz. of formalin to 10 ozs. of water. This formalin treatment will render the gelatine on the paper insoluble. The paper is allowed to dry, after which it may be stored for subsequent sensitisation.

In order to sensitise the paper make up a solution containing ½ oz. of potassium bichromate in 5 oz. of water. Also, prepare a solution of gum arabic by placing 1 oz. of the gum in a bottle containing 3 oz. of water. In a few hours, the gum arabic will have swollen up in the water, after which a gentle warming of the liquid will suffice to dissolve the gum completely. The gum arabic solution should then be filtered through muslin into an amber-coloured bottle and stored in the dark. If the gum solution is to be kept for any length of time a few drops of carbolic acid should be added to it, otherwise it will go mouldy.

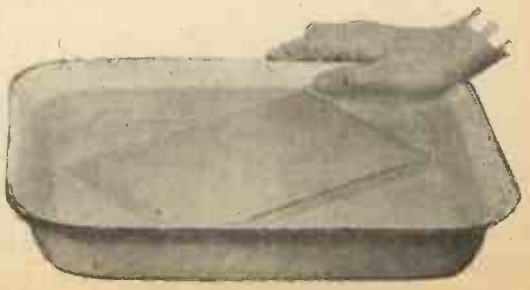
Having made up the bichromate and gum solutions, we may now proceed to sensitise and pigment the paper. These operations must be performed in artificial light and *not* in daylight.

First of all, we saturate a wad of cotton wool with the bichromate solution and rub it evenly over the surface of the sized and formalin-treated paper. The paper is now allowed to dry, after which it is given another coating of the bichromate solution. The paper, after having been allowed to dry again (it may be held in front of a fire for this purpose) will have a light orange colour and will be extremely sensitive to daylight, but not to ordinary artificial forms of illumination.

Pigmenting the Paper

Next comes the pigmenting of the paper and this, at first, is apt to prove the only

(Left) A finished print made on ordinary drawing paper. (Above) A gum-bichromate print in ordinary chimney soot. (Right) For development the paper is floated on cold water, face downwards.



difficult part of the whole process. Place at the bottom of an ordinary cup about two teaspoonfuls of the gum arabic solution prepared as above, and stir into it a small quantity of "clean" chimney soot. In place of soot, we may use lampblack, drop black, vegetable black or, in fact, *any* finely ground insoluble pigment. We may also use for the same purpose the water-colour pigments which are sold in small tubes for artists' use.

Whatever pigment we use, however, it must be thoroughly ground into and mixed with the gum arabic solution and the latter must not contain too much of the pigment. The right amount to use in the gum solution may be estimated by drawing a brush charged with the gum over a portion of a sheet of newspaper. The newsprint must be read clearly through the layer of the solution painted over it. If the print is obliterated, however, then the gum contains too much pigment and more gum arabic solution must be added in order to lessen the pigment content of the mixture.

Pigmenting the paper. Note the flat brush employed.

Using the Solution

Having obtained the right proportion a flat camel's-hair brush is charged with the mixture and is brushed over the bichromated surface of the paper, this operation, of course, being done in artificial light. As little as possible of the pigment mixture should be used, yet, at the same time, it should be spread evenly over the paper. It will be found almost impossible to brush the gum-pigment mixture perfectly evenly over the paper surface and to avoid all traces of brush marks. These, however, should be kept down to a minimum, after which the paper should be put away in a dark warm place to dry, a process which will take four or five hours. Paper so treated will then be highly sensitive to daylight.

The paper is printed under the negative for approximately one half of the time which it would take to print an ordinary P.O.P. or self-toning paper under the same negative.

Development

Finally, comes the development of the paper, this being a process which necessitates the exercise of patience more than anything else. We require for the development of the paper a large flat dish of cold water. The paper, after being removed from the printing frame, will be found to have a slight image on it. It is floated, face downwards, upon the surface of the cold water, care being taken to see that the paper surface makes proper contact with the water and that no air-bubbles are present on the paper. Development may take place in daylight, for once the paper is wetted it becomes insensitive.

The development of the paper will take anything from one to twenty-four hours, and very little can be done to hasten it. Gradually, the parts of the gum layer on the paper which have been unaffected by light will dissolve away in the water, revealing the image which has been printed on the paper. If the paper had not been given a preliminary sizing with gelatine, the particles of pigment which now dissolve away, would have become entangled in the fibres of the paper and would refuse to come away properly, thus making it impossible for a "clean" print to be obtained. Here, therefore, we realise the sole object of sizing the paper with gelatine and of subsequently giving the gelatine layer on the paper a treatment with formalin in order to render it insoluble in cold water.

Must Not be Touched

During the course of the development, the surface of the print must not be touched with anything, otherwise the print will be ruined. Towards the end of development, it may be permissible to stroke the white areas of the print (such as the sky) very gently with a very soft camel's-hair brush in order to remove traces of pigment which obstinately adhere to the paper. Nothing more than this, however, can be done to assist development. It is a question of waiting until the pigment mixture on the surface of the paper which has not been insolubilised by light action dissolves away of its own accord.

Finishing the Print

The print having been developed to the satisfaction of the worker, should finally be immersed for ten minutes in a solution of common alum (containing, say, ½ oz. of alum dissolved in 9 or 10 oz. of water) or in a solution of sodium bisulphite of the same strength. This will remove any traces of bichromate stain which may still remain on the print and the alum will, in addition, slightly harden the gum-pigment constituting the image of the print. The print is then immersed in two changes of still (not running) water and then allowed to dry without heat. The result will be a print of absolute permanency and one which, if the processing has been reasonably carried out, will present much charm of appearance.

As previously remarked, the process will not give very fine half-tone detail, but it will give a "rounded" image which, from an artistic viewpoint, is very effective. Negatives of black-and-white drawings, which are, of course, devoid of half tones, will be reproduced with great fidelity by the process, provided that the negative employed is a vigorous or "plucky" one and is not "flat" in character.

As an exceedingly flexible means of obtaining artistic and absolutely permanent photographic prints on a variety of different surfaces and as a very inexpensive mode of printing, the gum-bichromate process has much to recommend it to the interested amateur, particularly if he be of an experimental or artistic turn of mind.

NEW MILLION-VOLT X-RAY EQUIPMENT

A NEW X-ray equipment, designed to give a beam of higher intensity and of greater penetrative power than any so far employed for the treatment of disease, has just been installed at St. Bartholomews Hospital.

Remarkable in Design

The X-ray tube itself is of very remarkable design. It is 30 ft. in length and weighs 10 tons! It consists essentially of a long steel tube in which the filament and target are mounted and in which a high vacuum is maintained by continuously operating oil vapour pumps. Only the central 12 ft. of the tube are contained in the treatment room, the two ends projecting into the two generator rooms which are situated on either side of the treatment room. To prevent the spreading of the X-ray beam, the central portion of the tube is surrounded by a protective sheath consisting of a 6-in. layer of closely packed lead shot which is contained in two co-axial steel cylinders. An aperture in the sheath allows the transmission of the X-ray beam in the required direction.

In view of the great weight of the tube, it would not have been practicable to move it to adjust its position over the patient, so the floor of the treatment room was made movable instead!

The Working Voltage

The voltage for working the tube is derived from a step-up transformer which gives 150,000 volts. By means of a special circuit employing columns of continuously evacuated rectifying valves and large oil-immersed storage condensers, a rectified current of 600,000 volts may be obtained. The generating equipment is duplicated, and by connecting both sides in series, a maximum potential of 1,200,000 volts is available. At this voltage, the tube takes a current of 5 milliamperes.

The new equipment has been designed and manufactured by Metropolitan Vickers Ltd., of Manchester, and it is hoped that it will prove of value in the further conquest of that dreaded disease, cancer.

* * * * *

Television in Moscow

AN ultra-short-wave television station is being built in Moscow. The aerial is to be nearly 500 ft. in height in order to ensure satisfactory reception within a radius of 40 miles.

MODEL AERO TOPICS

BY F. J. C.

Registration of Models

IN view of the National Contest for Petrol-driven Model Aeroplanes announced elsewhere in this issue, and which is bound to attract an enormous amount of attention to this most modern and most realistic of all types of model aircraft, as well as to model aeroplaning in general, it is appropriate to mention that the S.M.A.E. are considering approaching the R.A.C. with a view to investigating the problem as to whether models should not bear some designating number as with full-size aircraft. They are also considering whether it should not be made compulsory for petrol-driven models to be insured against third-party claims. I do not suppose that a petrol-driven model will ever be responsible for serious damage, but it is wise on the part of the S.M.A.E. to wish to look ahead and to circumvent any possibility of legislation prohibiting the flying of such models altogether. We must remember that one or two local authorities lacking vision, and unnecessarily apprehensive of danger, are prohibiting the flying of any type of model aeroplane. This is a short-sighted policy, and it is questionable whether they have the right to do it. A petrol-driven model can be flown under controlled flight conditions, as in our Contest, and it is no more dangerous to spectators than a cricket ball, a golf ball, or a racing motor-car at Brooklands. The law is quite clear on this point. If a spectator unasked watches a cricket match, or a motor race, or a cycle race, or a model aeroplane in flight, they cannot sue for damage. I recommend the S.M.A.E. to circularise the Clubs stating this point of law, which may not be generally known.

Petrol Model Kit

I HAVE received a very well thought out kit of parts for a petrol-driven model, which retails at the very reasonable price of 3 guineas, carriage paid. It is supplied by Comet Aero Supplies, Barwell, Leicester, and it has been specially designed for the Baby Cyclone Engine. The kit includes all of the necessary wood, glue, wire, wheels, instructions, drawings, silk, dope, part-finished chassis, etc. It may easily be erected and the whole model is of pleasing lines and well designed. The same company tell me that they have designed and at present have on the test bench a British-made 3·5 c.c. engine, and promise to submit one to me for test. The special air wheels which they supply in the kit referred to above, or separately, have completely enclosed valves, and are extremely well made and light.

Another New Petrol Engine

MR. A. E. BROOKS, of the Aircraft Stores, 127b Hankinson Road, Bournemouth, sends me details of a new engine which he has designed—the "Spitfire." This is of 14 mm. bore × 15 mm. stroke, yielding a thrust of ¾ lb. It runs upright or inverted. The cylinder capacity is 2·31 c.c. and consists of a casting in semi-steel close-grained, hard-wearing alloy, with an electron piston fitted with a heat-treated molybdenum piston ring. The gudgeon pin is of hollow steel with soft copper end pads, whilst the crank is hollow and machined from the solid. The cylinder head, including pins, are of heat-treated electron. An innovation is that the petrol tank is an electron casting, bolted on to the crankcase, and fitted with reversible filler and delivery caps, making reversal of the engine quite easy. The timer cam is of steel, and the contact-breaker is adjustable. The coil weighs only 1½ oz. energised by a 1-oz. dry cell. The weight of the unit, including tank, coil, and propeller is only about 7½ oz. The price, complete with coil, tank, and propeller is 4 guineas, post free. The same firm are selling a number of petrol model kits at prices, including engines, of £7 15*s*. (the Comet II), the Comet Skyrocket at £13 10*s*., and the California Chief at £7 15*s*. They will send details to any reader. The accessories stocked by the firm include a 1-oz. time switch, B.B. air wheels, and the B.B. flexible carburetter control.

The Gloster Gladiator made from one of the kits supplied by Messrs. F. P. Sweeten, Ltd.

Sweeten's New Lines

MESSRS. F. P. SWEETEN, LTD., 38 Bank Hey Street, Blackpool, have taken up the sale of American solid kits to an exact scale of ¼ in. to 1 ft. These kits are excellent value, and incorporate a large amount of faithful detail. The kit, which includes cement and coloured lacquers, costs only 2*s*. 6*d*. each. One of the new kits is the Gloster Gladiator, which builds up into a really beautiful model, incorporating a shock-absorbing under-carriage. It is of 18-in. wing-span, and is excellent value for 5*s*. It is shown in the photograph.

The same company have developed their Ship Models, and now have four new kits at 4*s*. each—the Schooner Bluenose, the Cutty Sark, the City of New York, and the Chinese Junk. The kits include detailed plans.

The S.M.A.E. Notes

WILL readers please note that all enquiries concerning S.M.A.E. Competitions should be addressed to: The Competition Secretary, S.M.A.E., Mr. J. C. Smith, 1 Treen Avenue, Barnes, S.W.13. All other matters should be addressed to Mr. E. F. H. Cosh, 35 Maple Crescent, Sidcup, Kent. There are now over 30 Clubs affiliated to the S.M.A.E. A large number of enquiries are being received from other clubs.

* * *

The Council of the S.M.A.E. recently discussed the question of a standardised badge, and the delegates were requested to place the matter before their respective clubs.

* * *

Mr. R. Copland, of the Northern Heights Club, claimed a spar record of 18 min. 52 sec. made at the Albert Hall on January 22nd. This record was passed.

* * *

The list of S.M.A.E. Competitions to be held during 1937 is now ready; they include the Gamage Cup, the Pilcher Cup, the Model Engineer Cup, the Flight Cup, the Western Cup, Cup for Autogiro Models, the Lady Shelley Cup, and the C.S.S.A. Cup, the Sir John Shelley Cup, Bowden International Trophy, the National Cup, the Biplane Cup, Farrow Shield, Premier Shield, and the Wakefield International Cup Contest. Copies of the list will be sent to affiliated members.

The "Baby Gnome"

A COMPLETE construction kit for a new outdoor superduration model has just been produced by Model Aircraft Supplies Ltd., 171, New Kent Road, London, S.E.1. It is a fuselage model of 28-in. span, and it flies for at least 2 min. Its weight is only 1¼ oz. The kit includes all balso wood strips, tissue for covering, celluloid wheels, celluloid tube, gloss dope, rubber, cement, full-size blue print, instructions, wire, etc.

The model is of fine appearance, is well designed, and a guaranteed flier. The same company is supplying parts for many other models, all of them listed in their catalogue. They supply everything necessary for petrol and rubber-driven models—flying and scale.

STARGAZING FOR AMATEURS

A NEW SERIES

By N. de Nully

A GUIDE FOR APRIL

ON the nights between the 5th, 6th, and 7th, and again between the 19th, 20th, and 21st, the Moon's terminator will be in the vicinity of the fine lunar mountain Copernicus. If the weather is clear these occasions will afford excellent opportunities for seeing the object under both afternoon and morning illumination. Copernicus is the most perfect example of a ring formation on the visible surface; and its stately grandeur is enhanced by a comparatively isolated position on a vast sparsely occupied plain. Copernicus is nearly sixty miles in diameter and slightly hexagonal in shape. Its massive encompassing walls are tolerably uniform in height and are surmounted by lofty summits, many of which tower 12,000 feet above the interior. Both the outer and inner slopes of the gigantic ramparts are traversed by deep gullies and terraced by well-defined ledges. One of the peaks of the central pile rises 11,000 feet above the floor, and there are numerous hillocks and "craters" scattered about. The region surrounding Copernicus is ribbed by low ridges pitted with circular indentations; and, as the tide of sunshine advances, a labyrinth of gleaning streaks appear, stretching in all directions for hundreds of miles. A map of the Moon is recommended as a guide to the "geography" of that weird globe. Messrs. Geo. Philip & Son, of 32 Fleet Street, London, publish one at 2*s.* 6*d.* net.

The Elusive Mercury

Between the 10th and the end of the month will be the best time during the year to try and catch sight with the naked eye of that elusive little world, Mercury. It will be at greatest eastern elongation on the 20th and for ten days before and after that date may—weather permitting—be detected low over the western horizon glittering against the twilight like a yellowish star. At the beginning of the period indicated Mercury will be a little below and to the left of Venus. On the 12th it will be not far beneath the young Moon. The planet should be looked for as soon as the intense glare of sunset has somewhat subsided. A binocular will help in the search, and a telescope will show the phase to be a miniature crescent. All endeavours to establish the existence of permanent markings have hitherto failed. Various competent observers claim to have noted faint greyish patches from time to time; but these have been too vague and transient to be reliable. A patient and painstaking reader of PRACTICAL MECHANICS may nevertheless succeed in placing the reality of some feature beyond doubt, by carrying out a long series of careful observations. Material thus accumulated might prove of the utmost value in arriving at the rotation period.

The Smallest Satellite of the Sun

Mercury is the smallest of the Sun's nine important satellites, and also circulates closest to that luminary. It therefore rarely strays far enough out of the radiance of the latter (whether as a morning or evening "star") to be easily perceived without optical assistance. The diameter of the planet is only 3,000 miles—less than half as much again as our Moon—and its relatively restricted orbit enables its "year" to be accomplished in but 88 of our days, i.e. under three months. The great eccentricity of this diminutive track alternatively carries the planet from as near as 28½ to as far as 43½ million miles from the Sun. Consequent variations of heat must be terrific, with a scorching temperature even at minimum. As already indicated, the length of Mercury's day and night cannot be conclusively ascertained; but it is believed to coincide with that of its "annual" revolution. If so, one hemisphere is continuously bathed in fierce sunshine and the other perpetually steeped in glacial darkness save for the feeble glimmer of the distant stars and neighbouring planets. The heat pouring down on the sunlit side is estimated to be at least 650 degrees farenheit—hotter than the melting points of lead! Some of the rigours of the cold side may, however, be mitigated by warm currents flowing in from the baked one, if, as is thought, there is an atmosphere. A few authorities suspect that Mercury may not really be a planet in the ordinary sense of the term. Its physical condition and the abnormal eccentricity of its orbit suggest that it might perhaps have been the solitary satellite of Venus which, at a remote period "escaped" from the gravitational tether of that now moonless world. But how it managed to wrench itself free from the powerful attraction of so large a body remains unexplained.

Venus

Venus continues a brilliant "evening star" in the first part of the month. It will, however, set earlier each night and soon diminish in lustre as it drifts back into the glare of sunset towards "inferior conjunction" between the Sun and the Earth on the 18th. It will then temporarily be our nearest celestial neighbour, except the Moon. Mars rises shortly before midnight and may be found in the south-east towards the early hours of the morning. It is rapidly approaching us and its reddish glow is brightening considerably. Jupiter rises about 3 a.m. and Saturn a couple of hours later. Neither are conveniently placed for the amateur observer.

The Great Bear

The well-known constellation Ursa Major (the Great Bear), popularly called the Plough or Charles' Wain, is almost overhead. It is actually a naked-eye cluster on an extended scale and consists of a group of immense suns, most of which are moving in space together. In addition to the "Pointers," leading the eye to the north polar star, Ursa Major embraces several very interesting objects suitable for quite small instruments. Among them is Mizar (ξ Ursæ Majoris), a fine but close pair of twin suns associated with a quadruple system. It is the middle star of the three forming the "tail" of the Bear. Adjacent to it is Alcor, much less conspicuous and in olden days regarded as a test for keen vision. Alcor is an even closer double than Mizar, but there is no physical connection between them. There are numerous other double stars and nebulæ in this constellation, the separation and detection of which of course depend upon aperture and favourable atmospheric conditions. The most remarkable of the nebulæ is the "Owl" (M. 97), situated a little below and to the left of the star β Ursæ Majoris, the lower of the "Pointers." It was so named by that famous astronomer, the late Lord Rosse, who, while examining it through his mammoth reflector of 6 feet aperture, noticed two openings in the centre with a star in the middle of each. The curious effect produced naturally suggested the staring eyes of our familiar bird of the dusk.

Sunrise on the great Lunar Ring Mountain Copernicus.

TURN TO PAGE 366 FOR DETAILS OF OUR GREAT NATIONAL MODEL AEROPLANE COMPETITION

A NEW TWIN-TRAIN RAILWAY UNIT

By E. W. Twining

A Model Electric Unit for the Twin-Train System

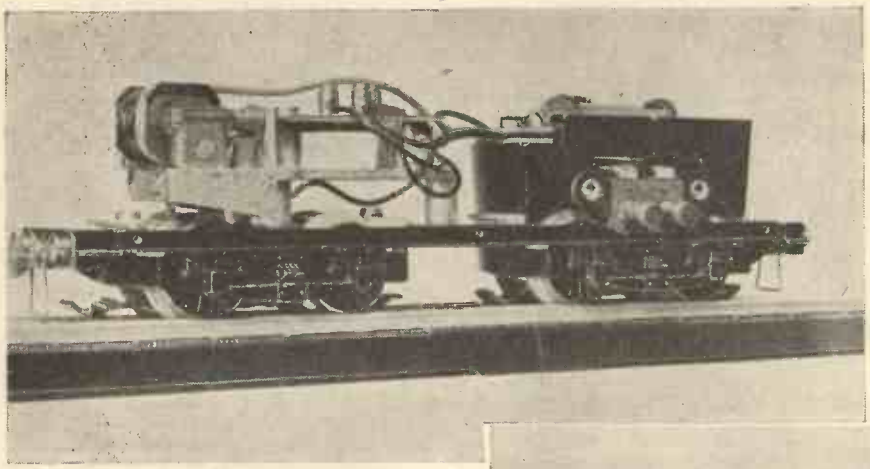


Fig. 1.—The chassis and motor unit of the new T.T.R. Southern Railway Electric Train.

THERE has recently been manufactured and put on the market, in co-operation with the Southern Railway Co., a very excellent reproduction of one of that company's electric unit trains in miniature for the twin-train system. This is sent out, boxed, with an oval track and controller, and sells at 55*s*. It consists of one motor third-class coach, one first-class corridor coach, and one third-class corridor coach, all finished and lined in the standard Southern colours—green picked out with black and fine lined yellow.

Although the train is sold as a set with rails, etc., the coaches can be bought separately. Since, however, only the train is new it is merely necessary to mention prices of vehicles. The motor coach sells at 30*s*., the other cars at 3*s*. each, and of these the following are available: first-class corridor, third-class corridor, third-class brake, and a restaurant car. Thus any reader who is already in possession of twin-train track can add to his rolling-stock as he thinks fit. If he fancies the green coaches of the Southern Railway he can quite well re-enamel one of his present locomotives to match.

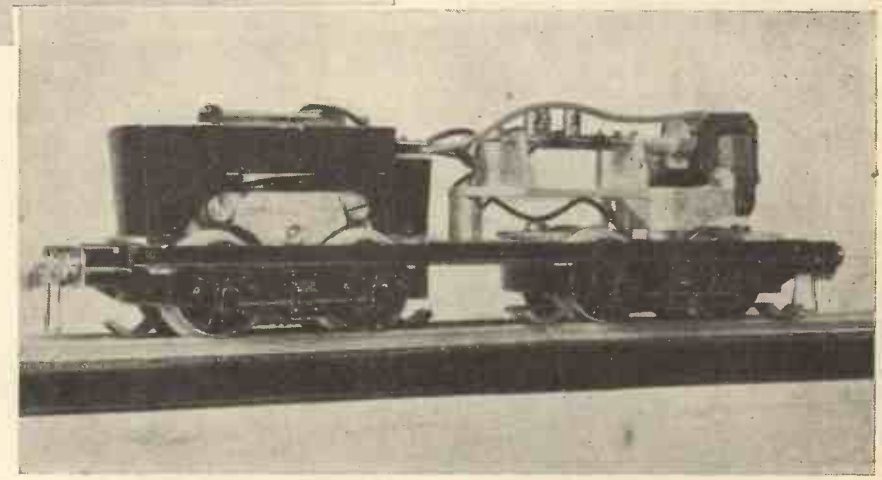


Fig. 2.—The brushes and commutator side of the motor unit.

The Motor Unit

This article is concerned chiefly with the motor coach of the train. Readers will remember that in the issue of PRACTICAL MECHANICS for March, 1936, I gave a drawing showing the motor mechanism of one of the twin-train locomotives of steam outline and diagrams of the electrical circuits showing the operation. The Southern Railway motor unit is exactly similar except for the fact that the reversing gear is separated from the motor. The coach is of the double-bogie type and in this case the motor is mounted upon and drives one bogie whilst the reversing electro-magnet and the cylindrical commutator with its brushes is carried on the other bogie. The two illustrations, Figs. 1 and 2, show both sides of the chassis with the body of the coach removed. Fig. 1 is the side of the chassis on which the reversing commutator and ratchet is placed, whilst Fig. 2 is the commutator and brush-holder side of the motor. Fig. 3 is a scale elevation drawing of the former side of the unit.

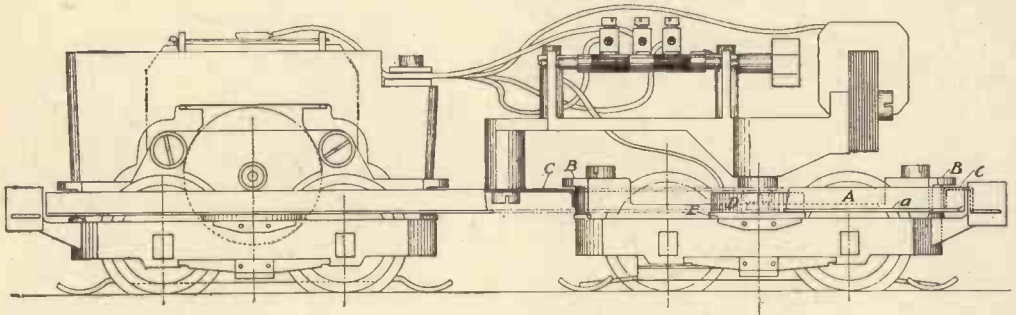


Fig. 3.—(Above) A scale drawing of the motor coach chassis.

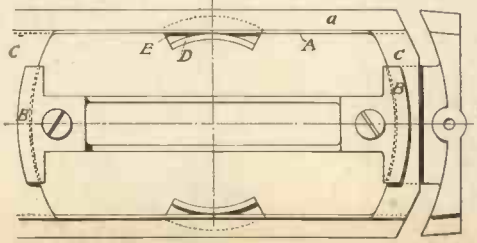


Fig. 4.—A plan of one bogie showing the swivelling girders.

Swivelling the Bogies

Since I have previously dealt so fully with the electrical gear it only remains for me to show how the swivelling of the bogies is provided for. As a matter of fact, before this train was produced the designing of it was put into my hands and the first difficulty which cropped up was the necessity for providing for the rotary movement of the bogies. Obviously, the usual bogie pins were not practicable: the same motor had to be used as in the twin-train locomotives. In other words the motor on its wheels had to be exactly as I showed in the drawing, Fig. 2, in March of last year, and there was no means of getting a stretcher across either the bogie or the main underframes. The usual way of pivoting in such cases is by arranging a swivelling pin in the roof of the coach over the motor, but I do not like this arrangement, so I designed curved guides *D*, with rubbing surfaces *E* and stops *B*, the last to prevent the bogie from dropping when the coach was lifted. Fig. 4 is a plan view of the bogie frame and coach frame only where the letters referred

to are repeated. In this plan nothing but the frames are shown, but I would explain that *D* and *E* are cast on the outside frames of the bogie which, for simplicity, have been omitted from the drawing. In this plan *A* is the main solebar or coach framing. *a* is the step running the whole length of the coach and *C* the flat upper surface of the chassis which is of pressed steel plate.

Improved Design

The manufacturers have improved upon my design in some details, though in the main the drawings which I now give here are the same as I originally prepared. I must say that the bogies swivel with perfect freedom and without that objectionable sloppiness which is sometimes associated with carriage bogies of much larger-scale models than this. Fig. 5 shows a side elevation and end elevation of the coach; Fig. 6 is a photographic view showing both side and end.

Owing to the fact that there were two bogies I was able to depart from the, it must be admitted, somewhat clumsy-looking current pick-up brushes which are so obvious in the electric locomotives, those which rub on the outer or running rails. The brushes for the middle rail are on the motor bogie as they are on the engine of steam outline, but those on the other bogie, although they press on one of the outer rails, are also placed on the centre line of the reversing unit bogie. This is done by making the stampings for the brushes project from the centre line out to the running rail. The removal of one screw in the centre alone is sufficient to enable the brush holder to be turned around to pick up current from the other rail if and when required.

True-to-scale or Otherwise

Now I want to say a few words about scale in connection with the twin-train railway system. It has been argued that there is no scale about the railway or its rolling stock. I do not agree with this. Let me say at the outset that no one could be more fastidious than I am over exactitude in scale in a general way, but we have to remember when criticising this system that it was produced to meet a certain demand—the demand for something which would sell at a low price, which would have good general proportions, would work well and continuously and be capable of being laid for a little while and then put away again. I do not think that any one should deny that it has met this demand admirably. Of course, this does not imply that it is true to scale, rather perhaps the reverse; but there is a scale underlying its design nevertheless. Perhaps the chief point about the system is that it works continuously or whenever it is called upon to do so, and I must say it does this in a more reliable and efficient manner than many so-called scale-model 00 gauge railways. For instance, has any one who has either manufactured or made for himself a scale-model track ever produced a set of electrically operated points which work as surely and as sweetly as those supplied for twin-train working, or a locomotive motor which never fails until it is quite worn out? I doubt it, and yet that can be justly claimed for the twins.

I will let the reader into a secret. Before very long curved track will be available of much bigger radius than that now obtainable and then, probably simultaneously, we shall have locomotives with wheel arrangements up to the 4-6-2 or "Pacific" type.

Origin of the Scale

Returning to the matter of scale, I should like to go back to the beginning of this small-gauge type of railway—a matter of about sixteen years. It was in the year 1921 that Messrs. Bassett-Lowke, Ltd., produced a small and cheap table railway which was manufactured for them in Germany. It consisted of an electric locomotive on four wheels, a train of coaches and a circle of track made from pressed tinplate. These sets had an enormous sale. For the sake of simplicity the size was arrived at by making it exactly half that of the standard 0 gauge. Now the width between rails of the 0 gauge is 32 mm., or 7 mm. to 1 ft. In the simple table railway the width between rails was made 16 mm., exactly half of the 32 mm. 0 gauge. It follows, therefore, that the scale of the gauge was 3½ mm. to 1 ft. The table railway made no pretence to be more than a toy beyond the fact that the gauge was to scale. It must be admitted that if 0 gauge is to scale, and so far as I am aware no one has said that it is not, then any railway which is exactly half that size must be equally to scale. When the much later Twin-Train Railway system was designed—and it was designed, be it noted, in Germany for German railway enthusiasts—the gauge was, for convenience, made the same as the earlier table railway; that is to say, 16 mm. Moreover, the Germans adopted 3½ mm. to the foot as the scale. So it will be seen that the Twin-Train Railway is not 00 gauge as it has been assumed, but is what has become known as H0 gauge.

An Important Point

Now we come to the important point which is, I take it, the one which some people quibble about. I have just said that the system was designed in Germany. Most people know that the German loading gauge is much bigger than the British. Let the critic, therefore, measure up one of the German-made locomotives which are on the British market and he will find that the overall width and height are correct for the German loading gauge on a scale of 3½ mm. to 1 ft. "Oh, but," it will be said, "when British locomotives were modelled the dimensions ought to have been altered." Well, perhaps this will come in time: there is so much yet to come that when all the present schemes are realised and things which are in preparation are marketed many people will be surprised, I can promise; but at present with the existing motor this decrease in measurements of the locomotives to conform to British standards is impossible because the highest points and the widest points on the motor and reverser already exceed the limits of the British gauge; but I for one, although I am a believer in true scale, do not carp unduly because the engines look a trifle bigger and more imposing than they ought to do.

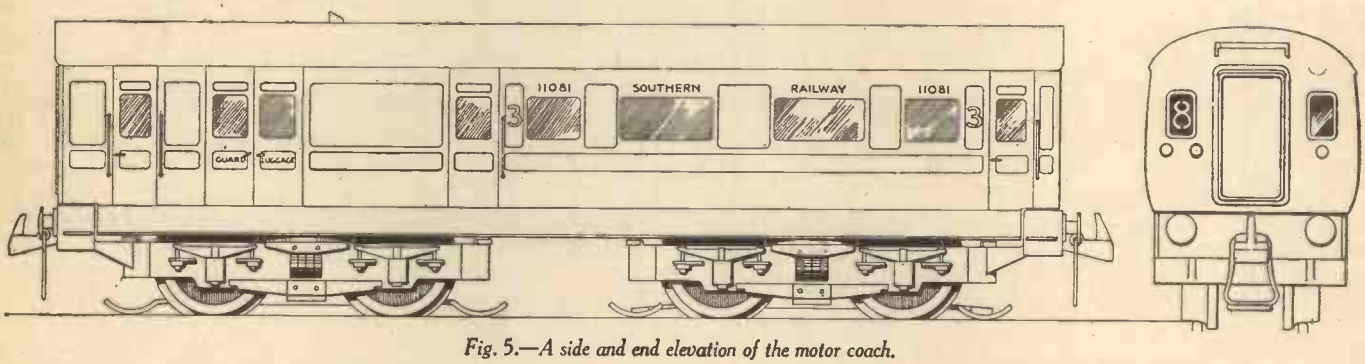


Fig. 5.—A side and end elevation of the motor coach.

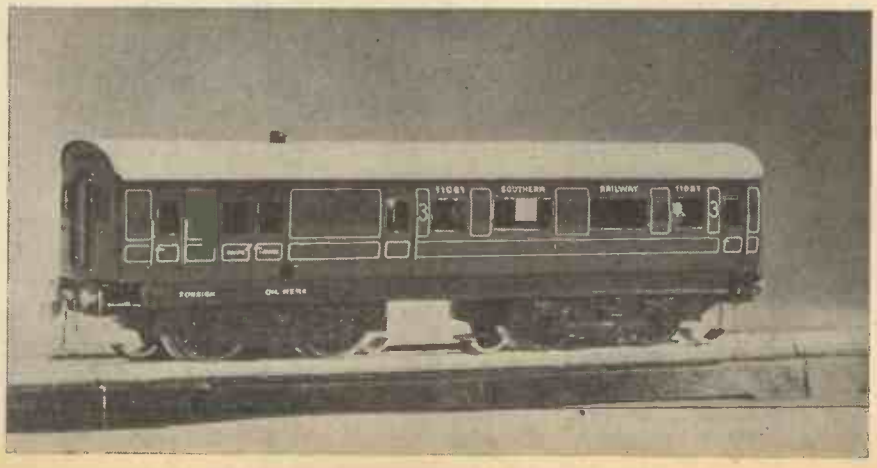


Fig. 6.—The Southern Railway T.T.R. motor coach.

(Left) : A view of the Jungfrau Railway and (right) the Pilatus Railway. *Illustration by courtesy of the Swiss Federal Railways.*

Some Swiss Mountain Railways

Travelling in Mountain Railways is a particularly Thrilling Experience for the Passengers. There are Two Main Types in Use, Both of which are Described Below.

THERE is no more spectacular achievement of the modern engineer, than the mountain railway, by which we can ascend in safety and comfort to the very summit of lofty mountains ; and no other form of travel offers such thrills to the passenger. I have travelled in aeroplanes, and also in an airship, but even when flying at a great height, there is far less thrill than I have experienced on the steeper sections of mountain railways, where the train slowly ascends an almost vertical rock wall, with perhaps a sheer drop of a mile if anything goes wrong. But nothing ever does, for mountain railways hold the record for safety, and the most nervous traveller has nothing to fear.

Two Main Types

There are two main types of mountain railway, the *rack and pinion*, and the *funicular*.

The first named consists of a track with three rails, the two at the sides are ordinary smooth lines for the wheels, but the centre one has a series of strong steel teeth, into which a cog wheel on the engine meshes, and so slowly winds the train up an incline almost as steep as a builder's ladder against a house. The steepest lines are usually built on the funicular principle, that is they are hauled by a steel cable. Frequently such lines consist of a double track, so that a pair of cars can work together, and the descending vehicle helps to draw the other up. These are fitted with a centre rail on which the brake works.

Another view of the Jungfrau Railway.

If the thin steel cable extending up the mountain above the car were to break, the automatic brake would instantly come into action, and it can hold the train at the steepest part of the line.

There is another form of funicular, used when only small cars are needed. This is an aerial rope-way, in which a steel cable is slung from the top to the bottom of the mountain on lofty brackets, and a small car is hauled up the cable by another rope.

The First Line

Swiss Engineers lead the world in the building of mountain railways, as is only natural. The first of such lines ever built was the Rigi line (there are now two). The line was completed in 1871, is 4¼ miles long, nearly six thousand feet altitude at the top, and an average gradient of 1 in 4. It is built on the rack and pinion system, and when first installed was hauled by steam engines. Nearly all the mountain railways now are electric, owing to the saving in weight, and the cheapness of power derived from waterfalls.

The success of the Rigi line was enormous,

and quite a mountain resort has developed at the summit of the mountain. The Rigi is one of the easiest mountains, the slopes being mainly grass, without the dizzy precipices found on many other peaks, but the superb views from the summit make it a very popular ascent.

Boom in Mountain Railways

The success of the Rigi line soon led to a boom in mountain railways, and more and more are being built. One of the most spectacular of the lesser mountains is Pilatus, which like the Rigi, is near Lucerne, and is well known to English tourists. To-day this mountain is ascended by thousands of jolly holiday makers every summer, but for centuries nobody dared to climb the accursed peak, which—legend averred—had been the grave of Pontius Pilate. The story goes that in despair Pilate committed suicide, but rivers into which the evil corpse was thrown rejected it. Finally it was taken up this mountain, and flung into a lake near the summit. If a stone were thrown into this lake, a frightful storm would arise, and once a year the wicked Procurator appeared in a scarlet robe upon a near-by rock. And so for centuries no one dared climb this wonderful peak, but in 1585 a brave Pastor did so, flung a stone into the lake, and dared Pilate to come forth. This exploded the legend, but it was not until the railway was built that tourists flocked to the top.

The line took two years to build, and was completed in 1888 by Locher of Zurich. The engineers who planned this daring line had to scale dizzy slopes of nearly vertical rock, and to use their instruments when slung by cradles from above.

The Jungfrau Line

The hardy mechanics who chiselled and blasted the rocks worked under conditions of great peril, which, of course, have been far exceeded by such later exploits as the Jungfrau line. But even on Pilatus, a single slip might mean death, a dropped tool, or a falling stone could sweep a man into the abyss and workers had to be roped on the more difficult stretches, though of course parts of this line were quite easy. It is built on the rack and pinion system, the *average* gradient is 38 per cent. and the maximum 48 per cent. The centre-toothed rail has vertical teeth on both sides, into which two pairs of toothed wheels attached to the train work horizontally; the summit of the line is almost seven thousand feet.

The Trubsee cable railway near Engleberg is a good example of this type of line. Two pairs of cables stretch from the top to the bottom of the mountain, and the cars are slung below the cable, and are hailed by another rope. The maximum gradient is about 68 per cent.

The Steepest Line

Probably the steepest line in Switzerland is the Ritom-Piora funicular, which ascends 2,145 feet in ⅞ of a mile, and has a maximum gradient of 87·8 per cent. This works on the double-car principle, the descending car helping to haul up the other. Cables are used for haulage the centre line seen in photo is for the brakes. Note the pressure pipes beside the line, which bring water from a high altitude to work the train. The photo of the little car well illustrates the principle on which the trains have to be built on steep lines. The seats are staggered one above another, like steps on a step ladder, if they were level—like the seats in an ordinary train—it would be impossible to keep one's seat.

A view of the Ritom-Piora line.

The Engleberg-Trubsee cable railway.

Two Remarkable Railways

The two most remarkable mountain railways in Switzerland are the Zermatt-Gornergrat, which is the highest open air railway in Europe; and the marvellous Jungfrau line whose summit is the highest station in Europe. These two lines are very useful to the ordinary tourist, because they enable non-athletic people to enjoy the glorious scenery of these lofty summits, which few could hope to reach afoot.

The Gornergrat is a rocky ridge of the Riffelberg, 10,290 feet high. It has long been famous as commanding perhaps the world's most impressive mountain view, a chain of snow mountains dominated by the matchless peak of the Matterhorn. The railway was finished in 1898. It is fitted with the Abt rack-and-pinion system, driven by electricity. The length is six miles, and the highest gradient 105. The journey takes 1¼ hours, which gives time to enjoy the scenery, and also for the human body to accustom itself to the vast change in atmospheric pressure. This prevents mountain sickness.

Into Eternal Snows

The Jungfrau Railway is the most amazing of all mountain lines, for it boldly ascends into the region of eternal snows, and culminates at the dizzy height of 11,340 feet that is more than three times as high as the loftiest peak of our own Snowdon.

Few mountain railways have involved such cost or trouble. It was commenced in 1897 by the eminent engineer Guyer-Zeller who died two years later. It was completed in 1912, and the cost reached the stupendous figure of £174,000 per mile—it is 5¾ miles in length.

At War with Nature

Throughout the work the engineers were verily at war with Nature in her sternest moods. Portions of the mountain are swept by avalanches of snow, and falling stones are a commonplace. The three upper stations, Eigerwand 9,405 ft., Eismeer 10,370 ft., and Jungfraujoch are actually blasted into the rock itself—no outside building would have been safe in that world of snow, ice and tempest. Several long stretches of the line are also tunnelled through the living rock, this is because a surface line would have been in continual peril from avalanches—huge masses of snow which sweep everything before them.

Perilous Conditions

The engineers who planned this line, and the hardy mechanics who executed the work, toiled under conditions of unimaginable peril. On the upper parts of the line weather conditions made work only possible during a few months of the year, and gales and snow were to be expected at any time. Workers were slung from cables with their feet dangling over infinity, while they hewed and blasted their way through the rugged flank of the mountain. The lower part is limestone, and the upper is composed of gneiss which is as hard as granite.

G.L.

J. L. McADAM—ROAD MAKER

The Man who First Demonstrated the Scientific Principle upon which Every Durable Road is made To-day

AT the beginning of the last century roads, as we know them to-day, did not exist in this country. Travel along the terrible tracks of the period was almost impossible during wet weather and during dry it was so hazardous that it was undertaken only when absolutely necessary. The country was composed of a number of isolated communities so that a man was looked upon as a foreigner in any district but his own. Thirty years later British roads were a shining example to the rest of the world.

This revolution was due to one man, who, though not an engineer by profession, first demonstrated the scientific principle upon which every durable road must be made. His name was John Loudon McAdam.

Roman Roads

When the Romans were recalled from this country they left behind them a network of great highways running all over the land. But they failed to teach the Britons the elements of engineering so that their thoroughfares immediately fell into a state of disrepair. Indeed the Roman roads have never been repaired to this day. In their place came rough winding tracks which could be traversed only on horseback. The social and material progress of Britain was retarded for fourteen centuries. Trade in tin, iron, lead, lime, cattle, pearls and oysters, exported in considerable quantities during Roman times, dwindled away. The mud of Knightsbridge, for instance, was so great that it defeated Wyatt's rebellion.

The highways ceased to be the concern of the Central Government but were left to the local parishes and Trusts. To obtain money for their upkeep, local authorities exacted tolls from the passers-by. Turnpikes sprang up all over the country which made travel very laborious and very expensive. The greater part of the money obtained from turnpikes went to the pockets of corrupt officials.

Such was the state of the roads in 1756, when McAdam was born. He came from an old Scottish family and spent his childhood days in Ayrshire where his father founded a bank. At a tender age he showed his interest in road construction by making a model of the route between two adjacent towns.

He Loses His Property

When John was fourteen his father died, so being the only son, he was sent to live with his uncle in New York. With the outbreak of the War of American Independence John McAdam joined up with the British forces and when peace came he, together with all the Loyalists, lost all his property. He decided that the best thing to do was to return to Scotland.

For fifteen years he lived in Ayrshire without showing any signs of the engineering genius which was to make his name famous the world over. But as he travelled about he gradually began to realise that what the country needed was some scientific method of road construction.

Although he had never been trained as an engineer McAdam began to experiment on

John Loudon McAdam.

materials. He soon formulated his basic principle of road construction upon which the foundation of every modern highway is built.

He reasoned that it was really the native soil which supported the weight of the traffic and that so long as it was drained and maintained in a dry state it would suffice for this purpose.

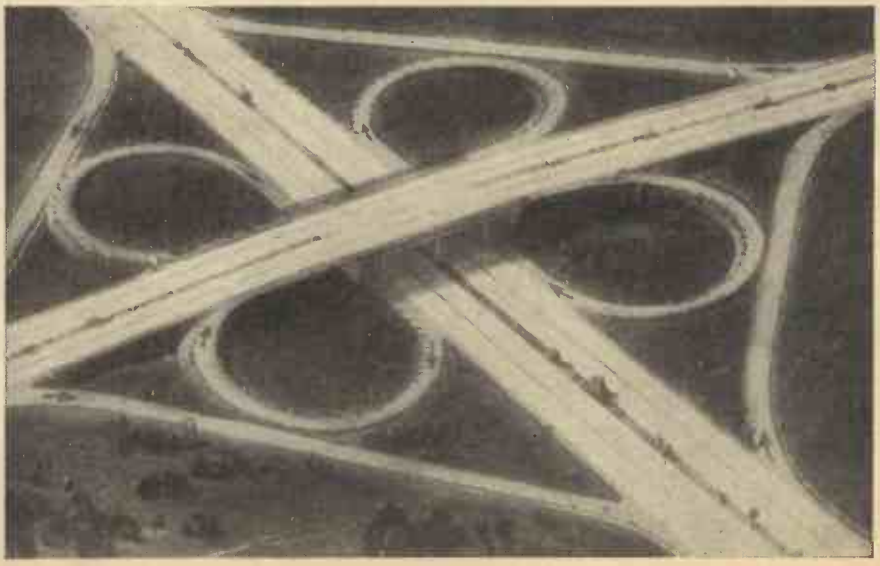
To do this he laid the foundation of his roads above the level of the adjacent ground instead of digging a trench as was the custom at the time. Over this was laid a layer of small stones about 6 in. thick.

An Amusing Story

McAdam was very emphatic as to the size of the stones for his roads and an amusing story is told on this theme. Before the introduction of the 2-in. measure McAdam used to tell the stonebreakers to try their mouths as a guide. If the stone would not go into the mouth it was too big. One day he was examining a stretch of road under construction when he found stones far exceeding the limits imposed. Turning to a workman he angrily accused him of laying the stones without testing them. The man stoutly denied the accusation and in support of this opened a mouth of extraordinary size completely devoid of teeth.

Under pressure of traffic the sharp angles of the stones united into a compact mass which kept the foundations absolutely free from water and frost which were the chief causes of the breaking up of the older roads.

The arrival of the motor vehicle and its rapid development as a means of transport was to prove the soundness of McAdam's system, though it brought the road engineer face to face with entirely new problems The first and perhaps most easily solved was the dust plague which quickly became most unbearable and detrimental to safety. In surmounting this particular danger highway authorities became widely acquainted with the possibilities of tar as a road material and at the same time were led to further discoveries of methods and materials which have since become of first rate importance It was found that the tar which so successfully laid the dust also had qualities of much greater significance. It possessed abilities to bind the stone



A modern road in Germany.

materials on the road with a power sufficient to withstand the ever-increasing strains and stresses which came as the numbers of the motor vehicles doubled and re-doubled. The demand for better and safer roads depended on its satisfaction for the further development of such materials and McAdam's own cry for arteries fit to cater for the great industrial life of the country was as nearly as possible satisfied.

His First Appointment

It was not until 1816 that McAdam got his first appointment as road engineer. He had been chosen as victualler of the Navy by the Government which necessitated his removal to Bristol. Here he managed to interest the leading merchants with his system of road improvement. Eventually the Bristol Municipality approved of his plans and invited him to take entire charge of the 146 miles of roads as General Surveyor.

When he was appointed, the roads in the district were as bad as any in the country and the Trust was heavily in debt. In eighteen months he was able to report that all his roads were in good condition, that he had reduced expenses, increased the income and had been able to pay off more than £2,000 of the road debt. Bristol roads soon became the best in the country and it was not long before a Petition was sent to Parliament pleading for macadamised roads throughout the Kingdom.

Others at Work

From that moment controversy began to rage round his name. There were other road builders at work. Telford, a trained engineer, insisted on a solid stone foundation and ridiculed McAdam's theory of an elastic soft base with a waterproof surface made with small stones.

London's streets were, at the time, quagmires of water and mud so that the public demand for better roads became urgent. When it was proposed that McAdam's process should be adopted a storm of protest arose. But experience eventually showed his theory was right.

Free of Charge

Within two years most of the main thoroughfares of the capital had been macadamised and it was not long before all the principal cities of the Kingdom had followed London's example. During this period McAdam worked incessantly for his cause, travelling all over the country in answer to the requests of numerous Trusts for aid and advice. For this he received no payment whatsoever. "My belief," he said, "is that if I had made it a money making speculation I should have strangled the business in its birth and my system never would have been introduced in the country at all."

A modern macadamised road surface composed of small stones welded together that the foundations are kept absolutely waterproof.

A typical example of the modern and tarmacadam road.

Refused a Knighthood

So exacting did his work become that he asked his three sons to aid him. Together the family laboured reconstructing roads, teaching others the new methods and brushing away old forms of mismanagement and corruption.

In 1823 a Select Committee of Parliament was appointed to consider the work done by McAdam for the country. Its decision was a triumph for him, but the opposition to his methods of trained engineers was still so strong that it was only after considerable controversy that the recommendations were passed by Parliament. As a recognition of his services to the country McAdam was voted a grant of £2,000. A few years later he refused an offer of knighthood on the pretext that he was too old. Instead it was bestowed on one of his sons.

His Work Completed

In 1825, his work completed, John Loudon McAdam retired from public service to live in Hertfordshire till his death in 1836. During this time he took a lively interest in the progress of the roads and watched with satisfaction the rapid increase in the coach traffic which contributed in no small way to the position Britain attained in the world's commerce during the nineteenth century.

G. M. Trevelyan summed up McAdam's work when he said, "Had it not been for his roads the industrial revolution could not possibly have taken place, for there would have been no means of transport to the new markets that were indispensable to its increased production."

"Tips for Turners," by W. W. Watson. 79 pages. Published by The Manual Press, price 2/6.

This is a new and up-to-date workshop manual for mechanics, giving, not only useful working data and tables, but many practical hints supplied by mechanics as a result of actual practical experience. Hints on adjusting the lathe, taper boring, face-plate and angle-plate work, reading a micrometer, screw-thread systems, four-jaw and self-centring chucks, bonus systems, and tool grinding are only a few of the subjects covered in this handy volume. It is complete with a stiff cover and should find a place in every mechanic's workshop.

Technical Books on Every Subject.

EVERY engineer and model maker has heard of the "Model Engineer" series of handbooks. These cover almost every practical subject from Railway Modelling, Microscopes, Motor Boating, Model Ships, Metal Turning, Electricity, Dynamos, Workshop Facts and Figures, Model Aeroplanes, Motoring, Motor Cycling, Aviation, Screw-cutting, Sheet Metalwork, Boiler Making, Fitting, Steam Engines, to Hardening and Tempering, Model Boats, Model Sailing Ships, Power Engineering, Accumulators, Electric Bells and Alarms, Telephones and Microphones, Electrical Working Models, Mechanical Working Models, Induction Coils, Scientific Experiments, The Locomotive, X-Rays, Patents, Gas and Oil Engines, Photography, Chemistry, Windmills and Wind Motors, Wireless Telegraphy, Magnetos, Milling, Gear Wheels, Clock Repairing, Watch Repairing, Small Transformers, etc., etc.

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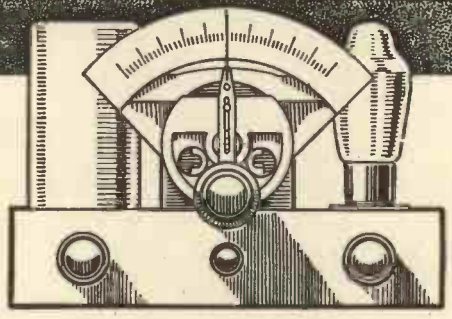
For example, some recent titles are: *Workshop Facts and Figures*, 1*s.* 6*d.*; *Engineering Mathematics Simply Explained*, 2*s.* 6*d.*; *Practical Lessons in Metal Turning*, 3*s.*; *Electrical Measuring Instruments*, 2*s.* 6*d.*; *Railway Modelling in Miniature*, 3*s.* 6*d.*; *Shops, Shed and Road*, 5*s.*; *Planning and Layout*, 1*s.*; *Signals and Signalling*, 1*s.*; *The Beginner's Guide to the Microscope*, 2*s.*; *Microscope Slide Making*, 1*s.* 6*d.*; *Every Boy's Book of Electricity*, 1*s.*; *Everybody's Book of Aeroplanes*, 1*s.* 6*d.*; *Britain's Fighting Fleets*, 2*s.* 6*d.*; *English Warships in the Days of Sail*, 3*s.* 6*d.*; *Motor Boating for All*, 2*s.*; *Boat Building Materials and Methods*, 5*s.*; *Model Steamers and Motor Boats*, 1*s.* 6*d.*, etc., etc. (Postage extra.) Percival Marshall & Co., Ltd., also have a large list of Blue Prints of model locomotives, model ships, etc. *Wonderful Models* is a complete encyclopædia on all branches of model making. They cost 25*s.* per set of two volumes. A complete list of titles is available free from the address given.

The PRACTICAL MECHANICS

WIRELESS EXPERIMENTER



THE P.M. CRYSTAL RECEIVER

Details of an Easy-to-build Crystal Receiver which has been Designed to Suit the Requirements of the Modern Listener.

ALTHOUGH the crystal receiver is often regarded with scorn by the listener with a powerful multi-valve receiver, it has a definite field of utility, and, in fact, to many listeners it offers the only form of providing entertainment from the broadcast programmes.

A Stand-by Apparatus

But it may also be used by the listener as a stand-by apparatus for use, for instance, whilst an accumulator is being charged, or whilst a receiver is being modified. Further, it is the most satisfactory receiver to be constructed by the beginner, as it will lead the way to larger receivers and enables all of the elementary principles to be grasped slowly. The old tag concerning the necessity of learning to walk before you try to run is very applicable to radio, and many constructors fail to make a satisfactory job of constructing a large receiver, simply because they have not commenced in a simple way. Primarily, the crystal set is a very simple piece of apparatus, consisting merely of a tuned circuit and a crystal detector, the latter being joined in series with a pair of 'phones across the tuned circuit. But in such a form several difficulties would arise under modern conditions. The high power of the modern B.B.C. stations, coupled with the fact that there are, in most districts, two such stations, renders it necessary to provide a fair degree of selectivity, but as is now well known, as soon as selectivity is introduced, sensitivity automatically disappears.

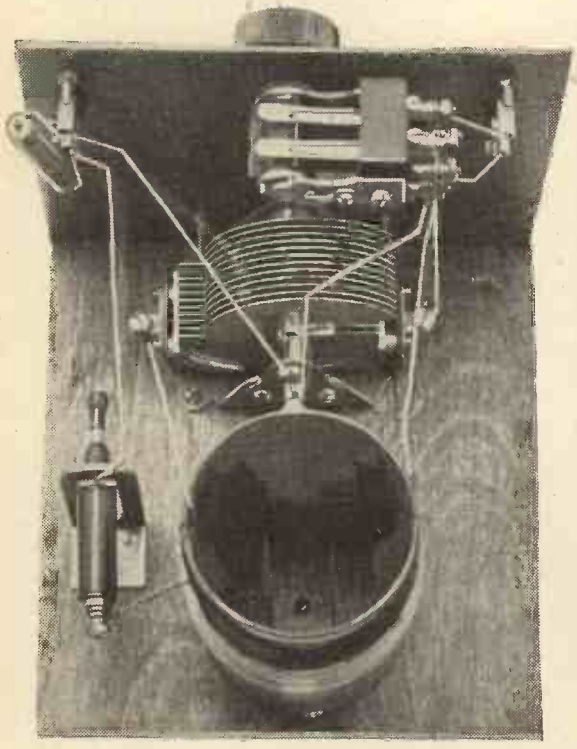


Fig. 1.—A plan view of the finished receiver, to assist in wiring.

The Circuit

Consequently, a compromise has to be adopted, and in a simple set such as a crystal receiver it is rather difficult to introduce such a compromise. After considering the results obtained with ordinary receivers in various districts, and analysing the various requirements of listeners who write to us on this subject, we decided that a form of "adaptable" circuit would provide the most satisfactory solution to the crystal set problem. It is not satisfactory to design a standard arrangement and say that it will suit every listener in the country.

Reception Conditions

Reception conditions vary in every locality, and there are no benefits such as reaction which we can include in the circuit to make up for losses or to sharpen up the

Fig. 2. — A three-quarter rear view of the receiver, showing the simple construction and wiring.

tuning. The circuit finally adopted is shown in Fig. 6, and it will be noted that two of the components are shown in dotted lines. The reason for this will be given later, but it will be noted that a coil made up of three separate windings is employed, and that a tuning condenser is joined right across it. The crystal is tapped to a point a short distance from the high-potential end of the coil, and this has the effect of removing the damping exerted on the circuit and gives a slight increase in the sharpness of tuning. The wave-change switch is of the double-pole double-throw type, and carries out two functions.

The Wave-change Switch

In the simplest form all that is necessary to change from medium to long waves is to short-circuit part of the tuning coil, but the same degree of selectivity is not required on the long waves as is needed on the medium waves, and thus it is an advantage to be able to modify the aerial connection when changing wavelengths. It will be seen in this circuit that when in the medium-wave position the aerial is joined direct to the top or high-potential end of the coil (ignoring the dotted condenser), whereas when switched over to long waves, the aerial is transferred to a point much lower down on the coil. If any doubt exists as to the advantage of this, the aerial should be removed from the aerial socket and connected direct to the top of the coil in the long-wave position. It will be noted that a coil is shown in dotted lines joined between the aerial contact for the long-wave position and the tapping on the coil, and this is a special anti-breakthrough choke which will be found invaluable to those listeners who are situated close to a medium-wave broadcast station.

1937 CRYSTAL RECEIVER LIST OF COMPONENTS

One Paxolin Panel, 6 in. by 6 in (Peto-Scott).
One Wooden Baseboard, 6 in. by 6 in. by ⅜ in. (Peto-Scott).
One Paxolin Former, 2½ in. by 4 in. (Peto-Scott).
One Formo Slow-motion Condenser with Mystic Dial, type SU.5 (Formo Products, Ltd.).
One Red-Diamond Crystal Detector (Jewel Pen Company).
One Component-mounting Bracket (B.T.S.).
One Double-pole Change-over Switch, type I.23 (Wright and Weaire).
Two Terminal Socket Strips (Belling-Lee).
One ·001 mfd. Tubular Condenser (T.C.C.).
Quantity 22 D.C.C. Wire, Screws, four 4BA Bolts and Nuts.
The following additional components are required in some districts, as mentioned in the text:
One ·0002 mfd. Preset Condenser (Formo Products, Ltd.),
One Anti-breakthrough Choke (constructional details given in the text).

Separating Two Stations

The condenser shown in dotted lines is also of value to listeners in a similar position as it may be adjusted to separate the two local stations when a large aerial is employed. Therefore, the receiver should be first made up, ignoring these two components, and if it is found in your particular case that the two locals are heard together, the pre-set condenser should be included between the switch and the top of the coil. Similarly, if when switched over to long waves the medium-wave station can be heard in the background, the special choke should be placed in circuit as shown in the wiring diagram.

Constructing the Receiver

The construction is exceedingly simple, and the components have been selected so that no soldering is called for, and thus the set may be made up with only a penknife and screwdriver. The panel and baseboard both measure 6 in. by 6 in., and the former is of paxolin. Ordinary three-ply wood may be used for the baseboard, but a thickness of about ⅜ in. is desirable in order

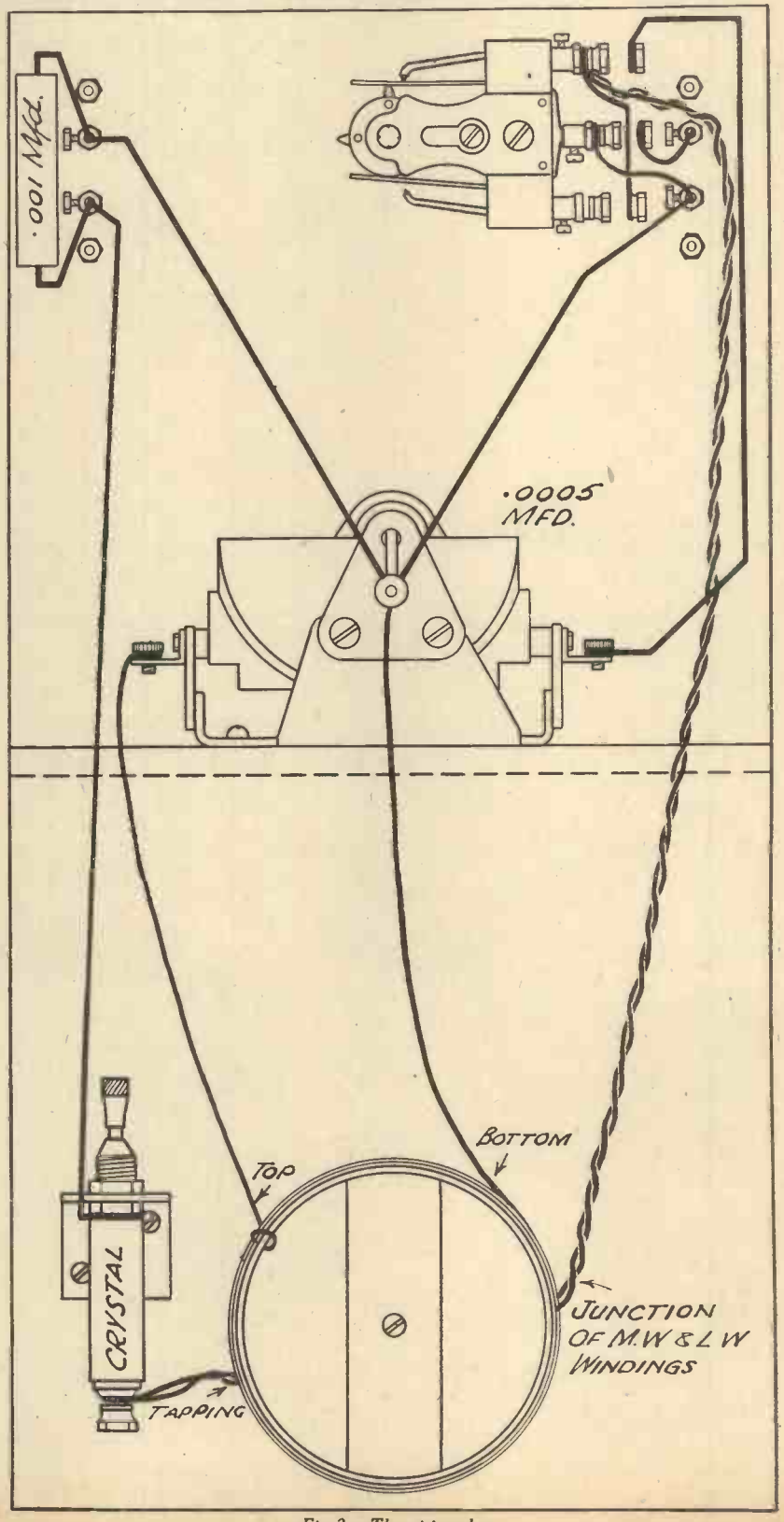


Fig. 3.—The wiring plan.

that the panel may be firmly screwed to the front edge. The panel may be drilled by following the measurements and details given in Fig. 5, and the switch and terminal sockets should be attached. The variable condenser is screwed to the baseboard, and the correct position may be marked off from the wiring diagram, or it may be placed upon the baseboard and the panel held in position whilst the condenser is slid forward until the mounting bush comes into the correct position. The holes should then be marked with a pencil and the panel removed whilst the condenser is screwed down. Follow the maker's instructions regarding the mounting of the special slow-motion drive and scale.

Winding the Coil

The coil is wound on a length of paxolin tubing measuring 2½ in. in diameter and 4 in. in length. Two small holes should be pierced at the upper edge and the end of the wire passed through, leaving a length of 5 in. projecting for connection to the variable condenser. Wind on 8 turns and then make a large loop—about 2 in. in length, and in the position shown in the diagram of the coil. Continue the winding for another 32 turns, and cut the wire so that when passed through a further pair of holes there will be approximately 5 in. left. About ¼ in. from this end of the coil make another pair of holes and pass the end of the wire through again, leaving a further 5 in. for connection, and then wind on the wire, hank fashion, for 80 turns, after which let the wire pass across the former for a quarter of an inch or so and wind a similar hank winding of the same number of turns. This will give you a grand total of 200 turns of wire, the lower two piles forming the long-wave loading coil. The coil is mounted by screwing a strip of wood inside the lower end. Alternatively, a disc may be cut from plywood for the purpose.

Wiring the Receiver

Now note carefully, when ends of the coils are connected to the respective points, and if the condenser and choke are to be left out, the end of the first coil and the commencement of the first of the two pile windings should be twisted together and taken to the switch. If the choke is to be included, it should be joined between the two switch contacts as shown. Note that the end of the complete coil is joined both to the variable condenser and to the switch, and the one length of wire may be used, scraping away the cotton covering for the purpose. The small fixed condenser is joined across the 'phone terminals, and the crystal detector mounted on the component-mounting bracket. The loop of wire in the first part of the coil should be scraped and passed over the end of the detector and locked beneath the terminal nut, whilst the lead from the detector to the 'phone terminals is anchored between the component mounting bracket and the locking nut on the detector.

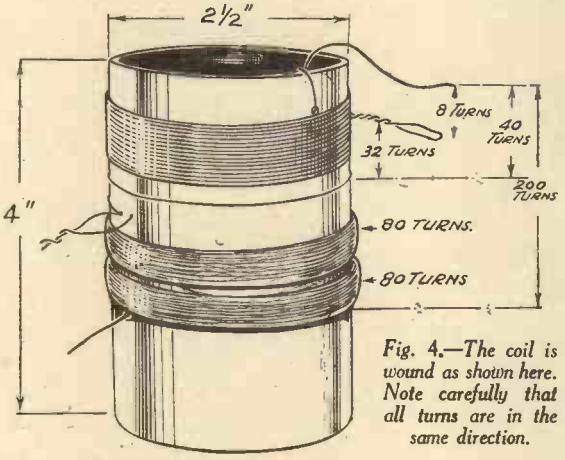


Fig. 4.—The coil is wound as shown here. Note carefully that all turns are in the same direction.

The Special Choke

If the anti-breakthrough choke is found necessary, it may easily be constructed from the same wire as is used for winding the coil. Cut a disc of plywood about ¼ in. thick and about 1 in. in diameter, and two discs of similar wood 1½ in. in diameter. Screw these together to form a spool and drill a hole through one disc near the edge of the centre piece. Anchor the wire in this hole and wind 150 turns of wire in the spool, afterwards anchoring the end of the wire through a further hole or by wrapping a piece of ordinary tape round the coil of wire and tying a knot.

The aerial should be provided with a plug and inserted into the aerial terminals, whilst the earth should similarly be connected. The 'phones are plugged into the right-hand pair of sockets. The condenser dial should be turned to tune in the desired station, and the small control knob on the detector should be pulled out, turned and gently released when adjusting the detector. On no account turn this without pulling it out, as by so doing you will spoil the surface of the detector and it will soon need replacing. The particular type of detector used will be found sensitive in practically every position, although it is worth while trying to find the most sensitive spot.

An Efficient Aerial

The aerial should, of course, be as efficient as possible, and in this connection height is the most important factor. The insulation of each end should be carefully carried out, by using two or three of the egg-type insulators, and the leading-in wire should be brought down well clear of the house walls, guttering, pipes and other earthed bodies. Similarly the earth should be as efficient as possible, and a good sound connection to a main water-pipe, through the medium of a standard type earth clip, will be found as good as any. A buried plate or connection to one of the proprietary earths such as the Graham Farish "Filt" may also be highly recommended.

For the Beginner

If this is your first receiver, it is worth while examining the arrangement of the parts and studying the relation between the theoretical symbols in the circuit diagram and the practical interpretation in the wiring diagram.

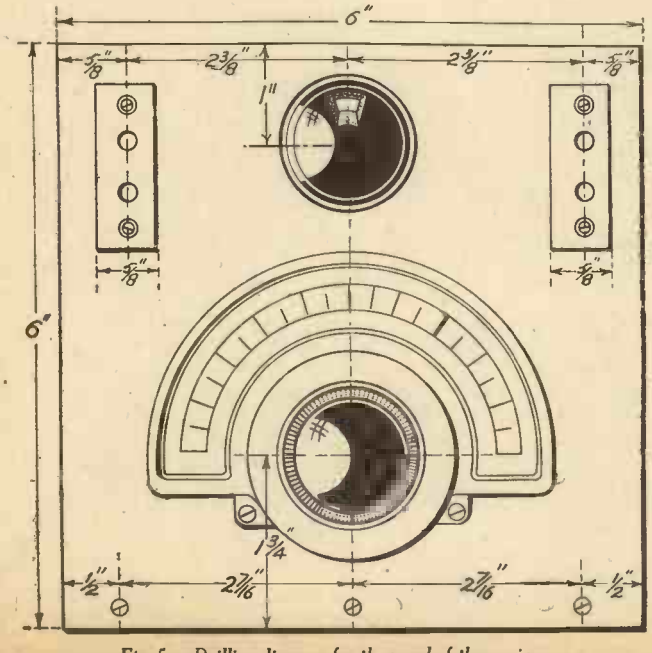


Fig. 5.—Drilling diagram for the panel of the receiver.

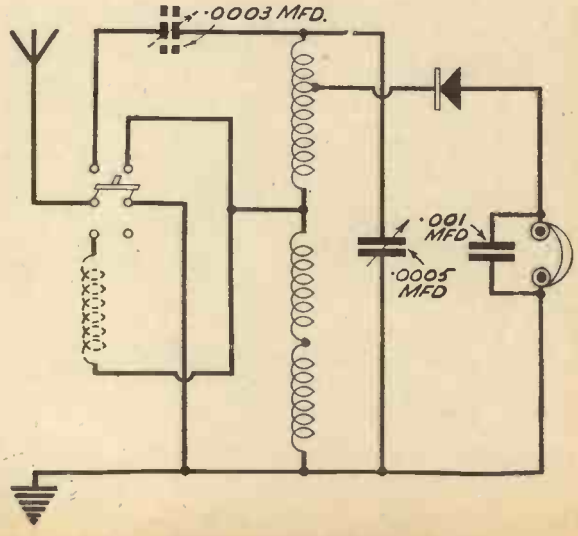


Fig. 6.—Circuit employed in the crystal receiver.

A Pendulum Harmonograph

A Device for Producing Complicated Curves, the Repetition of which make Attractive Patterns

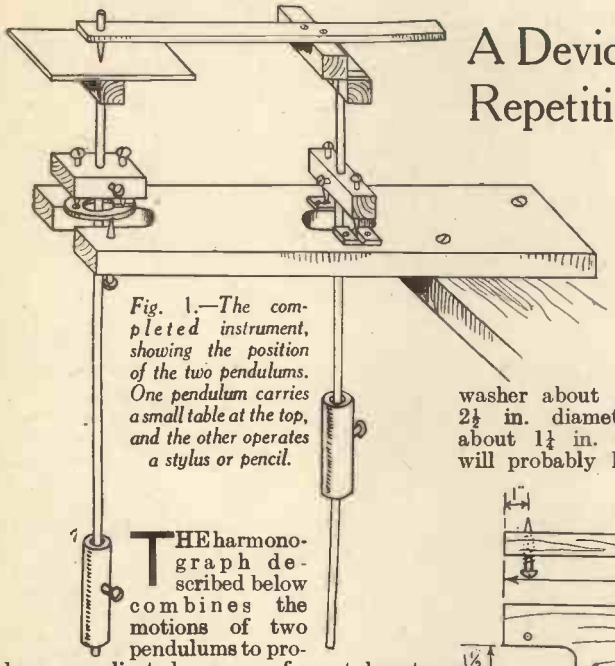


Fig. 1.—The completed instrument, showing the position of the two pendulums. One pendulum carries a small table at the top, and the other operates a stylus or pencil.

THE harmonograph described below combines the motions of two pendulums to produce complicated curves of great beauty and regularity, and the autogmatic repetition of these curves makes marvellous patterns. The number of different patterns that can be produced is incalculable, in fact, it is in practice, impossible to get two alike. The apparatus is quite simple to make and it is most fascinating to watch a pattern such as those illustrated herewith growing quite quickly before one's eyes; the illustrations each took about one minute to produce, and though it seems almost incredible at first sight, each of them is made by one continuous line.

The Designs

The complete instrument is shown in Fig. 1. The pendulum carrying the small table at its top end is mounted on gimbal bearings which allow it to move in any direction, so that it is able to swing in circles, ellipses, or straight lines. The second pendulum operates a pencil or stylus on the end of a hinged arm, and moves to and fro in a straight line only, just like a clock pendulum.

Commence construction by making the base board as shown in Fig. 2. It is intended that this should be screwed on to a firm table or bench, but be sure that there is no "ricketiness" about the support or the results obtained will probably show wobbly, irregular lines. Screw clamps can be used if it is not permissible to put screws into the bench or table. The two points are supports for the gimbal ring—they are ordinary wood screws with a few threads filed off and the remaining part filed to a nice point. Two small iron plates about $\frac{1}{8}$ in. thick are screwed down one on each side of the elongated hole, to carry the pencil pendulum; one plate is recessed with the point of a drill and the other has a V-groove filed across it.

The Gimbal Ring

This is simply an iron washer about $\frac{1}{8}$ in. thick and 2 in. to $2\frac{1}{2}$ in. diameter—the hole should be about $1\frac{1}{4}$ in. to $1\frac{1}{2}$ in. diameter; you will probably have to file the hole out if you use a standard washer. Make a recess with the point of a drill and diametrically opposite to the recess file a V-groove. Then turn the ring over and do the same on the other side, but be sure to make the groove and recess on one side on a line at right angles to those on the other (see Fig. 3). Do not try and make a knife-edge bearing for the gimbal, the arrangement described is much simpler and better—unless the knife-edge bearing is made with great accuracy.

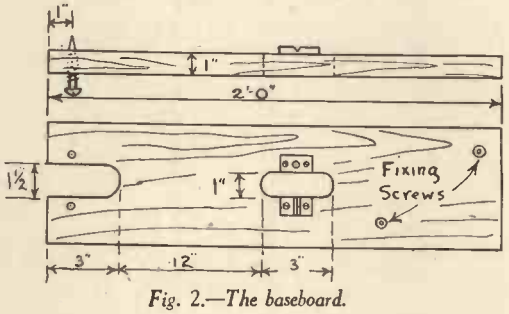


Fig. 2.—The baseboard.

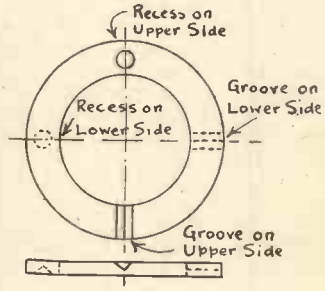


Fig. 3.—The gimbal ring.

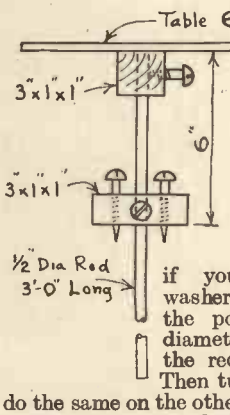


Fig. 4.—The weighted pendulum.

The Pendulum

It is all made of wood except the weight, which is simply a length of very stout lead pipe weighing about $1\frac{1}{2}$ lb., fixed with a single wood screw (see Fig. 4). If you find it more convenient to use any other form of weight make sure that it is rigidly attached to the pendulum rod; if it can wobble about it will probably spoil the results.

The pencil pendulum is shown in Fig. 5. The arm for the pencil may be attached by a couple of small brass hinges if you prefer it, but the paper or tape hinges shown will probably give better results as they are almost frictionless and free from rattle.

The apparatus can now be assembled for trial. Put the pencil pendulum weight about half-way up the rod, and the other weight at the bottom to commence, and try any other positions you like after. You can make a few trials with pencil and paper first, using a fine pointed pencil; adjust the pressure on the pencil by arranging a small weight on the arm—putting it on one side of the fulcrum will, of course, increase the pressure and on the other side will reduce it. Set the pendulums swinging, drop the pencil on to the paper gently and watch results.

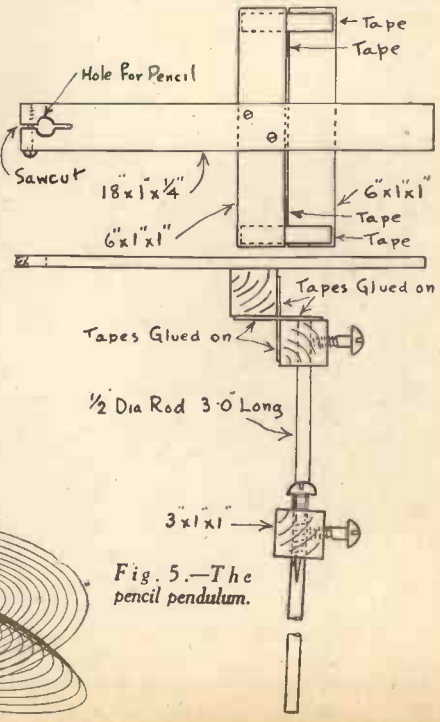
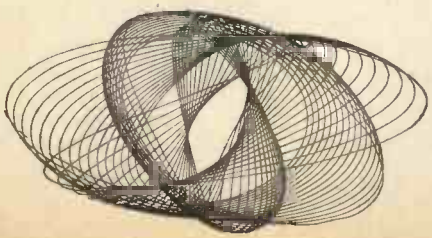


Fig. 5.—The pencil pendulum.



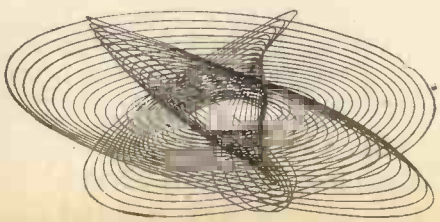
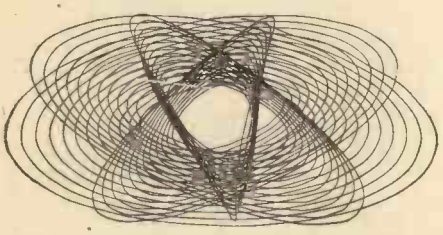


Fig. 6.—The designs shown here were made with a pendulum harmonograph.

Smoked Glass for the Designs

Although pencil and paper are suggested for a trial, far better results can be obtained by using glass smoked in the flame of a candle, the line being scratched with the point of a needle. The needle should be pushed eye-end first into a piece of wood equal in size to a pencil, allowing only, about ¼ in. of point to protrude. The illustrations to this article were produced in this manner, and photographic prints were then made from the smoked glass

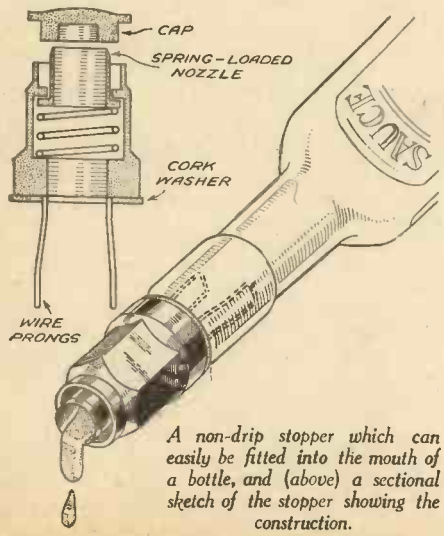


A further design made by a pendulum harmonograph.

diagram, which was used like a negative in an enlarger. Although the illustrations are thicked up somewhat in reproduction, they are still much finer than can be obtained with a pencil. The needle, too, causes much less friction than a pencil, for the slightest pressure is sufficient for the needle while that on the pencil is considerable and this causes the pendulums to die down quicker.

A Non-drip Bottle Stopper

THE novel stopper shown below, which can be fitted firmly into the mouth of a sauce bottle by means of two prongs, is capable of returning the drips back into the bottle, thus keeping the outside clean. This is particularly advantageous, as the top of a sauce bottle generally presents an unwholesome appearance after it has been in use over a short period. As will be seen, when the top of the stopper is removed, a spring causes a nozzle to project past the rim of the stopper, and any drips, instead of running down the outside of the bottle, run down the nozzle and so back into the bottle when it is stood upright. The device costs 1*s.* 6*d.* post free, and is obtainable from H. L. Joelson, 86 Ealing Village, London, W.5. Please mention PRACTICAL MECHANICS when ordering.



A non-drip stopper which can easily be fitted into the mouth of a bottle, and (above) a sectional sketch of the stopper showing the construction.

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 423. Send your queries to the Editor, PRACTICAL MECHANICS, Geo. Newnes Ltd., Tower House, Southampton Street, Strand, London, W.C.2.

FINGERPRINT POWDER

"WOULD you kindly tell me the name of the powder used for bringing out fingerprints on articles?

"Is there any substance that readily dissolves phosphorus oxide fumes other than water, which is too slow?

"Can formic acid be obtained from nettle leaves? If so, how?" (P. C., Surrey.)

1. THE best powder for fingerprint determination is *lycopodium powder*, an inflammable yellow powder which consists of the spores of certain fungi. Gamboge powder may also be used and, at times, the very finest air-blown talc powder.

2. There is no greater solvent of phosphorus oxide fumes than *hot* water. The white fumes of burning phosphorus are for the most part composed of phosphorus pentoxide (P_2O_5) and this compound is exceedingly soluble in water.

3. Yes, formic acid can be prepared from nettle leaves, although the process is tedious and the yield is small. Macerate a large quantity of nettle leaves with hot water and finally distil the mixture. A weak solution of formic acid will distil over. It cannot very well be concentrated by evaporation because the boiling point of the pure formic acid (101° C.) is too close to that of water. You may, however, be able to prepare the pure acid from the weak solution by boiling up the latter with a quantity of litharge (lead oxide) until the litharge ceases to be dissolved. Filter the liquid and then concentrate it to a very small bulk by boiling. Lead formate will crystallise out. These crystals should be collected and placed in a bulb tube through which dry hydrogen sulphide gas is passed, a small amount of heat being applied to the lead formate crystals in the bulb. By the interaction of the hydrogen sulphide gas, and the warmed lead formate crystals, black lead sulphide will be formed and pure formic acid will be liberated. The latter will be driven off by the heat and can be condensed in a tube cooled in ice-water.

A QUICK-BOILING KETTLE

"I HAVE designed and made a quick-boiling kettle as per the enclosed sketch. Do you think I could patent this idea, or register the design?

"I made the model in copper, tinning the inside with ordinary tinman's solder. Do you think this is perfectly safe to use in a district where the water is soft? The local water is obtained from the Severn, being filtered through sand beds and slightly chlorinated. It occurred to me that if the water was slightly acid there might be a risk of small quantities of lead being dissolved, especially in view of the large surface exposed." (H. E. M., Worcester.)

THE improved quick-boiling kettle, if novel, is fit subject matter for protection by Letters Patent. You are advised to make a search amongst prior patent specifications for kettles, before incurring any cost in protecting the invention. The idea of utilising the spout of a kettle for filling and emptying, is known to be old, and it is also thought that the broad idea of employing internal fire tubes is also old.

The exact exterior shape of the kettle, if not previously registered, could be registered as a design, but such registration would not give any protection to the particular interior construction.

It is not advisable to employ any lead-lined receptacle for boiling soft water for potable purposes. In ordinary solder, lead is usually the preponderating constituent, it would therefore be advisable to employ only pure tin as a coating.

ELECTRIC LIGHT GLOBES

"I WISH to make electric light globes square in design, incorporating a pattern in relief, and propose to cast or mould them with a white finish. Can you tell me if whiting or powdered chalk mixed with stucco will give a white effect or will I need potter's clay. Perhaps you will know of some other cheap mixture which I can make up for moulding." (A. C., Glasgow, S.W.1.)

WE are not perfectly clear from your letter as to the exact type of moulding which you propose to employ. If you are using a heat-moulding, you cannot employ chalk as a whitening agent, since it changes in composition under the influence of heat. Whiting, however, would be quite adaptable, as, also, would be magnesium oxide. Powdered alum and/or aluminium oxide could also be used as white pigments. The admixture of potter's clay into your moulding composition will give a greater binding effect, but if its proportion in the mixture is too great the material will be apt to be "grainy" and even to crumble.

PROTECTING A TRANSFORMER

"I HAVE recently bought a 3 amp, 9 volt transformer for use on a gauge 0 railway. Can you tell me how to protect the transformer from short-circuits? I have tried fuses, but they are not suitable as they have to be changed so frequently.

"Would a cut-out be of any use—if so can you explain the construction?

"Can you give me the name of a firm who can supply a cheap ammeter which will serve my purpose?" (J. P., Ludlow.)

THE only satisfactory way to protect the transformer in the case of short circuits on the model railway track is to instal a cut-out. Such a cut-out was described in the article by Mr. E. W. Twining in PRACTICAL MECHANICS for March, 1936, on pages 352 and 354. See also diagram No. 4 in Fig. 3.

As will be seen it consists of a solenoid, i.e. a coil having a sliding core, the coil being in the main supply circuit and the core actuating a break switch which must be restored to normal position by hand after it has come into operation.

WEATHER RECORDS

"PLEASE could you inform me on the following, as I am shortly undergoing a test for a weatherman badge for scouts.

"1. The wettest month on record?

"2. The wettest day on record?

"3. The extremes of temperature recorded, and dates?

"I wish these records to apply to the Reigate borough, or failing this, for London." (R. M., Surrey.)

ACCORDING to the Meteorological Office the following are the records required.

Wettest month, June 1903. 183 mm.

Wettest day, June 28th, 1906. 60 mm.

Maximum temperature, August 9th, 1911. 94° Farenheit.

Minimum temperature, January 17th, 1881. 9° Farenheit.

The foregoing are for Kew Observatory, London. Period 1870—1936. Similar data for Reigate is not available.

COMETS

"I AM very interested in the branch of astronomy dealing with comets, and would like information on the following questions.

"1. Out of the 79 comets observed during the period before Christ, the orbits of four were calculated, namely, those of 370 B.C., 136 B.C., 68 B.C. and 11 B.C., and of these four, only one was identified, that of Halley's comet on its return in 11 B.C. As the book which contains this information was written in 1889, I thought that perhaps during later years, more orbits of these 79 comets may have been calculated. If this is so, will you give me the date(s) of their appearance(s) and if they have been proved to be apparitions of other comets?

"2. Will you give me the name of a good up-to-date text-book dealing with cometary astronomy, also the name and address of the publisher, together with any other details needed in order to purchase the same?" (L. C., Walworth, S.E.17.)

NONE of the latest works on general astronomy refer to the returns of any of the pre-Christian era comets mentioned, except that of 11 B.C. (or 12), known as Halley's. Identification of even this one was probably a matter of working backwards. Observations of comets in those ignorant times were too vague to admit of accurate determinations of their orbits and periods.

We do not know of a book devoted entirely to comets. Most of those on general astronomy give a section to the subject. For *advanced* mathematicians there is *The Calculation of the Orbits of Asteroids and Comets*, by Prof. R. P. Williams. (Principia Press Inc., Bloomington, Indiana). Price in this country, 15*s*.

COLOURED LAMPS

"CAN you please give me the formula for making coloured lamp lacquer both transparent and translucent as is used on the colour-sprayed lamps made by several electric lamp firms? I require the transparent lacquer for lamps for indirect lighting and the translucent lacquer for lamps for direct lighting, the lamps I propose coating being the small 'fairy lights' used for decorating Christmas trees, etc.

"I have had a number of these sets in

use, and find that whilst the filaments are very robust, the colours very soon bleach out of the lacquer." (P. L. P., near Leeds.)

YOU will be able to obtain the effects you desire quite easily by preparing a thin solution of celluloid in a mixture of approximately equal parts of acetone and amyl (or butyl) acetate, and by adding to the clear solution a few grains of an acetone-soluble dyestuff. In order to obtain a translucent effect, the proportion of acetone in the varnish should be increased and a quantity of ester gum dissolved in the liquid. The precise quantity of ester gum to be dissolved depends entirely upon the intensity of the translucent effect required.

All the chemicals above mentioned may be obtained retail from Messrs. A. Boake, Roberts & Co., Ltd., Stratford, London, E.15.

SELENIUM CELLS

"IN the March (1934) issue of 'Practical Mechanics' you gave details of the construction of selenium cells, particularly of the condenser type. The sizes you gave were rather small and I was wondering if it is permissible to use plates and mica of larger sizes and thicknesses. Alternatively, could I use a sheet of mica clamped between two supports and coated with selenium in place of the condenser? I have facilities for sealing this electrode in a partial vacuum, so am wondering if this would be an advantage or disadvantage to its working.

"My idea is to use this selenium cell for measurements of colorometric chemical tests. Do you think that the idea is feasible, using selenium in place of photo-electric cells, as the response to light need not necessarily be instantaneous as sensitive. A sketch is enclosed." (E. F., Cardiff.)

THE selenium cell which you propose to construct will probably function satisfactorily, provided that you obtain the selenium in the "grey" sensitive condition, but the cell would be rendered more sensitive if it consisted of a number of fine copper wires, wound in parallel formation over the mica sheet, the wires being clamped at one end of the cell. Such wires should be about $\frac{1}{16}$-inch apart and the entire surface of the cell (wires and mica) should be covered with a thin coat of the selenium. This, particularly in a partial vacuum—which will prevent atmospheric contamination of the sensitive selenium—should be particularly effective, provided that the well-known selenium "time lag" is of no consequence in your work.

The principle of colorometric chemical tests by means of selenium cells is an old one, having been experimented with before the war. Nevertheless, there is ample scope for research in this direction.

Plates of mica having larger dimensions than those given in PRACTICAL MECHANICS for March, 1934, may, of course, be employed, but with little or no real advantage. In a condenser type of cell, it is essential to keep the plates as thin as practicable.

Your circuit sketch is incorrect. A selenium cell requires a direct current across it and the current must be of steady, constant voltage which, usually is under 60 volts. Such a current is best supplied by means of a H.T. battery.

CHEMISTRY

"COULD you give me some information regarding the following:—

"1. What is the action of hydrochloric acid on bleaching powder? Please give equation.

"2. Why does hydrochloric acid fume in moist air?

"3. Is the acid any stronger than nitric acid?

"4. Which halogen is the most active?" (J. W., Newcastle 4).

(1) WHEN acted upon by hydrochloric acid of medium strength, chlorine is evolved and calcium chloride is left in solution:—

$$Ca(OCl)Cl_2 + 2HCl = CaCl_2 + H_2O + Cl_2.$$

If, however, a bleaching powder solution is treated with very dilute hydrochloric acid, hypochlorous acid is first formed and this eventually reacts with any excess of the hydrochloric acid to form water and chlorine:—

$$Ca(OCl)_2 + 2HCl = CaCl_2 + 2HClO$$

(Hypochlorous acid)

$$HClO + HCl = H_2O + Cl_2.$$

2. Hydrochloric acid fumes in moist air because its vapour, as it were, dissolves in the moisture of the air and thus renders itself visible. These fumes consist of minute globules of hydrochloric acid solution.

3. Pure hydrochloric acid solution is somewhat "stronger" than nitric acid, yet nitric acid is a powerful oxidising agent, and this property, combined with its great acidity, makes it, in many instances, a more corrosive liquid than hydrochloric acid solution.

4. Fluorine, a pale yellow gas, is by far the most active member of the halogens. It is, indeed, the most active of all the elements.

ROCKET PROPULSION

"I WOULD be extremely grateful to you if you could inform me of the clause in the Explosive Act of 1875, which prohibits the use of liquid fuels in rocket experimentation.

"Liquid oxygen is obtainable at 7s. 6d. per litre. Do you think liquid air will be cheaper than this?

"Re the powder-fuels mentioned in the December issue of your paper. Does this fuel need compressing? I have made several experiments with it and with mixtures using more potassium chlorate, but I do not seem to be able to get any propulsive force. The enclosed sketch shows the proportions of the nozzle, etc. Do you think that the diameter of the nozzle is too great?" (E. B., The Manchester Interplanetary Society.)

1. THE explosives act can be studied at your local police station or post office. You must not use explosives in any manner likely to cause injury to persons or property and adequate precautions must be taken.

2. Liquid air, in small quantities, is priced the same as liquid oxygen, i.e. about 7*s.* 6*d.* per litre. For large quantities of liquid air, a reduction might be obtainable.

3. The fuel powder does not need compressing. It should be "tamped" down, i.e. lightly rammed down in order to prevent its becoming too loose. The powder should burn with a fair propulsive force, which, within limits, can be increased by augmenting the potassium chlorate proportion of the powder. You do not actually state the nozzle diameter of your experimental rocket, and it is therefore difficult for us to make a true guess at it from your sketch. Generally speaking, the nozzle diameter should be just sufficient to give a free flow to the gases generated by the combustion of the powder. In place of a single nozzle, two, three or even more may be tried. You will, no doubt, be able to discover books on rocket construction in the Technical Library, St. Peter's Square, Manchester.

COLD LIGHT

"WITH reference to your article on 'Cold Light' in the January issue of 'Practical Mechanics,' I would be glad if you could answer the following questions.

"1. How is orthoaminophthalic cyclic hydrazide prepared? If possible I would like to prepare some in a home laboratory.

"2. Is it possible to alter the colour of the light radiated by a luminous compound by the addition of another salt? If so, could you tell me the names of the most important of these?

"3. In what oils is phosphorus soluble? I tried warming phosphorus in olive oil, but although it melted, it did not seem to have any appreciable effect. I used yellow phosphorus; should it have been of the red variety?

"4. I am not quite clear as to whether the luminous appearance of putrefying fish is due to the action of bacteria, or the spontaneous combustion of minute quantities of hydrides of phosphorus, given off by the decaying flesh.

"5. Some materials become luminous under the influence of a radium salt. Does this apply to a uranium salt? If so, which salts give the best results?" (J. H., Lincs.)

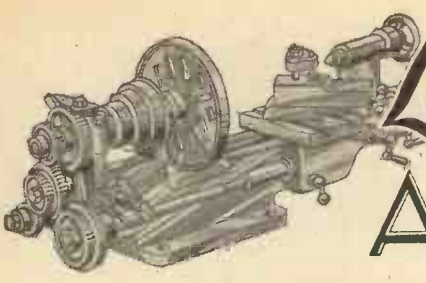
1. IT is quite impossible, from a practical standpoint, to make orthoaminophthalic cyclic hydrazide successfully in an ordinary home laboratory, for the preparation of this compound from phthalic acid is a long and exacting process. It would be much cheaper for you to purchase a small quantity of the material. If you will write to British Drughouses, Ltd., Graham Street, City Road, London, they will forward to you particulars of this compound.

2. The light emitted by luminous compounds may be varied somewhat by incorporating traces of different impurities with the materials used in the making of the luminescent substances. Thus, for instance, traces of manganese compounds in calcium sulphide tend to impart a ruddy hue to the luminescence of the latter. Copper salts produce bluish and violent shades of luminescence, potassium salts, violet-white shades, and barium compounds, greenish hues. It is, however, impossible to lay down the law on this subject, since the exact colour of the light emitted by a luminous compound is governed not only by the impurities in the latter but, also, to a certain extent, by the exact manner in which the luminous material has been made. Very little is known concerning the influence of impurities on the colour of the light given out by a luminous compound.

3. Yellow phosphorus is soluble in olive oil, turpentine, alcohol and other oils. It is extremely soluble in carbon bisulphide. We cannot understand why you were unable to get the phosphorus to dissolve in olive oil. The oil, of course, must be warmed. Red phosphorus is not soluble in any of the usual liquids which dissolve yellow phorphorus. Incidentally, you should be extremely careful when carrying out experiments on the solution of yellow phosphorus in oils, since such solutions easily take fire, and, once alight, are difficult to extinguish.

4. The luminescence of decaying fish is due to the presence of luminous bacteria and not to any phosphorus hydrides.

5. Only radium compounds and those of its closely allied elements excite luminescence in other materials when the latter are brought near radium or radium-like substances. Uranium compounds do not possess this power of exciting luminescence.



Lathe Work FOR AMATEURS

AN ADJUSTABLE BORING-BAR.

IN the making of any tool or appliance it is always best to use the simplest methods for obtaining accuracy. It will be seen from the drawing, Fig. 1, that the radial extension of the cutters *B* is limited and fixed by the flared interior of the sleeve *D* and, as this sleeve has to be rotated on the bar for the purpose of adjusting cutters in the bar, it is necessary that the flared interior should always be concentric to the axis of the bar. The drawing shows the sleeve held concentric to the axis of the bar by a plain bore fitting on to a plain cylindrical portion of the bar *A*. Now it is obvious that more accuracy and a closer fit can be obtained for the sleeve on plain fitting than on a threaded fitting, and that this facility exists apart from the degree of skill possessed by the constructor. It will also be apparent that the production of a central hole to house the coned spindle *C* is difficult, if accuracy is required, and the hole may wander appreciably in the length required in spite of careful observance of the method given for drilling true to centre. It is, however, not necessary for the spindle *C* or its coned end to be true to the axis of the bar so long as both the cutters are pushed firmly to contact with the flared end of the sleeve *D*. This feature can be ensured by making the hole for *C* somewhat larger than the spindle and then, provided previous boring instructions are followed and the hole is reasonably near to truth, the spindle will have freedom to spring sideways and impart equal pressures to each of the two cutters *B*.

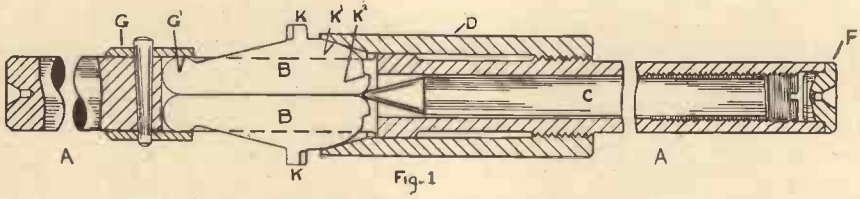


Fig. 1

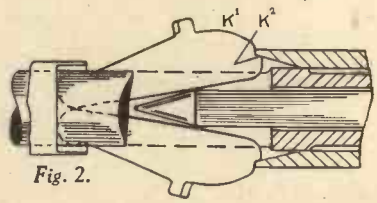


Fig. 2.

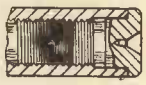


Fig. 3.

Figs. 1 to 3.—Details of the adjustable boring-bar.

For Greater Accuracy

Another point making for simpler production and greater accuracy is that the false centre *F* should be fitted into a plain bore and against a plain square face or alternatively as shown in Fig. 3 with the addition of a threaded extension to prevent it from being lost by falling out when the bar is not held between lathe centres. It would also help to maintain accuracy if the sleeve *G* were made with projecting lugs G^1 which were faced flat on the inside for the support of the cutters *B*. This increases the support from being that of two points, to that of a line, and will not be so liable to damage from the pressure of the hardened cutters *B*. To obtain substantial surfaces on the cutters at K^1 so that they may not damage the flared cone of *D*, it is advisable to turn the faces *K* when they are in position in the bar. This may easily be done if the cutters are made with small projections *K* whereby the cutters can be held as shown in Fig. 2, while the faces *K* are being turned.

Making the Bar

The procedure in making the bar would be to take a piece of round Bessemer bar of diameter just over the diameter of the threads, place one end in the chuck and run the other end in a steady. Drill and counter-bore for centre, then reverse the bar in the chuck and drill up the centre for the required distance, preferably by the method previously described, to $\frac{9}{16}$-in. diameter, enlarge the bore of the outer end to about $\frac{3}{4}$-in. diameter and face the end true to take the false centre as shown. Now bore a further recess of $\frac{19}{32}$-in. diameter to a depth of 2 in. for tapping $\frac{5}{8}$-in. standard Whitworth iron gas (19 T.P.I.) to take the threaded portion of the spindle *C*. Next scribe centre lines, mark out, drill and cut the slots for the cutters *B* as previously described. Make and fit the false centre, adopting either of the methods shown and then turn the outside diameter of the bar between centres to the finished dimensions, screw out the outer thread and tap $\frac{5}{8}$-in. standard iron gas thread internally for the spindle. Then fit the sleeve *G* with flats filed on the inside faces of the lugs in order that the cutters may have line bearing to take the pressure on these ends.

The Sleeve

The screwed sleeve should now be made from a piece of high quality steel as there will be no possibility of hardening unless it

can be ground afterwards. If hardening is done and the sleeve is not subsequently trued, any warping will interfere with accuracy, but an unhardened sleeve made from tool steel will give good results if care is taken not to over-tighten the coned spindle *C* and thereby press the hardened cutters sufficiently to cause damage to the flared mouth of the sleeve *D* when locking by the spindle *C* after adjusting the diameter over the cutters *B*. The cutters should be turned over the tops of projections *K* to make them both of equal cutting radius and the side faces could, with advantage, be machined at the same time. It would be as well to mark the lugs of the collar *G*, say 1 and 2, and then to mark the cutters in the same way so that minor errors of making do not cause inaccuracy by accidental reversal of cutter positions in the bar.

FAIR COMMENT

(*Continued from page 372*)

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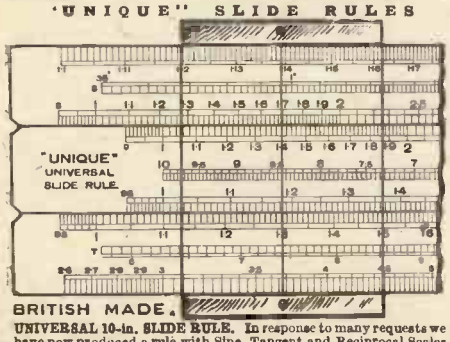

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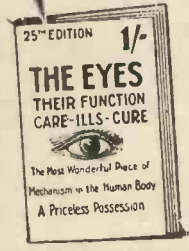

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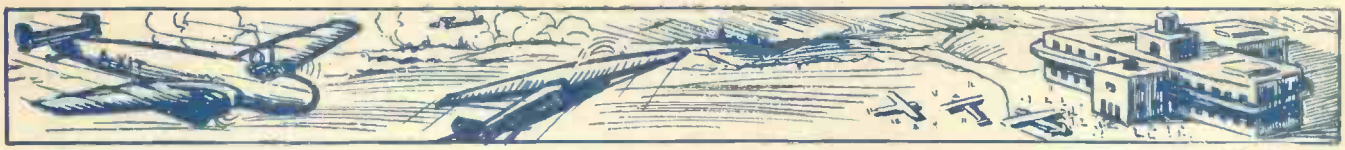

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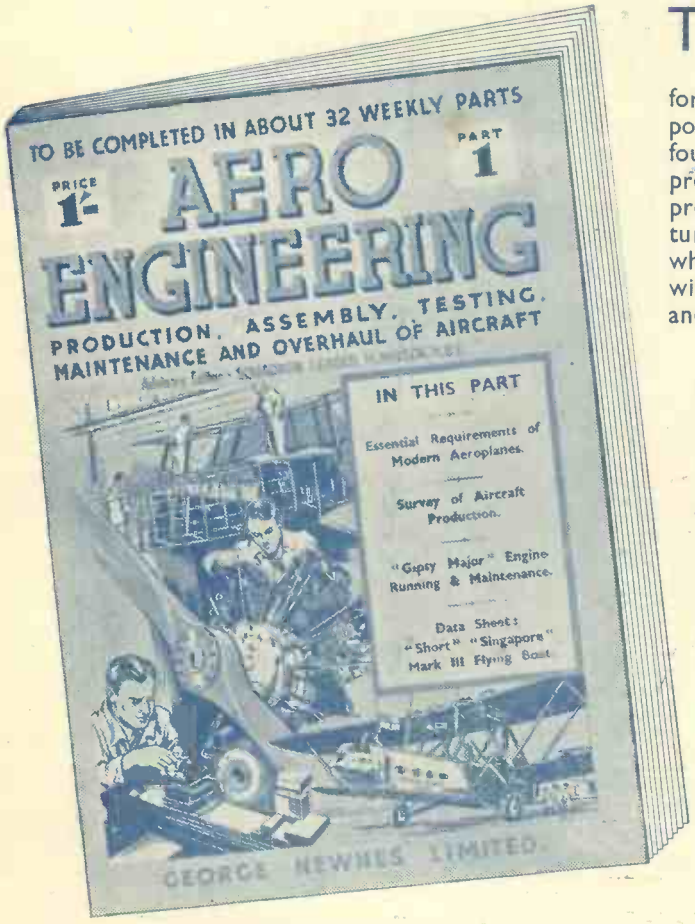

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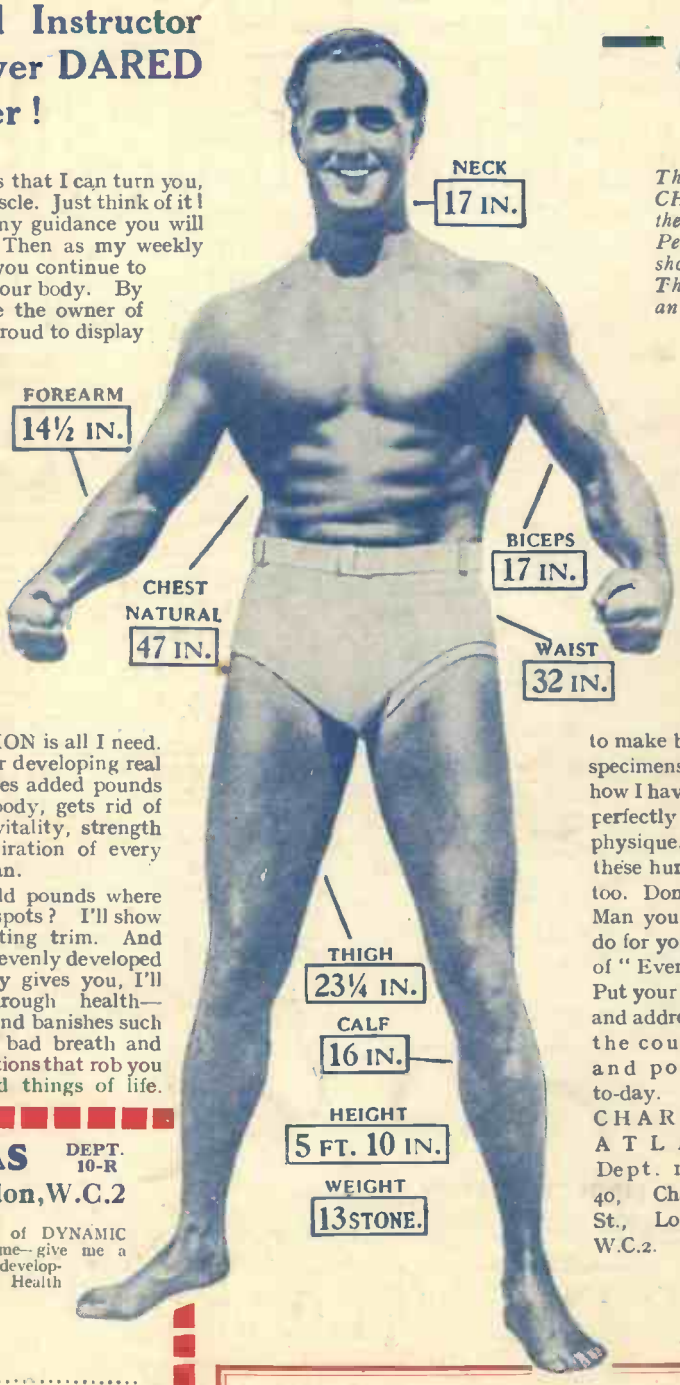

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