UNORTHODOX AIRCRAFT

NEWNES

PRACTICAL MECHANICS

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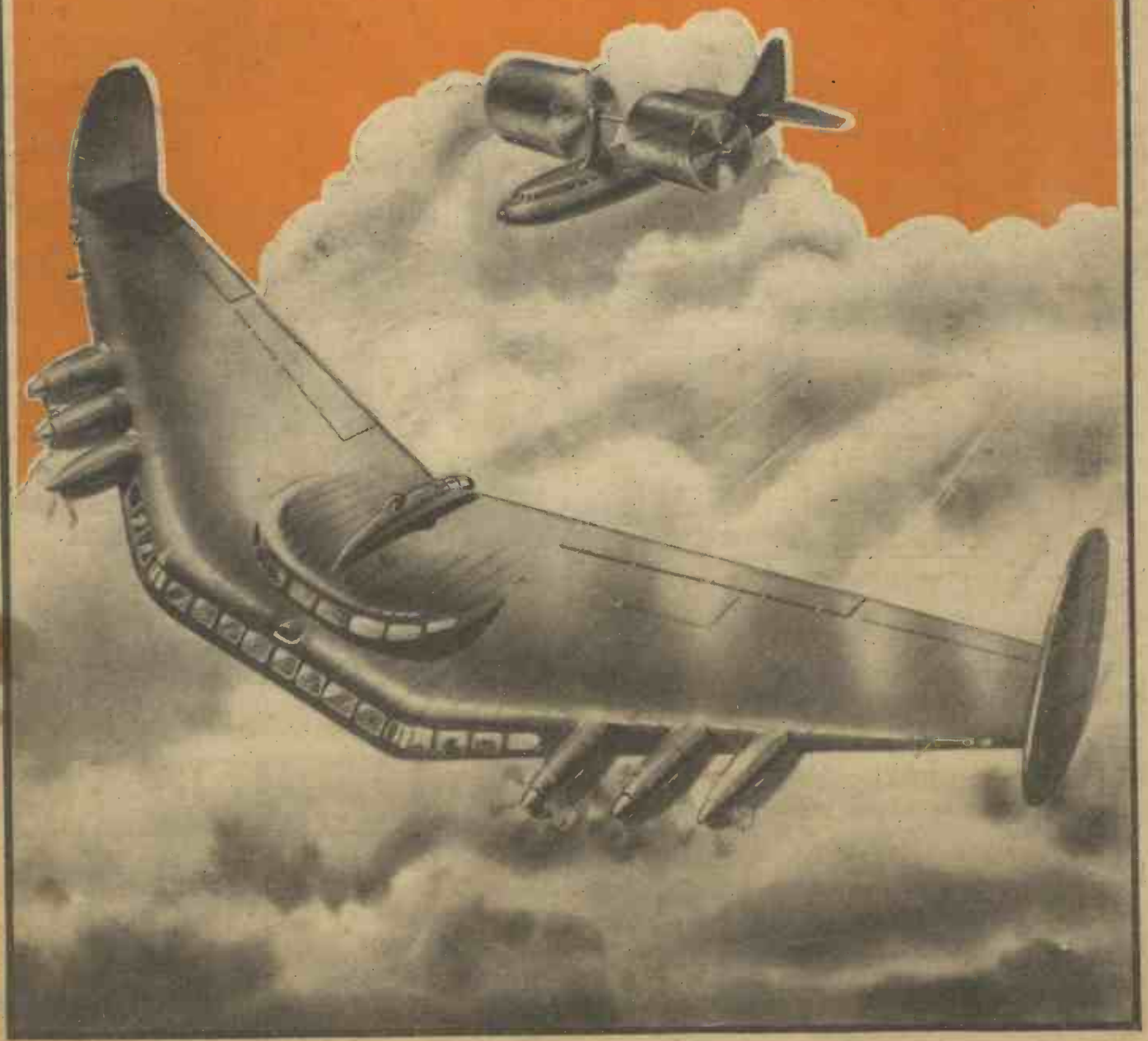
OCTOBER 1943



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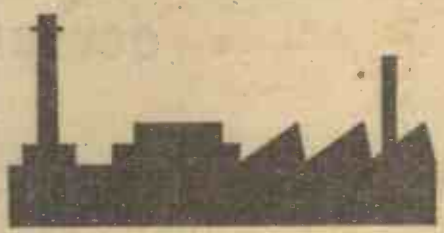

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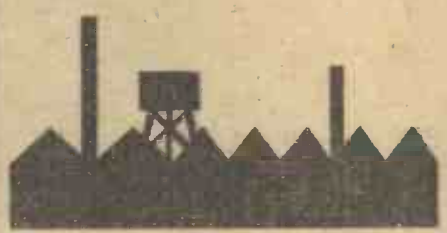

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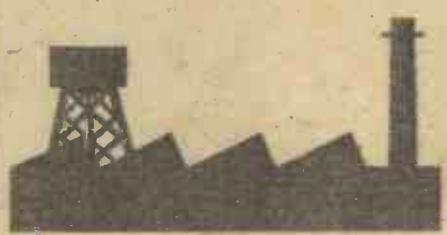

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PRACTICAL MECHANICS

Owing to the paper shortage "The Cyclist," "Practical Motorist," and "Home Movies" are temporarily incorporated.

Editor: F. J. CAMM

VOL. XI. OCTOBER, 1943 No. 121

FAIR COMMENT — BY THE EDITOR

Electricity and Re-planning

NEARLY every industry has a post-war plan, and each industry seems to be making its plan without consideration for the impact it may have on other industries. We know that the Government has taken steps to co-ordinate these plans, but it seems to us that they are merely considering the plans after they have been prepared, when all of the parties should really be called together and before the plans are prepared. Some of these plans will undoubtedly be found unworkable, many depend upon Government subsidies, whilst others are purely selfish and merely designed to benefit a particular section of the community.

Electricity plays such an important part in industry and in national life that it is only to be expected that there is an intention to remodel the electricity supply industry when the war is over. Almost every factory to-day uses the independent electric drive for machine tools. This system is not only economical in that you do not have to start up the whole of the line-shafting in order to drive a particular machine, but it also saves considerable wear and tear and reduces maintenance costs. The radio, television, electric lighting, cooking, and power supply are vital parts of our national life, and the Electrical Power Engineers' Association has just issued a report entitled "Post-war Planning for the Electricity Supply Industry, Part I," in which a number of important suggestions are made. The report says that the Electrical Power Engineers are vitally concerned in the proper reorganisation of their industry, and it is likely that they will be called upon for their views in any reconstruction that is proposed. They must be ready, therefore, with their proposals so that they can submit them at the proper time, for if electrical power engineers do not play their part in post-war planning the industry may be planned by people who are not as familiar with its operation, and it will probably be planned wrongly. The Electrical Power Engineers' Association is, of course, a body of technicians and not a body concerned with commercial interests.

The gravamen of this report is a recommendation that there should be set up a National Electricity Supply Board, which would own and operate all power stations and transmission lines, and make itself responsible for national policy concerning local distribution and utilisation. It goes farther and suggests that all existing organisations, either municipal or company owned, should be purchased by the State on terms to be agreed. The constitution of the Board would parallel the Central Electricity Board, and the members of it would be appointed by the appropriate Minister according to their knowledge and connection with the industry. Also included on the Board would be those representing broad interests vitally concerned in the electricity supply industry, including the employees engaged therein. Whilst generation and bulk transmission can be controlled nationally, the detailed administration of distribution and utilisation on a national scale would prove cumbersome, the report says, unless accompanied by some form of regional control. The National Electricity Supply Board should, it is suggested, appoint regional distribution engineers and managers who would be in control of the regional distribution to be designated by the electricity commissioners. Local interests would be represented by regional committees.

Now the Central Electricity Board is largely controlled by the Electricity Commission, and the board has to obtain the approval from the commissioners, even in matters of detail. The report proposes that the commission should continue to serve the industry in a semi-official capacity, and act as technical adviser to the Government to ensure that the interests of the community are being adequately protected.

A single authority, it is thought, should be made responsible for generation, transmission, and distribution. Under present arrangements the Central Electricity Board purchases current from the proprietors of generating stations, and, strange though it may sound, sells it back to them. Of course, the problem of private or State ownership is a wide question, and it will have to be solved before any reorganisation of the industry can be brought about. Two-thirds of the industry is already under public ownership, and electricity distributors are subject to compulsory purchase by public bodies after the lapse of a period of years. The power companies, however, have rights in perpetuity. How any post-war plan of reorganisation can therefore operate without legislation seems obscure at the moment.

One of the great snags at present is the variety of voltages, the use of A.C. as well as D.C., variation of frequency, and a wide divergence of charges, even in adjacent districts. If there is to be a national control of electricity there should similarly be a national charge with it, as there is with the telephone, radio, and the postal services. These are, indeed, wide questions, and that is why we say that in some cases it is a waste of time to produce plans which cannot be put into effect until the Government has announced its intention of introducing legislation if such should, indeed, be necessary.

Certain it is that electricity will play an increasingly important part in the life of the nation, and that some steps should be taken to see that the industry operates on national lines.

Notice to Intending Contributors

WE invite contributions from readers on subjects within the scope of this journal. Such manuscripts should, for preference, be from 1,500 to 2,000 words in length, and, where necessary, be accompanied by sketches and/or photographs. Manuscripts should preferably be typewritten, using double spacing, with 1in. margins down each side of each sheet. Original matter only should be submitted, and readers should state, when sending in manuscripts, their qualifications to write on a particular subject. Drawings and photographs should be sent flat, and not rolled. It is advisable in the first place to send a précis of the article, as this will avoid the contributor spending time on it if it is likely to be rejected because an article on the same subject has already been accepted. A stamped and addressed envelope should be enclosed for the return of rejected manuscripts, although the editor does not accept responsibility for their safe custody. All manuscripts are promptly considered, and promptly paid for if accepted. They should be addressed to the Editor, PRACTICAL MECHANICS, George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2.

Special Designs

WILL readers please note that during the war we are unable to prepare special designs under our Query Service. We are, of course, always happy to help readers, but we are unable to extend the special service which was in operation before the war. We should also be grateful if readers would keep their queries down to the minimum. It is essential to comply with the Query rules, and to enclose a stamped and addressed envelope.

Unorthodox Aircraft

The Unusual of Yesterday is the Commonplace of To-day. Will the Types Dealt With in This Article be the Aircraft of the Future?

By T. E. G. BOWDEN, Grad.R.Ae.S., M.I.E.T.

The Mustang undergoing tactical exercises. This would have been considered unorthodox a few years ago.

SINCE the days of the first practical flying machines many developments have taken place and many unorthodox types have been built and sometimes flown. Not all of these out-of-the-ordinary designs have proved successful, although one or two have definite possibilities. The average aircraft of to-day does not differ in principle from those constructed in the early part of this century; many details have, of course, been altered and improved, but it would still be recognised as an aeroplane if it could be transported back twenty-five years.

In the near future it is almost certain that aeroplanes, as we know them to-day, will alter in form and principle. The ideas which have been tried out in the unconventional aircraft described in this article may be incorporated, or altogether new ideas invented. The science of aircraft design and construction is still only in its infancy, and as it grows older many startling steps forward may be confidently expected.

A description of several of the more interesting unorthodox aircraft follows.

Cyclogiro

A very unusual and odd-looking aircraft is illustrated in Fig. 1. It will be noticed that the wings and airscrews possessed by normal aircraft have been replaced by paddle wheels. A fuselage of conventional design contains an engine which is connected to the paddle-wheel shaft by means of a worm drive. Each of these rotating assemblies consists of several miniature wings attached to a main central member.

The manner in which this system operates is as follows. As the aerofoils rotate in an anti-clockwise direction, a lifting force is developed in a similar manner to that of a normal wing. At position A an upwards force lifting the aircraft is generated, and at B the angle of incidence is so arranged that the lift developed acts in a forward direction. Thus at B a force equivalent to airscrew thrust propels the cyclogiro forwards. When position C is reached, the fact that an aerofoil develops lift in an inverted position is utilised to supplement the upwards lift of A. For position D no really useful work is performed, so the aerofoil is positioned to give the minimum drag, i.e., at a small angle of incidence to the relative airflow.

One of the most successful inventors working on this type was Dr. Rohrbach, and in his design the rotating blades could be altered in position during flight. By this means vertical flight was made possible, no forward thrust being developed. The manner in which the blades were varied in incidence is illustrated in Fig. 2.

A practical successful aircraft of this type has yet to be constructed, although its possibilities are interesting. Its chief advantage is the fact that it possesses an extremely high degree of manœuvrability, as it can fly upwards, downwards, forwards and backwards. The idea of replacing the standard design of airscrew with a system of rotating aerofoils has been tried out, and this also has possibilities.

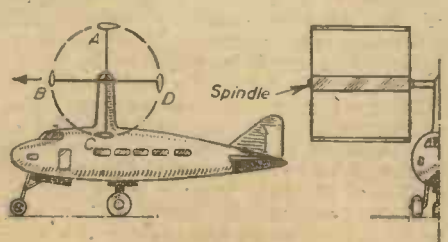


Fig. 1.—The cyclogiro.

Telescopic Wings

Inventors in many countries have built aircraft with variable wing areas. The object in altering the wing area is to increase the lifting properties of the wing for taking-off and landing. When the aircraft becomes safely airborne, the wing area may be safely reduced, consequently reducing the drag and allowing a greater speed for the same horsepower to be attained.

Unfortunately, as in many other promising ideas, there is a serious snag to this idea. Any method adopted to vary the wing area also increases the weight of the aircraft, and this sets back the advantages which may be gained. Complication results in increased cost and more skilled maintenance.

Various methods have been tried out, and telescopic wings, in which the outer portions slide into the inner portions, have been constructed. As the wing slides inwards, so the overall span is reduced, as is also the wing area (see Fig. 3). An aircraft constructed by a Russian, M. Makhonnie, allowed the wing area to be reduced from nearly 300 sq. ft. to approximately 70 sq. ft.

An extremely novel alternative scheme is the fitting of flexible extensions to the normal leading and trailing edges. These extensions, partly constructed of spring steel, may be rolled up when not required, by means of a motor. The maximum wing area was approximately five times the minimum, allowing a large difference in maximum and minimum speeds of flight.

Ornithopters

An ornithopter differs from the normal design of aircraft in the fact that the method of propulsion and derivation of lift depends upon the movement of the wings in a similar manner to that utilised by birds. No

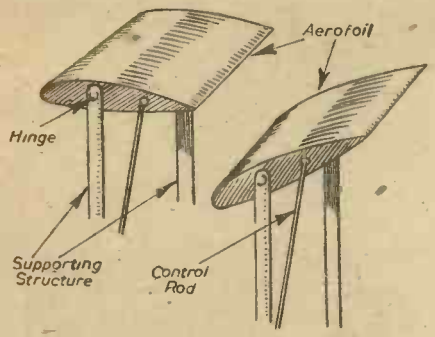


Fig. 2.—Blade angle control.

satisfactory aircraft have been constructed on this principle, although it offers good prospects.

The famous inventor, Leonardo da Vinci, designed an ornithopter, and was followed by other designers in later centuries, none of whom had any great success. The main difficulty was the complicated movement required, which resembles a figure 8. An extremely complicated mechanism is needed to imitate the flapping movements of a bird's wing.

Both manual and engine-driven ornithopters have been constructed. In 1909 a full-scale ornithopter, driven by a petrol engine, is supposed to have made several flights, gaining a height of 25ft.

Other alternative driving units have been compressed air and a combination of springs and magnets. In the latter design the springs were incorporated to take the place of muscles, and the electro-magnets working on the attracting and repelling property possessed by magnets were used to give a flapping motion.

Many model ornithopters have been built in the past, and model-aircraft fans are designing and constructing them at the present time.

Pterodactyl

An unusual type of aircraft, differing from many of the other ideas, is the pterodactyl, which has flown and proved successful. The first of this type was constructed by Dunne in 1911. His idea was to design an aircraft possessing inherent stability, as many of the aircraft then flying were not too stable.

As shown in Fig. 4, this type does not have the normal tail unit, and the wings are swept back to an abnormal degree. The fore and aft stability is quite good, and may be further improved by reducing the angle of incidence of the wings at their tips. The difficulty introduced in this design is the problem of manœuvring, as no normal elevators or rudder are fitted, due to the absence of a long fuselage.

Captain Hill overcame this difficulty by allowing the rear portion of the wing tips to be movable, either in opposite directions to give aileron control, or together to give elevator control. Rudder control presented a rather difficult problem, and was overcome by incorporating split flaps, which were capable of being lowered independently. If a turn to the right or starboard was required, the starboard flap was depressed. For landing purposes both flaps could be lowered, as in the case of normal aircraft, and thus reduce the landing run by acting as a brake. A later type of pterodactyl designed by Captain Hill had vertical control surfaces at each wing tip, resembling a normal rudder in outline.

A military advantage of this type is the fact that if the power unit is mounted in the nose of the aircraft, an extremely good field of fire is available for a rear gunner. There are no projecting tail booms or control

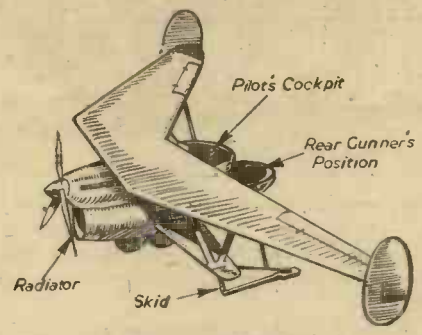


Fig. 4.—Pterodactyl

surfaces, resulting in the elimination of the blind spot which occurs on aircraft of standard design. A two-seat fighter incorporating these principles was constructed and flew successfully.

An American variation of the pterodactyl

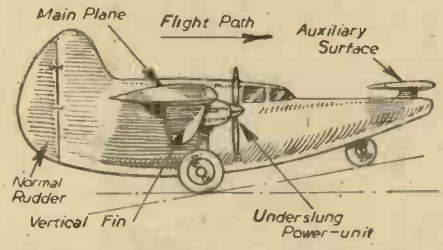


Fig. 5.—A typical canard aircraft.

was that designed by R. J. Hoffman and Dr. C. L. Snyder. The wing plan form was semi-circular, the diameter being the leading edge and the curved portion forming the trailing edge. A cockpit was incorporated in the centre of the wing and an engine

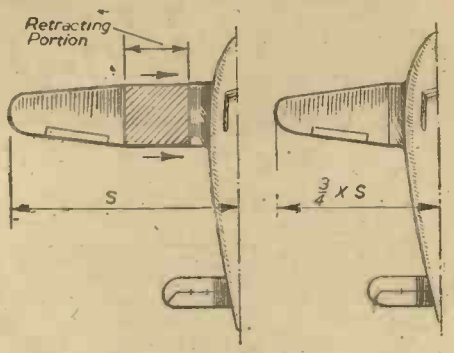


Fig. 3.—Telescopic wings.

mounted in the nose. To obtain the necessary control, a rudder was mounted above the rear of the wing. The elevators formed part of the trailing edge.

Another alternative pterodactyl design was that in which the trailing edge was normal, but the leading edge tapered backwards. The method of control is similar to that adopted by Captain Hill, and this type, constructed by a German, Herr Lippisch, has made successful flights.

Canard

An unusual type is the canard (duck) type of aircraft, in which the positions of the wings and tail units have been reversed. As shown in Fig. 5, an auxiliary control surface is mounted at the forward end of the fuselage and vertical fins are positioned under the wing out near the tips.

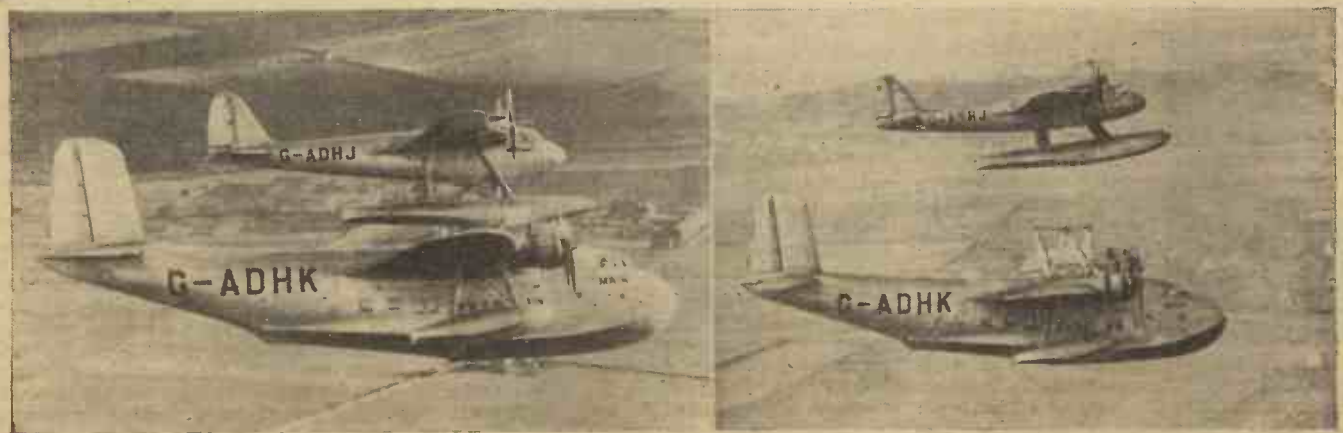
The idea behind this rather freak-looking aircraft was the prevention of stalling. By situating the forward control surface at a certain angle it is possible to allow this control to stall before the main wings. When this auxiliary surface stalls the nose falls, and it is impossible to stall the aircraft as in the case of conventional aircraft.

It is interesting to recall that the aeroplane constructed by the Wright brothers in 1903 was of the tail-first type. A more modern successful canard was the Focke-Wulfe monoplane built in 1930. Two 110-h.p. engines were installed, as shown in Fig. 5, and a speed of approximately 90 m.p.h. attained. It is doubtful if this type will be developed, as the more conventional designs have proved just as efficient.

Pendulum Design

Another attempt to improve stability resulted in an aircraft with the wing mounted high above the fuselage. An engine and tail unit were also attached to this wing and another tail unit fitted at the aft end of the fuselage.

This "pendulum" design was supposed to assure stability by allowing the fuselage



(Left) Composite aircraft flying over Rochester. (Right) The "Mercury" leaving the parent "Maia" at eight hundred feet over the Medway.

The famous Typhoon—which carries two 500lb. bombs and flies at 400 m.p.h.

to act as a pendulum and thus maintain stability. When trial flights took place, the stability was so great that the aircraft was found to be almost impossible to manœuvre.

Another unorthodox aircraft which proved to be too stable was a monoplane built in 1913. The wing plan form resembled a plate with a circular hole in the centre. A fuselage was mounted on the wing, but although the major defect was overcome by modification this aircraft has not been developed.

Flettner Rotor

An ingenious device which has worked under practical conditions when applied to sailing vessels is the Flettner rotor. Attempts have been made to utilise these rotors for aircraft purposes, but so far no great success has been attained.

The principle of operation is as follows: As shown in Fig. 6 (a), if air flows past a cylinder the streamlines are equally divided above and below the centre line. When the cylinder rotates, the airflow is altered to Fig. 6 (b). As will be seen, the velocity of the air on the upper surface is increased, and on the lower surface it is decreased. Consequently the pressure is also reduced and increased, thus providing a lifting force acting at right angles to the direction of motion of the cylinder.

Experiments have been carried out in which the normal aerofoils have been replaced by revolving rotors, but no practical aircraft has developed.

Airscrews

Alternative designs of airscrews have had very little success, and the normal airscrew as fitted to all present-day aircraft has no serious rivals (excluding rockets and jet propulsion).

A device resembling a screw thread with aerofoil section threads was designed by a German. It was claimed that the efficiency of this airscrew was higher than that of the normal design.

An unusual-looking aircraft was constructed by the Caproni Aircraft Company. The fuselage took the form of a tube, with the engine and airscrew fitted inside. The idea was to ensure a good, smooth flow of air past the airscrew, resulting in increased efficiency.

Many attempts have been made to fly by the aid of human muscular power and to do away with the normal power units. The majority of these experiments have not proved very successful, although many ingenious and complicated ideas have been tried out.

Hand-powered Aircraft

A novel hand-powered aircraft was constructed by two Germans in 1935. The

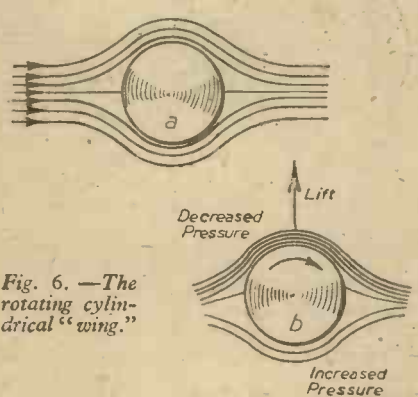


Fig. 6. —The rotating cylindrical "wing."

exterior outline was similar to that of an orthodox glider. A normal airscrew was fitted, but the motive power was a length of rubber wrapped round a drum. The pilot, by stretching the rubber, caused the airscrew to revolve, and thus it was hoped prolonged flight would be possible. When actual flight tests were carried out it was found that a maximum flight of 500 or 600 feet only was obtainable, and this duration only by using a trained athlete.

The ordinary bicycle has been utilised for a great number of experiments. By fitting wings and sometimes even an airscrew, enthusiastic inventors have endeavoured to imitate the flight of birds. All these attempts have resulted in only short hops of a few seconds' duration. The weight of the additional structure required is the main handicap of this type.

Short-Mayo Composite

An extremely interesting and successful design which may be classified as unorthodox, is the Short-Mayo composite aircraft. The problem of enabling a heavily laden fast aircraft to become safely airborne was solved in a very satisfactory manner.

The principles of the design are as follows. A seaplane loaded to capacity is mounted on the back of a large and comparatively lightly loaded flying boat. Normally, without assistance, the seaplane would require several miles of take-off run, and could not climb safely until a considerable amount of fuel had been used. By mounting it on another aircraft, the equivalent of increased power and wing area is the result. Consequently the combination may safely take off and climb to a reasonable height in perfect safety.

Releasing Method

On reaching the operating height of the seaplane the two aircraft are parted, the carrier flying-boat returning to its base and the seaplane continuing on its journey. The method of release is interesting and simple. To enable the upper component to lift away and to avoid fouling the lower aircraft, special precautions were taken in the aerodynamic design.

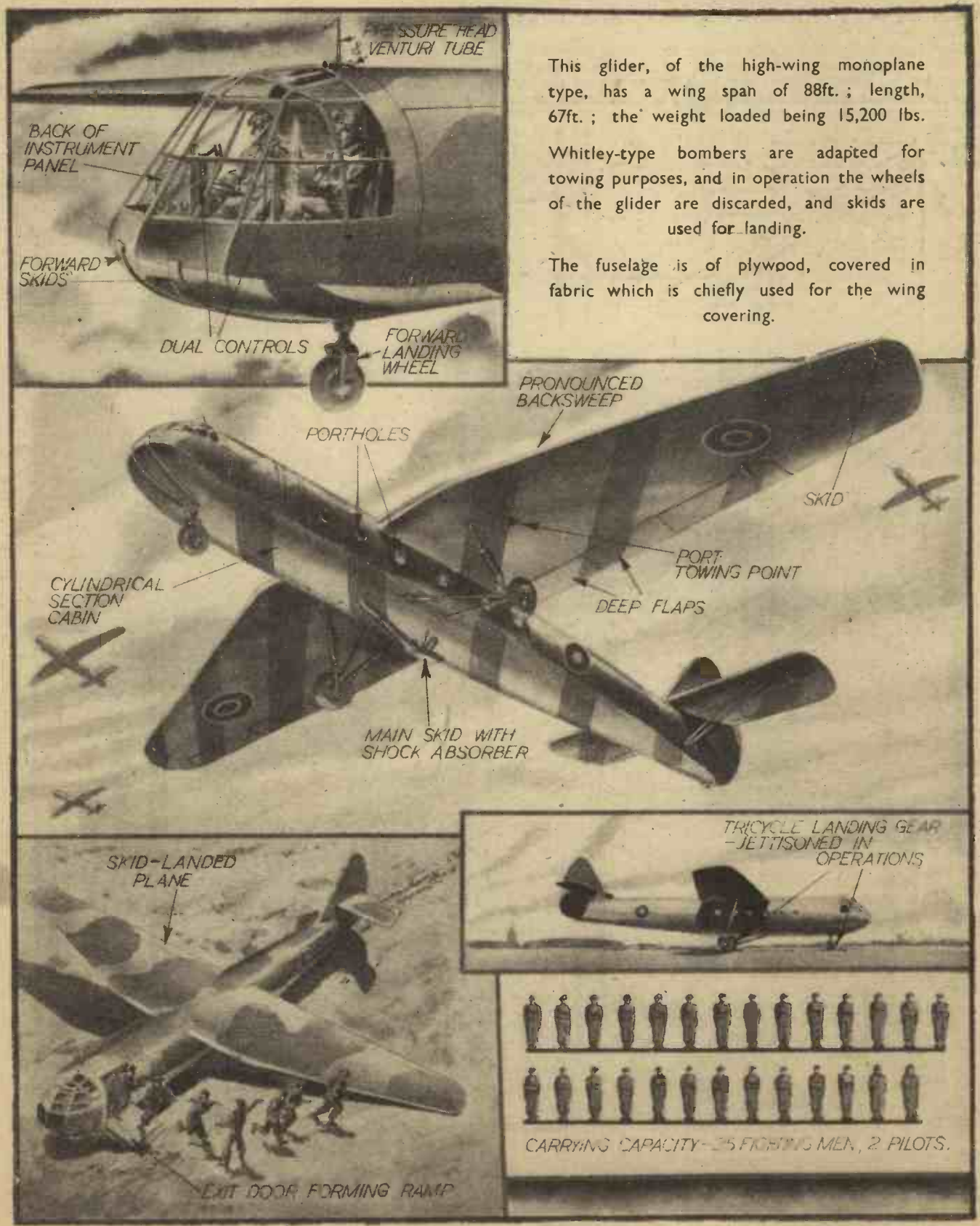
The wings of the two components were so designed that at a definite angle of incidence the upper seaplane was trying to lift upwards. When the locking mechanism was released, the result was that the seaplane and flying-boat parted company in a definite manner and all risk of fouling avoided.

This principle has prospects for future development and is one of the few unorthodox arrangements that have proved successful.

From the above description of several of the more unusual types of flying-machine, it will be seen that there are many problems facing the would-be inventor. Although many of the ideas are laughed at, there is always the possibility that the secret of the ideal flying-machine is hidden in one of those unorthodox aircraft.

The "Horsa" Glider

A Few Years Ago This Type of Aircraft Would Have Been Thought Unorthodox. To-day, in the Various Theatres of War, Troops and Equipment are Rapidly Transported Over Long Distances by This Type of Monoplane



This glider, of the high-wing monoplane type, has a wing span of 88ft.; length, 67ft.; the weight loaded being 15,200 lbs.

Whitley-type bombers are adapted for towing purposes, and in operation the wheels of the glider are discarded, and skids are used for landing.

The fuselage is of plywood, covered in fabric which is chiefly used for the wing covering.

Engineer-built Houses of the Future—9

(Continued from page 417, September issue.)

The Banks and House Financing : Steel Skeleton Framed Walls : The Wiles of Jerry-builders

By R. V. BOUGHTON, A.I.Struct.E.

(4) A bank will probably only advance to an owner-occupier, and if a change of ownership is essential before the bank is "paid off," then three courses are open to the mortgagee: to sell under conditions which will allow the liability to the bank to be paid out of the proceeds of the sale; to pay off the bank out of funds which are independent to those gained through the selling of the house; or, if the new owner is a customer of the bank, and requires financial assistance, it will probably be obtainable on the same conditions as those granted to the previous owner.

(5) A bank will usually grant advances

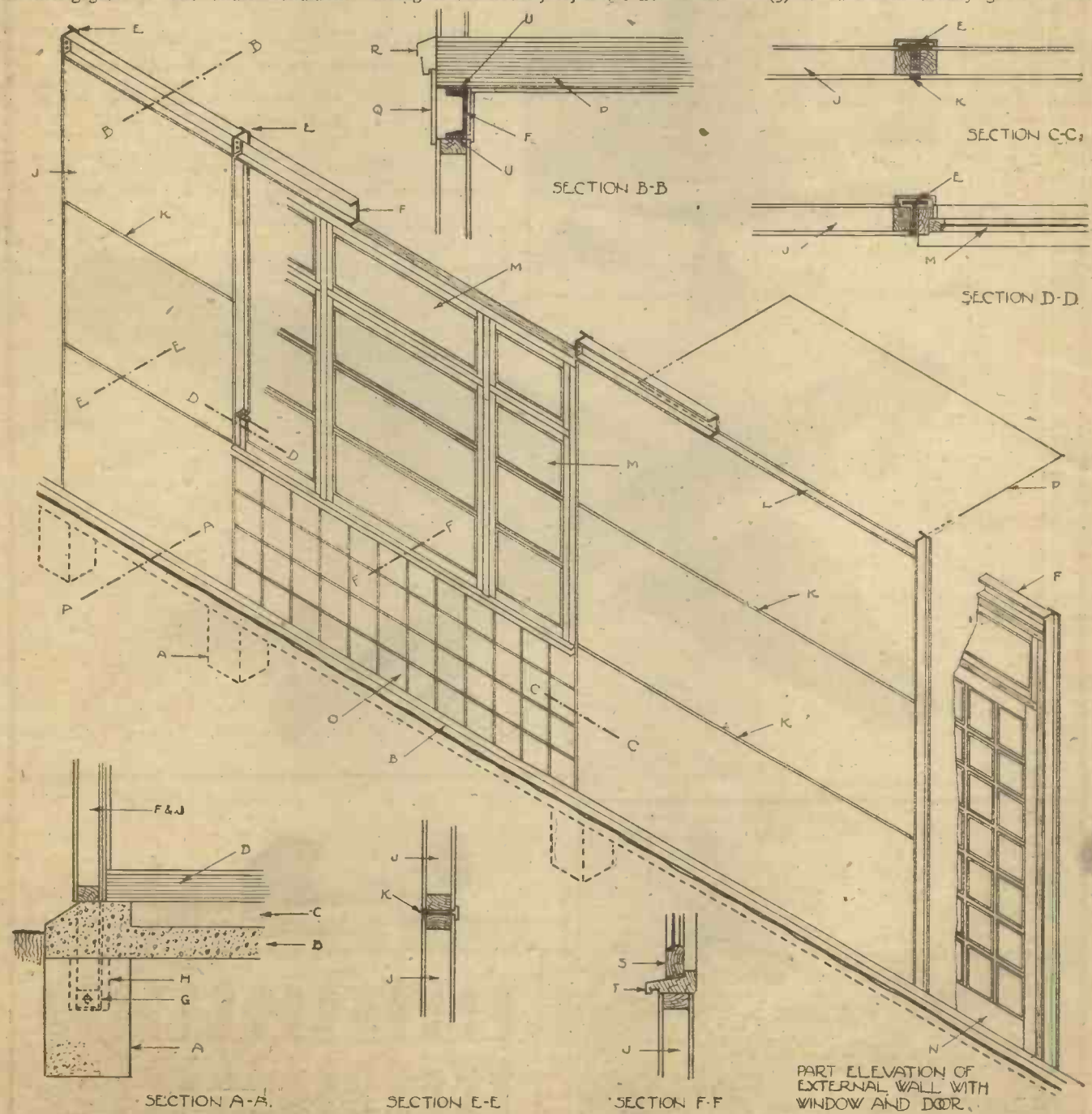


Fig. 43.—External wall constructed with steel skeleton framework and pre-built wall units set with their length horizontally; general details and sections A—A to F—F.

A—Pre-cast concrete pier. B—Surface concrete on hardcore if necessary. C—Air space required for ventilating purposes. D—Floor units. E—Small section steel T stanchion. F—Steel channel beam. G—Base of stanchion with base cleat. H—Pocket in concrete base for stanchion; pocket is filled with fine concrete. J—Wall units of any suitable kind. K—Watertight joint formed on site. L—Framing of wall unit. M—Standard wood or metal window. N—Door of any desired design. O—Wall unit faced with tiles. P—First floor units. Q—Fascia. R—Moulding if required. S—Bottom rail of sash. T—Sill. U—Acoustical insulation pads.

under the above system of 75 to 80 per cent. of the fair value of a freehold house; if leasehold they may require not less than about 75 years' unexpired lease.

(6) The ordinary bank system of assisting an owner to purchase a house is to advance against the deeds about two-thirds of the value, the capital to be repaid over a limited number of years in agreed amounts every three, six or 12 months, the interest to be paid monthly or other negotiated period.

(7) Although it will be found that a bank will normally reserve the right to call in an advance at short notice, no reputable customer need have the slightest apprehension about the bank exercising this right—the right is only required for certain protective reasons.

FORMULA A. THE BANK METHOD OF COMPUTING INTEREST ON THE DAILY BALANCE SYSTEM.

To compute the total amount of interest which is payable up to the end of a given number of years at any specified rate of interest per annum:

$$\frac{\text{Amount advanced} \times \text{Rate of interest} \times \text{Number of months in mortgage period plus 1}}{2{,}400}$$

(J.C.S. formula.)

Example. £500 is advanced at 5 per cent. per annum for 15 years. What is the total amount of interest only which would have been paid at the end of the 15 years?

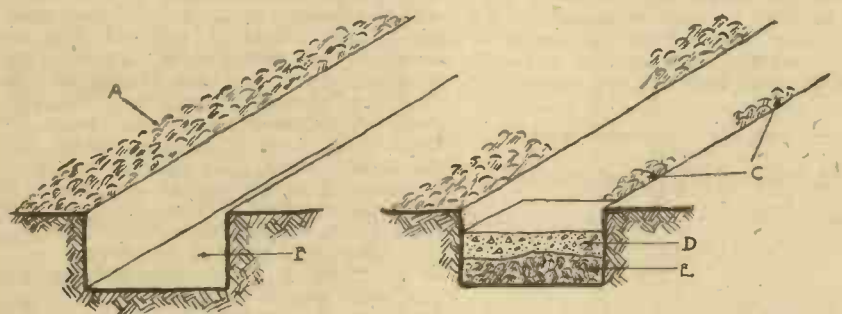


Fig. 45 (Above).—The foundation trick. The left-hand illustration shows trench dug and excavated earth thrown out at A. The trench B is ready to receive concrete foundation. The right-hand illustration shows at C part of the excavated earth A tipped into trench just before concrete is placed. The concrete in part of the trench is as D and rests on soft earth E. This construction weakens the concrete base but saves money.

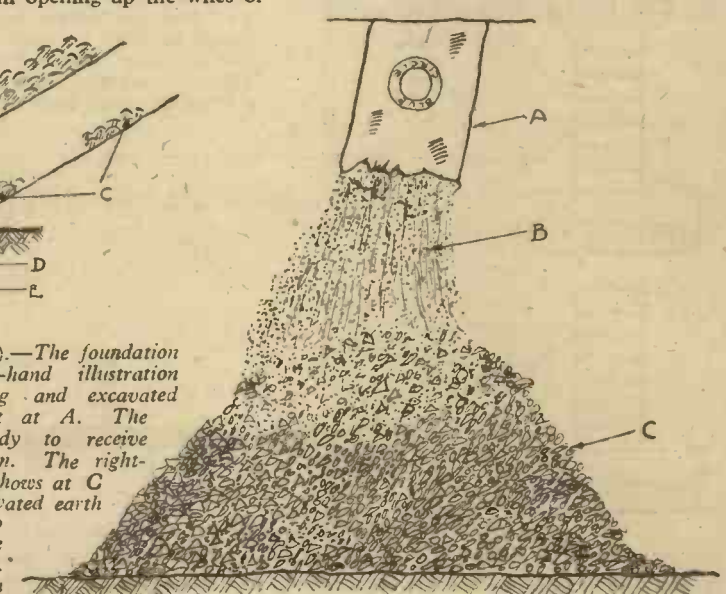


Fig. 44 (Right).—"Sprinkled or floured ballast concrete." A, Cement bag out of which is tipped cement B, which sprinkles or "flours" part of heap of ballast C, the result being a mixture which is usually proportioned wrongly and causing a very weak concrete.

$$\frac{500 \times 5 \times 181 \text{ months}}{2{,}400} = \text{say, } £189.$$

NOTE.—£500 plus £189 = £689 as example given in text.

FORMULA B

THE BUILDING SOCIETY METHOD OF COMPUTING INTEREST AS EXPLAINED IN TEXT.

How to compute the equivalent rate of interest charged by a building society if the true rate of interest per annum is known.

(a) Compute the total amount of capital and interest which is returned to the building society at the end of the mortgage period. (b) Deduct the amount of capital from total as (a), which will give the interest only. (c) The "equivalent interest" may be found by proportion thus:

$$\frac{\text{The rate of interest per annum} \times \text{Total amount of building society interest}}{\text{Total amount of bank interest.}}$$

Example. £500 is advanced by a building society under the "5 per cent. scale" for 15 years, and the total amount of capital and interest paid at the end of 15 years will be £723 15s. (at 16s. 1d. per £100 per month repayments). If £500 is deducted the interest only is £223 15s., or, say, £224. How does this compare with £189 charged by the bank, which is based on 5 per cent. per annum interest?

$$\frac{5 \text{ per cent.} \times £224}{£189} = \text{nearly } 6 \textit{ per cent.}$$

Another difference between the financing of houses by building societies and the banks is the by no means unimportant matter of legal and surveyor's charges. As a rule it will be found that the banks so arrange the business that the charges are less than those charged by building societies; of course, these do not relate to Inland Revenue stamps.

The subject of fines which are levied on repayments that are in arrear are well worth studying. Although the banks expect repayments to be made when due, and little delays which may happen only cause the interest to be charged on the daily debit balance system over the period of the delay, this in effect amounts to about a ½d. per £1 per week. Prior to the war it was the custom of some building societies to charge only ordinary interest on arrears; others charged 1d. per £1 or part thereof for every week or part thereof in arrears: this equals from 20 to 25 per cent. on the arrears. Another and more costly method was to charge interest and fines. Although I believe most building societies are nowadays more lenient in the matter of fines, it is advised most strongly that payments be made when due, and that a borrower should make enquiries as to his liability in the event of delay in any repayment.

The Banks, Building Societies and Builders

It is hoped that the opening of this article by the concluding references to financing, and the last columns in opening-up the wiles of jerry-builders may be an incentive to many to guard as much as possible their interests, and to bear in mind that one of the main aims of this series is to point out how engineer-built houses can overcome many of those influences which can affect so adversely the pocket and peace of mind of house owners and occupiers.

Steel Skeleton Framed Walls

Fig. 43 depicts the introduction of steel to form a skeleton framework to carry the main loads of walls, floors and roof. Steel, when compared with equal sectional areas of reinforced concrete and timber, is considerably the strongest of the three materials. Although steel, area for area, is much heavier than the two other materials, the very small sectional area required to meet loads imposed on it cause it to be lighter than the necessary section of a reinforced concrete member, but as a rule, but not always, is heavier than the necessary section of a timber member. Steel, like timber, is a resilient material and is not so liable to breakage as is reinforced concrete, which is less resilient. The general layout drawing in Fig. 43 shows how most external walls of an engineer designed and built house may have a light steel skeleton framework of stanchions in the walls and beams at first (and other) floor levels, and the roof level, to carry the chief loads, including wind pressure, and to brace the whole structure together. Although British standard sections are depicted by the illustration, it is probable that special sections will be designed and manufactured for pre-built housing work; but in this respect it is suggested that the thickness or gauge of the metal should not only be considered in relation to strength but also to longevity and loss of strength due to corrosion, which latter can, of course, be prevented, at least for a very long time, by anti-corrosion treatments. There is no doubt that the great strength of steel permits the use of very light-weight sections; but the disposition of the steel in those sections must be such as to comply with all the reasonable and economic laws governing mechanics of structures, particularly in connection with beams and stanchions or posts. An ordinary engineer designed and built house will have a dead weight of only about 40 tons (instead of about 125 tons in the brick-built kind) and the superimposed loads on first floor and roof will be under 20 tons. Comparatively little steel is necessary to support safely these loads. It is advisable to state that no parts of the structures shown in this series have been designed on the assumption that lesser permissible superimposed loads and stresses than required by the present building by-laws will be allowed; in other words I have adhered to the present by-laws. The superloads to which reference is made are based on 40lbs. F.S. on floors, 15lbs. F.S. of covered area of pitched roofs, and 30lbs. F.S. on flat roofs (the latter is for houses outside London area; 50lbs. F.S. being required by L.C.C. by-laws, such load being in my opinion too much) and other by-law requirements. The subject of dead and particularly

superimposed loading and permissible stresses in materials does not appear to have received sufficient attention by some designers of pre-built houses—such designers perhaps thinking that much lower loads, etc., may be permitted in the future, which I doubt, although little variations to ensure economy compatible with good principles of construction may be allowed.

The enlarged details of Section A-A, Fig. 43, show the foot of a stanchion supported by and embedded in a precast concrete pier—a deep mortice being formed in the pier to allow for practical tolerances and a site filling of fine concrete. There are various ways by which the levels of concrete base, the base of wall panels, the floor units and surface concrete may be adjusted to suit the needs of ground levels; the chief aims should be (1) to ensure that rain draining down the face of the walls is conducted as far away from the base as practicable and that none of it can work its way on to the surface concrete under the floor; (2) that surface excavation should be limited as much as possible but not so as to cause surface concrete to be laid on any weak top soil; (3) to ensure that the floor level is not at an uneconomical distance above ordinary external ground level; and (4) that any necessary means of ventilating the floor by air bricks or other apertures will not be made difficult or impracticable by relative levels of ground and floor. Section B-B depicts the use of steel channels at first floor level, and how they may be connected simply to the top of the stanchions and form one level beam-ring around the house to support the first floor units and the first storey superstructure, which, according to principles and conditions which are explained in a future article, may or may not have a steel skeleton framework. Instead of steel channels, it is of course possible to use ordinary rolled steel H beams, as indeed it is possible to use other types of beams, even of timber; but it is recommended that if steel is used for stanchions it is better practice to use a similar material for all main structural framework. Sections C-C and D-D show details of the T section stanchions and connection of wall units and window, etc., frames to them in accordance with the following information.

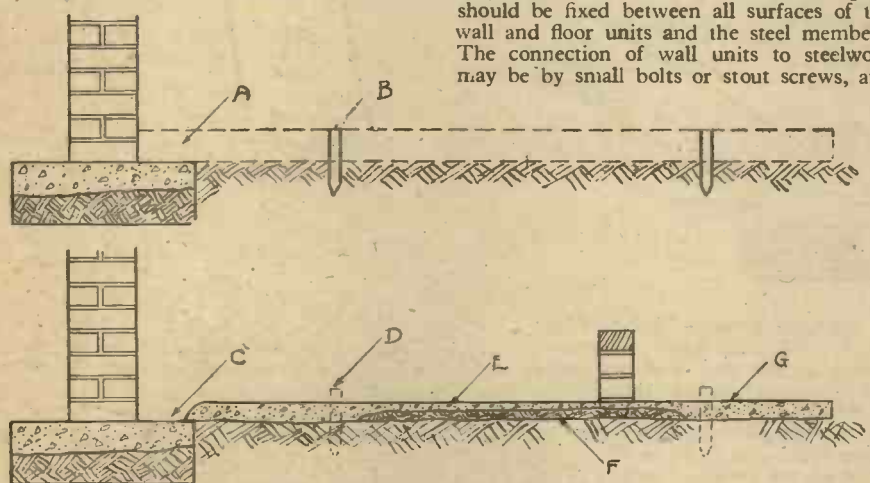


Fig. 46.—The surface concrete trick.

Top illustration: A—Surface concrete as it should be. B—Level pegs at correct levels. Bottom illustration: The level pegs D are either withdrawn or knocked down an inch or two; the ground is covered in places with a layer of earth or cheap ballast as F; the surface concrete is then laid, being one or two inches too thin as at G and practically a skin at E. A little more concrete is saved by not filling space C.

Wall Units

The *horizontal* wall unit system—where the length of a unit is situated horizontally—has been adopted for the filling in to steel skeleton framework. In the last article the *vertical* unit system was described. If a steel skeleton framework is used with stanchions at comparatively considerable distances apart, such as 8ft. or more, horizontal wall units may be economically designed and constructed to provide great strength as what may be termed long span slab units spanning horizontally between the stanchions. This method of designing does not, however, prohibit the use of "vertical" units if desired, or a combination of "horizontal" and "vertical." Although timber framed units are depicted by Fig. 43, it must not be inferred that timber is the only material which can be used; many of the wall unit types of construction, explained and illustrated in the article in the September issue, may be used with the greatest ease in a steel framework.

Sections C-C, D-D, E-E, and F-F indicate how simple it is to make proper connections between the steel framework and the wall units and between the wall units. The water-tighting of the various vertical and horizontal joints is ensured by mastic compositions which will be described fully in later articles. The vital subject of acoustical or sound insulation, especially where steel skeleton framework construction is involved, is a matter which requires particular attention. Although this matter will be explained fully under a separate heading, it may now be stated that insulation pads should be fixed between all surfaces of the wall and floor units and the steel members. The connection of wall units to steelwork may be by small bolts or stout screws, and such connection should be so designed as to ensure speedy fixing as well as providing easy access to the bolts or screws when any repairs or renewals are necessary.

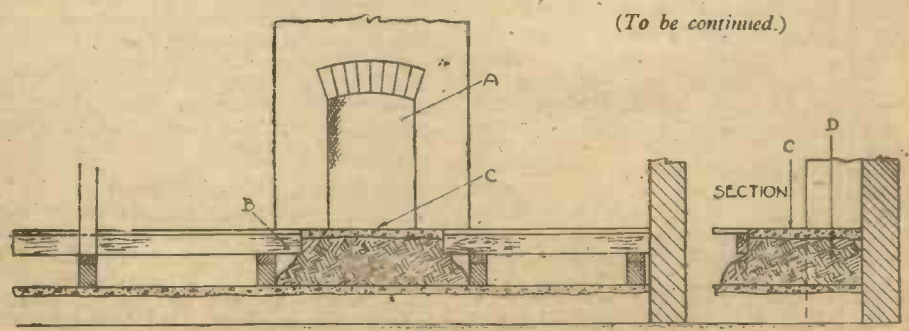


Fig. 47.—The ground floor hearth trick.

Although this trick may be detected before the flooring boards are laid it is sometimes practised as it saves a few shillings worth of fender walls. A—Fireplace. B—No fender wall provided but joists cut off as shown. C—Thin concrete hearth laid on rubbish D.

It has been decided to respond to the considerable amount of criticism—mostly favourable, and a little otherwise—and to the seeking of further information regarding the very hard but fair hitting in these articles of some of the jerry-building and associated principles, and the references implying that, even if engineers stooped to such very low grades of jerry practice, pre-building does not lend itself to otherwise than straightforward and honest building.

One of the most outstanding features about jerry-building—the scourge of building which swept this country between 1919 and 1939 and affected a very great proportion of the more than 4,000,000 houses which were built during this period—is that interests and influences were at work which caused an almost complete complacency in the many powers which could have ended it; that any person with little or no knowledge about building was in a position to gull the gullible public.

I consider myself fortunate — or unfortunate may be the correct word to use—in having most closely studied, and been definitely "anti" to, jerry-building during the past 20 years, and having been involved in many "battles," and a great legal one, in connection with it.

Some years ago, for the purpose of comparing the difference in cost between a typical standard house built in accordance with reasonable standards and that same house fully jerried, I prepared bills of quantities and priced them separately for reasonable goods, and also allowing for the nearly 100 items which could be jerried. The result showed that 25 per cent. could be saved by the wiles of the jerry-builder. In the rather famous litigation, in which I was engaged on the side of one litigant, I stated in effect that if about £25 extra was spent by the builders on the small ordinary type six-roomed house it would have been of reasonably sound construction and not give much trouble to its owner. It is not practicable to explain all of the nearly hundred items mentioned above, but the Editor has given me permission to use sufficient space in this and following articles to deal with the more glaring examples, which are not only interesting and instructive, but, apart from their seriousness, have a definite humorous value. Fig. 44 represents "*sprinkled or floured ballast concrete*"; instead of 1cwt. of cement (1½ F.C.) being properly added and mixed to 10 F.C. of ballast (or the same proportion to suit any other amount of aggregate) the cement is grudgingly sprinkled like flour over the top of a heap of ballast, and then the lot is turned over dry, wet mixed, and the result is a concrete proportioned about 1 cement to 12 parts aggregate, or other proportions depending on the "eye" of the labourer who mixes it.

(To be continued.)

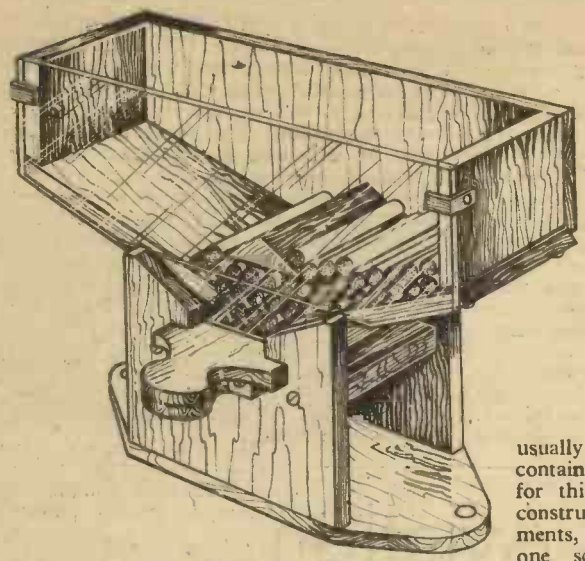


Fig. 1.—A three-quarter front view of the finished machine.

Automatic Cigarette Machine

By A. F. KING

Constructional Details of a Simple Hand-fed Machine for Delivering Five Cigarettes at a Time

THE following is a description of the design and details of an efficient and useful device suitable for retailers of cigarettes now being distributed in loose form. It is, of course, impossible to produce these machines in any quantity owing to the material difficulty, not to mention the labour requirements.

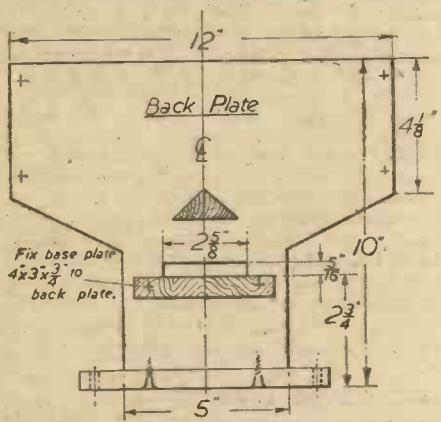


Fig. 2.—The back plate with base plate in position.

A few models similar to that illustrated, constructed from oddments of wood, with the exception of a few screws and glass panel for a front, have been made by the writer for local friends in spare moments. One useful feature is that the machine will take brands of Woodbines and Players variety without any adjustments, and this covers the bulk of supplies.

Details

The object of the device is to deliver rapidly five cigarettes each time the slide is operated to and fro. A saucer, ash tray, tin or box, to catch the required number, is all that is required to enable the order to be conveyed to the customer in the speediest and most hygienic manner. Since the cartons supplied by the manufacturers usually contain quantities of 500, the container in the illustration is arranged for this amount. If it is desired to construct a machine to personal requirements, a useful guide will be to allow one square inch to ten cigarettes. Providing that the essential principles are adhered to, there is room for considerable scope in this direction by the individual.

As will be seen from a study of the diagrams, the filter bar, Fig. 8, ensures a steady flow or feed to the slider, which has depressions or cams incorporated to shake the two support or rocker plates, thus regimenting the "five" feed required.

Almost any salvaged pieces of wood are suitable, but ply of 5/16in., ⅜in. or ¼in. thickness is particularly suitable. Tools required consist of no more than a file, hand saw, pocket knife, drill, countersink and screwdriver. If a fretsaw is available, it will be found extremely useful for cutting the two slots required for the ejector slide.

Construction

A few hints will now be given on the construction of the machine. Cut the back plate and front plate, preferably in plywood, to the necessary overall dimensions (Figs. 2 and 3), and the base plate (Fig. 2) from, if possible, a piece of mahogany. Drill and fix the base plate as indicated in Fig. 2. A centre line in pencil should previously have been made on the inner sides of the front and back plates. Now the slots 2⅜in. wide by 5/16in. deep can be marked off and put into the plates. The celluloid strip can be omitted from the front plates as shown in Figs. 1 and 3, if the slot is cut accordingly. The end plates, Fig. 4, are quite satisfactory in 3/16in., ¼in. or ½in. wood, and can now be fixed in position. The ejector slide can be made as shown in Fig. 7, preferably from mahogany, the stops being best left to be set on assembly in the machine. The rocker plates are fixed to the end plates in the model as in Fig. 1. Care should be taken to set the rocker plates as shown in Fig. 8. In place of the brass eyes suggested in Fig. 8, wooden pegs are equally efficient. A strip as shown on Fig. 3 can be cut and fixed, which allows the cigarettes to drop clear. The stops for the slider are cut and positioned to allow the cigarettes to drop comfortably in the slider slot. The assembly can now be completed by making two lugs (Fig. 5) and obtaining a glass front to fit. This can be obtained locally for about 6d., and a suitable finish for the glass is to tape the edges with passe partout

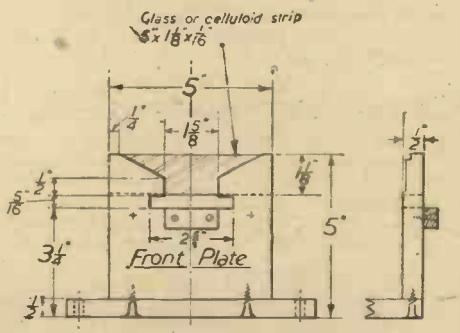


Fig. 3.—Details of the front plate.

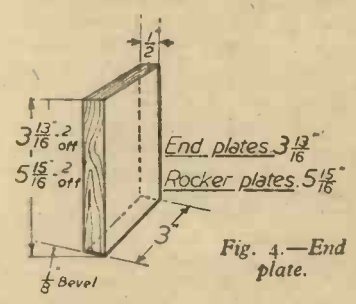


Fig. 4.—End plate.

The Slide

A further note on the slide (Fig. 7) is that the slot was cut with a fretsaw, the cams cut with a penknife, the grooves made with a round file. The head of a countersunk woodscrew attached to any convenient handle is a good means of scraping the grooves to shape.

Operation

To operate the machine, top up with cigarettes in the upper compartment, the

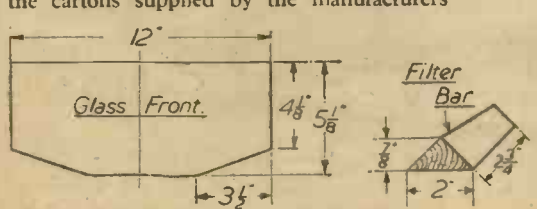


Fig. 6.—Glass front and filter bar.

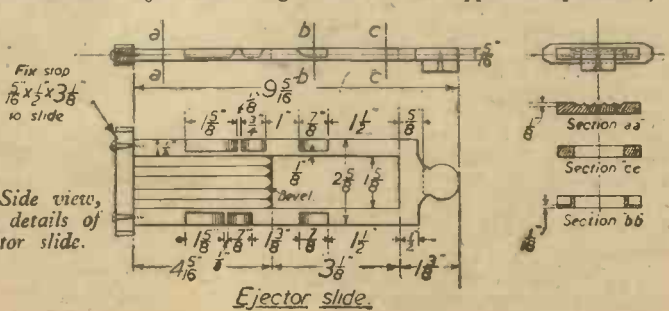


Fig. 7.—Side view, plan and details of the ejector slide.

ejector slide being in the forward position. Push the slide in and withdraw, repeating the operation a few times. The machine is then in working order, and will give no further trouble. As regards finish, it is difficult to generalise. The internal surfaces are certainly best left in their natural state, but, again, individual initiative can have full play according to available resources and experience.

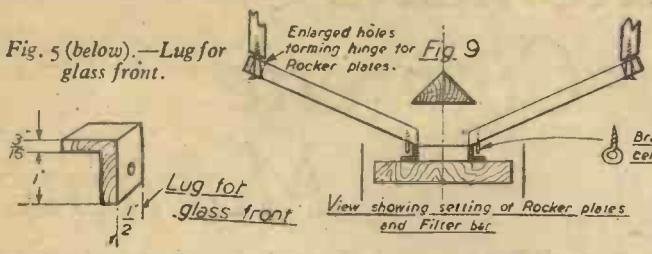


Fig. 8.—Sectional view, showing setting of rocker plates and filter bar.

Mechanically, the chief point to note is the freedom of the slider in the slotted front and back plates to ensure no undue friction. Furthermore, as good a polish as possible should be given to the under surface of the slider and the base plate. The cam surfaces may be treated by rubbing a soft lead pencil over them a few times. Provision is shown in Fig. 1 of a base plate for securing the device in position. This is optional and can safely be discarded, if desired, as stability is found to be quite adequate.

In conclusion, it should be mentioned that special brands, such as "Embassy" and "Senior Service," which are larger in diameter than the standard brands, are best dealt with by making up a separate machine. The only alterations required will be dimension 1⅛in. + 1/32in. on the slide (Fig. 7), increased to 1 11/16in. × 1/32in. Machines made with this slight modification will take Players size in addition to the special sizes mentioned, but, of course, not the thinner or Woodbine variety.

The World of Aviation

"Flying High" : New U.S. Fighter : The Miles M.28 : Contra-rotating Airscrews
Tank Buster : Long Range Delivery

"Flying High"

THAT aircraft designers and aero-engines have surmounted the many complex problems of flying in the lower stratosphere is proved by the fact that to-day we have heavy bombers flying at heights ranging from 30,000 to 40,000ft. Why stop at 40,000ft., one might say! Why not go up to 60,000ft. or even higher?

It sounds quite plausible for the man-in-the-street to make some such suggestion, but let us consider the conditions which exist in the stratosphere. There, visibility is poor, as the 'plane would be flying in perpetual twilight deepening from purple to black; there would be no radiant heat to the air crew, the sun would look like the moon, and there would be no clouds. In fact, the world of stratosphere flying is a weird, Wellsian one.

Another important item which must be considered is that the higher the 'plane goes the rarer becomes the air. Thus, an engine capable of developing 1,000 h.p. at sea-level would find its h.p. cut down considerably at 40,000ft., and, as the 'plane went higher, the efficiency of its engine would drop alarmingly.

Yet again, difficulty would be experienced in igniting the fuel owing to lack of air. This would necessitate fitting the engine with specially designed turbo superchargers in order to prevent the engines becoming starved for air.

Aircraft engineers would also have to build a special type of pressure cabin in order that the crew could breathe freely at great heights, devise a method of enabling the crew to bale out, and finally a means of arming the machine.

New U.S. Fighter

A NEW single-seat fighter, which saw much service in Tunisia with the Allied Air Forces, is the American-built Warhawk.

Produced by the Curtiss-Wright Corporation, the Warhawk is a development of the Tomahawk and Kittyhawk. Its chief difference is that it is powered by a Merlin engine, built in U.S. by the Packard Motor Co., who have been supplied by Rolls-Royce with blue prints.

The Miles M.28

A MACHINE which has recently gone into service with the R.A.F. is the Miles M.28, which is a new training and reconnaissance aircraft. It can also be adapted for freight carrying and ambulance work. Its main constructional features are a retractable undercarriage and constant speed airscrew, but there are many others which have not previously been incorporated in a low-powered trainer. The machine is fitted with a 150 h.p. engine, and pilot and instructor can sit side by side in an enclosed cabin.

The M.28 has a wing span of 30ft. 6in., and an overall length of 22ft. At a rated altitude of 7,000ft. the maximum speed is 176 m.p.h., and cruising speed 166 m.p.h.

700 m.p.h. Wind Tunnel

A NEW wind tunnel is being built at Pasadena, California, jointly financed by the Consolidated, Douglas, Lockheed and North American aircraft firms. Costing over $2,000,000 the tunnel will be capable of testing speeds up to 700 m.p.h.

Contra-rotating Airscrews

THE U.S. Air Force are now using a large number of contra-rotating variable pitch airscrews. Built by the Curtiss-Wright Corporation, the airscrews have been specially designed for use with 2,000 h.p. engines, and are considered to be the first six-bladed dual-rotation airscrews with the blade pitch electrically controlled. According to a statement made by Curtiss-Wright they increase by approximately 5 per cent. the high altitude efficiency of aircraft capable of a speed exceeding 400 m.p.h. The blades are of hollow steel, constant speed, feathering type.

Tank Buster

THE Hawker Hurricane IID is now in service, fitted with two 40 m.m. cannon. This machine has had a great success in the African campaign by destroying many tanks and vehicles. Each cannon weighs 320lb. and one is slung under each wing. Streamlined fairings are fitted and despite their bulk the appearance of the aircraft has not been spoilt. Sighting is carried out by firing tracers from two ordinary machine-guns.

Long Range Delivery

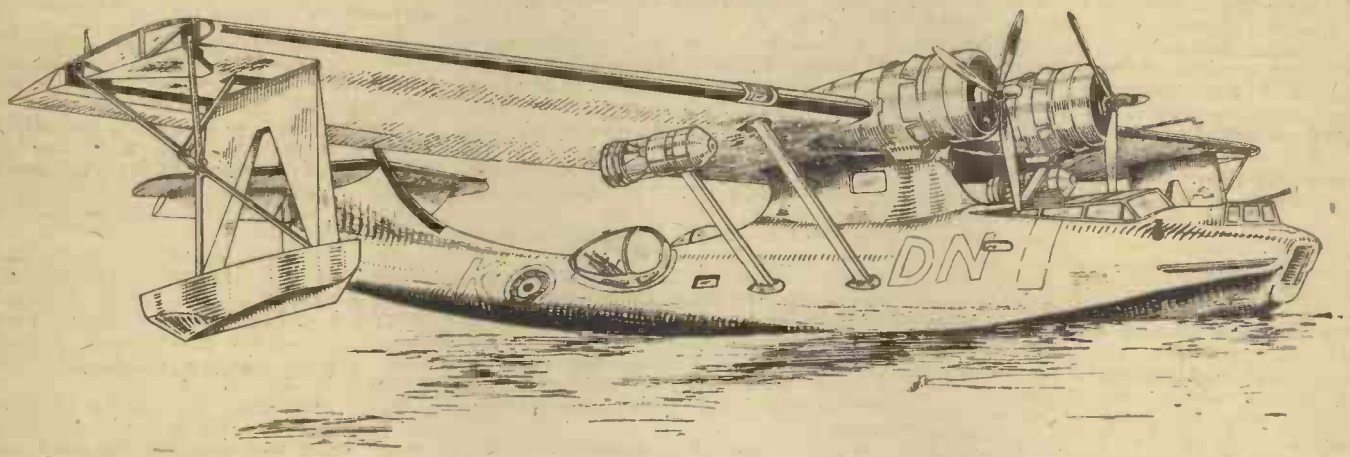
EXTRA fuel tanks have been fitted to several American single-seat fighters, which enables them to fly non-stop across the Atlantic. Lockheed Lightnings, Thunderbolts and Warhawks are amongst the aircraft fitted with long-range tanks. By this plan their delivery is speeded up and the risk of loss through U-boat action avoided.

A Lockheed Vega Ventura with its "props" rotating to warm up the engine prior to taking off for a daylight raid, somewhere on the Continent.

AIRCRAFT ON ACTIVE SERVICE

2.—The Consolidated Catalina

By L. H. HAYWARD



The Consolidated Catalina Flying Boat.

THE Consolidated Catalina, designated as a General Reconnaissance flying boat by the R.A.F. Coastal Command, and as a Patrol Bomber in the United States Navy, is manufactured by the Consolidated Aircraft Corporation at San Diego, California.

The table given below shows details of the three types of Catalina now in service with Coastal Command.

Type	Span	Length	Wing Area	Height	Aspect Ratio	Weight (Max. Load)	Max. Speed in m.p.h.	Alighting Speed	Max. Range	Engines (14 cyl.)	Engine Type	Engine Power
Mk. I.	104ft.	65ft. 2in.	1,400 sq. ft.	17ft. 11in.	7·75	30,500lb.	199 at 7,800ft.	75 knots	4,000 miles	2 Pratt and Whitney Twin Wasp	SC4-G	1,050 h.p.
Mk. II	104ft.	65ft. 2in.	1,400 sq. ft.	17ft. 11 in.	7·75	30,500lb.	199 at 7,800ft.	75 knots	4,000 miles	2 Pratt and Whitney Twin Wasp	SC3-G	1,200 h.p.
Mk. III	104ft.	65ft. 2in.	1,400 sq. ft.	19ft. 9in.	7·75	30,500lb.	185 at 10,000ft.	69 m.p.h	3,750 miles	2 Pratt and Whitney Twin Wasp	SC3-G	1,200 h.p.

Wright Cyclone engines are now being fitted as an alternative, and give slightly improved performance figures. The addition of three retractable wheels has led to a much wider sphere of activity for the MK.III amphibian type.

A unique feature of the design of these giant flying boats is that the wing floats are retracted to become the wing tips, and thereby decrease drag and improve the lift of the wing.

Construction

The monocoque hull of the Catalina is constructed of aluminium alloy, and is divided into seven major compartments by large bulkheads. An aluminium alloy stressed skin covers the all-metal, strut-braced, pedestal wing structure from the leading edge to the rear section, where fabric completes the wing and aileron covering. Fabric is also used to cover the tail-plane elevators and rudder.

A streamlined superstructure supports the wing and allows the engines and airscrews to be well clear of the water. Approximately 1,500 gallons of fuel are carried in the wings, and four depth charges or bombs totalling 1,800lb. can be slung under the wings.

Armament

Two streamlined glass cupolas or blisters are fitted behind the wing, one each side of the hull. The rear portion of the cupola slides up, allowing two machine-guns on a manually-operated mounting to be used. A Vickers gas-operated type of machine-gun is fitted in the nose, and on the later types of Catalina a retractable machine-gun is fitted in the base of the hull just aft of the step.

De-icing strips are fitted to the leading edge of the wings, tail-plane and rudder.

It was decided to equip the MK.III Catalinas with a retractable, tricycle undercarriage to enable them to be shore-based if necessary. The nose wheel retracts into the keel, and the two side wheels retract into the sides of the hull.

Crew

The crew of the Catalina usually comprises two pilots, an observer, who must also be a navigator, a flight engineer, a fitter, two riggers and three wireless operators, and they must all be able to handle the machine-guns. Rest bunks and even an electric cooker are installed for the convenience of the crew.

It is dangerous to send out wireless signals from an aircraft protecting a convoy, and so that the navigator can obtain his bearings without using the wireless transmitter, a direction-finding aerial loop is fitted to the top centre section of the wing, to enable him to take bearings from various radio transmitting stations.

In Service

Catalinas are often patrolling for more than twenty hours at a stretch, and they are nearly always the first Allied aircraft that the convoys see. They took a prominent part in the action which led up to the sinking of the *Bismarck*, their long range enabling them to fly far out over the Atlantic and track down the fleeing German battleship.

Due to the watchful eye that these flying boats keep around our shores, the German submarines have been forced to operate farther afield.

Some while ago, while being delivered across the Atlantic, a Catalina got into grave difficulties when the aileron controls jammed owing to a partial failure of the automatic pilot. The huge flying boat went into a steep dive which was only corrected just above the water, but unfortunately the force of being pulled out of such a steep dive tore both wing ailerons off. Nevertheless, the pilot managed to bring his aircraft safely to England.

An idea of the reliability of the Catalina may be gained from the fact that Sir Hubert Wilkins, the explorer, flew a Catalina over 19,000 miles in his Arctic search for some Russian fliers who were lost during an attempt to fly from Moscow to New York. Although carrying an extra heavy fuel load, supplies and special rescue equipment, the flying boat gave a perfect performance in spite of the bad flying conditions and severe icing-up.

Commercial adaptations of the Catalina have set up new records for flying boats across the continent of America, and it is to be expected that they will be widely used by air-line companies after the war.

Artillery Through the Ages

The Long-sustained Record of Invention Applied to Cannon and Other Pieces of Ordnance

IT is said that the ancient Chinese civilisation saw the beginnings of gunpowder. Possibly, however, the art of making pyrotechnical powders was known to earlier nations than the ancient Chinese, although it seems to be tolerably certain that the Chinese themselves first harnessed the inherent powers of gunpowder to the age-old chariot of Mars.

The Catapulta

The Romans had their giant catapults, by means of which they were able to hurl masses of stone for some distance through the air, but these contrivances were operated by mechanical means alone. So far as is known, the Chinese may be said to have been the originators of warfare explosives when they tied metal arrows to gunpowder rockets and sent them careering across the sky into the ranks of their enemies.

Apart from this primitive use of gunpowder at almost the dawn of recorded history, no further use seems to have been made of explosive powders until the Moors hit upon the idea and developed it into a crude variety of cannon, which they used successfully against the Spaniards at the siege of Cordova in 1280. The Spaniards subsequently took their cue from the Moors, and, contriving to make better cannons, they afterwards used the latter against them some thirty years later.

From Spain the knowledge of artillery spread to France, and from France to England, the English Army making use of three small gunpowder cannons at the famous battle of Crécy in 1346.

All these early ordnance pieces were, of course, simple, and even crude in the extreme. They were constructed by welding long bars of iron together and by binding the bars with iron rings, which were shrunk on to them hot. The resulting creations were shaped somewhat like an apothecary's mortar, and for this reason they came to be known as *mortars*, a name which has ever since persistently clung to certain types of ordnance. Later, however, the larger mortars became known as *bombards*, these pieces being considered to be the most formidable to an enemy.

Mortars and Bombards

Both mortars and bombards projected stone balls, and, at a much later date, balls of wrought or cast iron, a few hundred yards through the air. Usually these pieces were muzzle-loading, that is to say the charge of powder was rammed into the breech of the cannon before the ball was inserted. Such cannons were fired off at a touch-hole situated in the breech.

Surprising as it may seem at that early date, the artillerists of those days even got as far as designing a breech-loading cannon, which had a movable compartment at the breech into which a charge of powder was inserted before being clamped on to the gun. Technical history seems to record the fact that these early breech-loaders were more to be feared by their gun crews than by the enemy, for very frequently the rapid combustion of the gunpowder charge merely served to blow out backwards the breech compartment of the cannon to the serious detriment of the gun crew, leaving the iron or stone ball almost unmoved in the barrel of the gun.

During the fifteenth, sixteenth and later centuries ordnance designers stuck to the muzzle loaders, these being much safer to operate, although less convenient than the breech-loaders.

As the years went on, the cannons of the nations became larger and larger. The French ones especially became so heavy and cumbrous that they could not be transported without first being dissembled, either wholly or partially.

All the bombards, basilisks, cannons royal, carthouns, assicks, culverins, demi-culverins, falcons, sirens and serpentines which we read about in history comprised merely one variety or another of these simple muzzle-loading ordnance pieces which, in their larger sizes, were dragged from place to place by means of teams of oxen. Some of the later cannons of these types were mounted upon trunnions so that they could be elevated or lowered at will. Cast-iron cannon balls also came into universal fashion.

The Howitzer

In the seventeenth century the initiative in cannon construction had passed to Holland. The Dutch originated the howitzer, which was originally a very short type of bombard into which iron projectiles would be introduced rapidly by hand. Movable gun-carriages also came into practical existence in this century, and the elevating screw was invented by means of which the muzzle of the gun could be raised or lowered rapidly at will.

In the eighteenth century there rose up in France a celebrated artillerist named Gribeauval, who, about 1765, invented many different types of cannon. He made them lighter and stronger, even going to the extent of introducing ultra-small howitzers which fired a six-pound iron projectile. Gribeauval effected numerous improvements in gun carriages. He introduced the principle of inserting the charges of powder in paper or cloth bags, and he also enormously improved the mechanism of the elevating screw which raised or lowered the cannon.

Napoleon

It was with Gribeauval's improved system of artillery that Napoleon Bonaparte scored his earliest successes and thus rose to the not very enviable status of Europe's scourge. Napoleon, in his triumphs, operated with cannons which, basically, were identical with ordnance of the very earliest type. The explosive shell was more or less unknown to him as a practical means of attack, although at an earlier date projectiles had been designed which contained a charge of gunpowder which was fired by lighting a fuse *before* the projectile was inserted into the cannon.

With the opening of the nineteenth century, however, an entirely new principle in firearms came into existence. This new principle came from the ingenious brain of a Scotch clergyman, the Rev. Alexander Forsyth, minister of the kirk at Belhelvie, near Aberdeen. The Rev. Forsyth was an amateur sportsman who had a passion for grouse shooting. He was dissatisfied with the performance of his flint-lock gun, which operated by causing a piece of flint to strike against the steel edge of a pan containing a quantity of priming powder, which latter was ignited by the resultant spark and consequently set fire to the main charge of the weapon.

Detonation

Alexander Forsyth wanted something more certain in the way of sporting-gun action. He made numerous experiments, and eventually success came his way, for on July 4, 1807, he patented a gun which directly ignited its charge of powder by means of a "detonating powder" (consisting mostly of potassium chlorate), which was struck by a hammer as soon as the gun trigger was pulled.

The new principle of Forsyth was a highly successful and even a revolutionary one. There is a story about Napoleon offering the Scotch minister £20,000 for the patent rights of the gun, although perhaps little reliance must be placed upon the authority for this.

Nearly ten years later—in 1814—came the percussion cap, the invention of Joshua Shaw, which was originally the little steel cylinder (later a copper one) filled with a mixture of mercury fulminate and gum. The blow of the hammer on the percussion cap detonated the mercury fulminate and so exploded the powder charge in the gun barrel.

A few years before the introduction of the percussion cap, General Shrapnel, an English Army officer, introduced his well-known shell principle. The original shrapnel shell consisted of a thin canister filled with lead bullets. It had an internal charge of powder and a fuse which was lighted by the firing of the gun. This type of explosive shell has been much improved since then, but, even in modern times, its principle remains the same.

The Columbiad

A distinctive type of cannon known as the "Columbiad" came out about 1812. It was the invention of an American officer, one Colonel Bomford, who, it will be seen, had not an inappropriate name for an individual of his inventive propensities. Bomford's "Columbiad" was a long-chamber ordnance piece. It combined the most desirable qualities of the cannon, the mortar and the howitzer, and it was capable of projecting solid shot and shrapnel shells at very high angles of elevation, for which reason it was particularly adapted for coastal defence work.

Many of the mid-Victorian cannons of Russian and other manufacture were based upon the Bomford "Columbiad," and not a few of these pieces still survive as relics of a military age now gone by.

Rifling

About the middle of the last century rifled cannon came into use, mainly through the endeavours of an American, General Rodman, and his scientist-assistant, Dr. W. E. Woolbridge. The success which had been attained in rifling small arms was applied to cannon. At first the principle did not operate very well, and it was not until Dr. Woolbridge, in 1850, invented the device of a metal ring which was *softer* than the metal of the gun barrel and which was fixed at the rear of the projectile, that the rifling principle functioned satisfactorily. Previously attachments had been fixed behind the projectile, and these either stripped off when the gun was fired or else stripped the

barrel rifling during the passage of the projectile along it.

The introduction of cannon rifling, which imparted to the projectile a spin or rotation on its own axis as it speeded through the air, enormously accentuated the accuracy of cannon fire. Cannon rifling was, of course, preceded by the introduction of a serviceable breech-loading gun in various forms, these guns being strengthened by a system of wire-winding invented by Woolbridge which consisted in closely and tightly coiling wire over the barrel of the gun, thereby giving it extra strength.

Krupp, and Armstrong and Whitworth

Notable advances in the mechanism and reliability of breech-loading guns were made at Essen by Friedrich Krupp. Krupp eventually went in for constructing large breech-loading steel guns, the first of his guns of this category being exhibited at Paris in 1867. Essen, in 1870, produced, under the ægis of F. Krupp, the largest steel gun which had ever been seen. It weighed 72 tons and was 32ft. long. It fired a shell weighing 1,660lb., it being estimated that if the gun were fired at an angle of elevation of 43 degrees, the shell would be carried a distance of some 15 miles.

The barrel of an old English field cannon which is nowadays serving as a street corner post.

An old Russian siege gun and undercarriage which was used at Sevastopol in 1855.

Krupps 2nd Field Cannon of 1849. It was shown at the Great Exhibition of 1851.

A modern mortar; its shells are fired by being dropped down the barrel by hand.

A German howitzer captured during the last war.

A modern field gun, firing 18lb. shells.

In England inventors were not slow to realise the possibilities of the new steel guns. Sir William Armstrong, the noted machinist, in 1885, built up a gun of wrought-iron bars twisted tightly into coils and then applied over a steel core and secured in position by two or more wrought-iron rings which were shrunk over the barrel at white heat.

Armstrong's earlier guns were smooth-bore ones, and they were also muzzle-loading. On the other hand, they were of immense calibre, weighing about 100 tons each.

Afterwards, Armstrong applied the breech-loading principle to his guns. Blakely, another inventor, constructed improved cannon out of steel tubes, the whole having an outer jacket of cast iron, whilst the renowned Sir Joseph Whitworth came out with his all-steel cannons and his compressed steel projectiles.

Since the days of Krupp, Armstrong and Whitworth heavy ordnance production and invention has proceeded apace and, sometimes, at a recognisably competitive rate between the artillery designers of England, Germany and France. The invention of gun-cotton, dynamite, cordite and the high-explosives, such as T.N.T., naturally revolutionised artillery science and practice. Range-finders and other artillery equipment came gradually into being, designers and inventors vying with one another in the production of the most accurate and foolproof forms of these necessary appurtenances.

A race between armour-piercing shells and shell-proof armour plate developed and went on at an extensive rate. The problem was mainly a metallurgical one, and it was investigated by means of the new metallurgy which arose towards the end of the last century. It is a race which is still being run. Perhaps, indeed, it may comprise a variety of competition which may never be conclusively ended.

The 1914-18 war saw most of the modern theories of lifelong artillerists put into active practice. Bigger and bigger guns were constructed, as witness the "Big Bertha" of the Germans. It became realised, however, that in this matter of "outsize" cannon it is possible for a designer to overreach himself in view of the enormous amount of strain and wear which is placed upon such giant pieces of ordnance.

The present war has tended so far to take the emphasis off large-size cannon in consequence of the development of aerial bombing, to say nothing of rapid tank warfare. Nowadays combatants choose to get to closer grips with each other rather than to rely upon the technique of heavy ordnance firing. The pendulum, to some extent, has swung the other way. What it may do in the future, of course, no one knows, for if war is not abolished altogether there may come the era of the heavy cannon fired as rapidly as the present-day machine-gun, and even, in time, the introduction of the "atomic gun" operating under the colossal energy-release of atomic disintegration.

A Cycle Crank Attachment

By H. H. VALENTINE

THE accompanying sketch shows an attachment I have fitted to my tandem, and which enables me to once again pedal with both legs, and so use a variable gear. Of several disabilities, owing to active service with the R.A.F., one to my left leg left it with only a very small amount of knee movement.

I tried the usual one-leg cycling with a low fixed gear; but found I was limited to level roads. And, as I live in a hilly district, I gave up the idea of cycling altogether.

After finding myself a partner I tried the one-leg idea again; this time on a tandem. But once more was forced to give it up, as it placed too much work on my partner.

The idea then came to me that, as I can bend my leg a little, there must be a certain diameter I could swing, even though quite small. So I made up a wooden "hook-up," and with this I proved that I could turn a 4in. crank, if it could be arranged to radiate around a centre that was lower than the bottom bracket, and farther forward.

The "hook up" determined the position of this centre; which in my case was as shown on the sketch.

This attachment is to be a temporary measure for the duration, but I hope in time to incorporate a train of gears instead of sprockets and chain, thus lowering the frictional resistance.

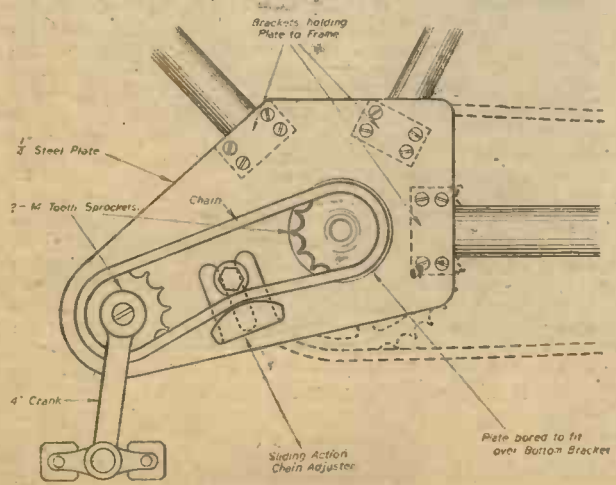
It will be noticed that although I had to lower the centre on which the short crank revolves, I still retain the standard ground clearance, owing to the shortened crank.

I now feel inclined to try myself once again on a solo, and I feel there are many (and will be more) who, owing to leg injuries, could avail themselves of this idea. The length of crank and position of centre could only be determined by the person concerned.

The rear sprocket is welded to the stump of old crank, so that it could be "cottered" on. Part of remainder of crank was used, welded to front sprocket boss, to give me the 4in. crank. I found that two brackets will securely hold the plate if used on a solo machine.

The front sprocket runs in a plain bronze bush, a grease nipple at rear of sprocket stub feeding grease to the bearing.

I might add that after two or three short runs there was no unusual sensation, as might be expected when pedalling on two centres.



Cycle crank attachment.

Testing Glass Bottles

IN a modern bottle works, bottles are taken at random from every given consignment and subjected to a number of tests. The internal strain in the glass can be examined by means of polarised light. There is also an impact test, in which a steel hammer is allowed to hit the bottle with varying intensities of impact. There is, too, a test which subjects jars and vessels to alternate treatments with cold and boiling water, noting the percentage of fractures among a given number of bottles so tested, and there is, in the case of bottles, the "bursting test," in which water is hydraulically compressed within the bottle and the bursting pressure noted. Finally, it is possible to subject the bottles to chemical tests for their resistance to corrosion and attack by any given liquid which the bottle may be expected to contain. These, and other specialised tests, are all part and parcel of the daily routine which is little known by the public at large, yet such tests contribute to the convenience and safety of almost the entire population of the country, for, in one direction or another, we are nowadays all bottle, jar and bulb users.

Many articles of bottle and bulb-ware are nowadays subjected to various "finishing" operations before leaving the factory. Take, for example, milk bottles. These are frequently lettered by means of sand-blasting, or by means of low-temperature fusible enamels which are burned on to the glassware in special enamelling furnaces. Other glassware articles may be acid-etched with mixtures of sulphuric and hydrofluoric acids.

Myford Parting-off Attachment

THE Myford Engineering Company, Limited, of Beeston, Notts, have just introduced a new parting-off attachment for use on their 3⅛in., 3½in. and 4in. centre lathes. The attachment permits heavier cuts and faster speeds to be used in parting-off, turning, screwcutting, knurling and cutting operations in general. The patented damping action eliminates chatter and the periodicities set up by tool vibration, thus enabling light lathes to perform heavier work than was previously practicable.

The attachment consists of a torsion bar, one end of which is mounted on a specially shaped bracket bolted to the cross-slide, as shown in the accompanying illustration. The other end of the torsion bar is attached to the top of a long tool-post stud supplied with the attachment. In practice the torsion bar flexes and provides damping without visible movement.

The Myford parting-off attachment.

The Story of Chemical Discovery

Rare Earth Metals

An Enduring Triumph of Chemical Endeavour

RIGHT in the middle of the International Table of Chemical Elements there occur the names of some fifteen metals which few people, professional scientists included, have ever seen.

Where is the reader of this journal who has ever set eyes upon dysprosium or lutecium or europium or ytterbium? How many, indeed, are even the day-by-day practising researchers, the chemists and the metallurgists, who have ever handled a sample of metallic erbium, holmium or praseodymium?

So rare, in fact, are these metals that, with a few notable exceptions, they are practically unknown to all but a few isolated chemical workers, who have made the manipulation and the separation of these metals and compounds their speciality.

They are called the "rare earth metals" on account of the fact that they are extracted from a few rare minerals or "earths" which are scattered here and there throughout the world. So excessively rare are some of these metallic elements, notably the element illinium, discovered as late as 1926, that it has never been found possible to accumulate a sufficient quantity of their chemical compounds from which to prepare the pure metal. Hence, metallic illinium, and also metallic lutecium, thulium and probably ytterbium, have never been isolated.

To the ordinary student of chemistry these rare earth metals must, for the present, remain more or less non-realisable elements. The majority of us must be content to read about them rather than to see or to handle them. For the "rare earth" metals are, for the most part, really rare. Their extraction and production is not, as in the case of radium, the subject of "control" by financial and commercial "rings."

Yet, surprisingly enough, although any one of the rare earth metals comprises a modern chemical curiosity, there must exist in the earth's crust a substantial amount of such element. Furthermore, it has been remarked by many observers that as soon as a commercial use is found for an element, that element (or its compounds) sooner or later appear on the market in increasing quantities. Since, therefore, there is no denying the truth of this undoubted fact, we must assume that the rare earth metals are only relatively rare, and that if an important use were to be found for, say, the metal gadolinium, that metal, or its compounds, would gradually appear on the market in slowly increasing amounts and at correspondingly decreasing prices in consequence of the more intensive search which would be made for new sources of this metal and for new, more economical and speedier methods of extraction and purification.

Phenomenal Similarity

Apart from their relative rarity, the one curious feature of all the rare earth metals is their almost phenomenal similarity. This fact, coupled with the exceedingly small amounts of material which experimenters and researchers have had to work on, has constituted the great stumbling-block to a more complete knowledge of the properties of these still somewhat mysterious metals and their compounds. It is well within reasonable conjecture that many of the rare earth metals, if they could only be produced cheaply and economically, would exhibit valuable properties. Indeed, it is almost certain that such would be the case, since it is difficult to imagine a group of fifteen different metals without at least a few of its individual members having some features and qualities of economic import.

But Dame Nature, it seems, has dealt out the rare earth elements to us with a very grudging and stinting hand. Perhaps even

Dr. Carl Auer von Welsbach, discoverer of rare earth elements, and inventor of the incandescent gas mantle, which provided the first commercial use of rare earth elements.

more so than the radium elements, and certainly more so than the platinum family of metals, the rare earth metals are among Nature's own curiosities. They are her museum pieces, the natural commodities which she has not produced in any abundance and which, indeed, for the most part, she appears to have been loth to produce at all.

Let no one imagine that all the rare earth elements are discoveries of our modern times. On the contrary, their story goes back precisely 140 years to the year 1803, when Martin Henry Klaproth, a Continental chemist, discovered a new "earth" when analysing a mineral from Sweden. The new element was named "cerium" in honour of the minor planet, Ceres, which had been discovered in 1801.

Commonest Rare Earth

It was not until 1826 that metallic cerium was first prepared in small amount and in the impure state by the chemist, Mosander. Cerium nowadays is the commonest of the "rare earths" in view of its presence in monazite sand. It is, as we shall see later, practically the only rare earth metal which has attained some industrial importance.

For more than a century after the discovery of cerium, chemists brought to light traces of other rare earth elements. Many of these new elements proved to be imaginary ones and, after a brief existence in scientific papers and other records, were found to be complex mixtures of known elements. The story of the many "false elements" which have been reported at various times from the world's laboratories has never been narrated fully. It would make an absorbing account, but, for space reasons alone, it forms a subject which cannot be entered into on this particular occasion.

After the discovery of the element cerium in 1803 nearly forty years went by before other elements of its class began to be brought to light. In 1839 the chemist, C. G. Mosander, separated the oxide of an unknown element from an "earth" which he thought to be pure ceria or cerium oxide. This new "earth" he termed *lanthana* (from the Greek, *lanthanein*, "to hide"), and, at a later date, when the new metal was first isolated, it received the name of "lanthanum."

In 1841 Mosander hit upon another new "earth," which he showed was the oxide of a then unknown metal to which the name *didymium* (Greek, *didymos*, "hidden") was applied. A couple of years later—in 1843—the same investigator analysed a Swedish "earth" called "yttria." This was known to contain the oxide of the metal yttrium. However, Mosander found that his sample of yttria was not of the 100 per cent. order. In fact, he found that the material actually contained the "earths" or oxides of two related elements which he named *erbium* and *terbium*.

It transpired ultimately that Mosander's didymium preparations were not entirely pure, although they remained unchallenged for nearly forty years. But in 1879 an enthusiastic French chemical worker, Lecoq de Boisbaudran by name, separated another element, which he named *samarium*, from didymium oxides, whilst later, in 1901, E. Demarcay, another Frenchman, managed to show that Lecoq de Boisbaudran's samarium compounds were not absolutely pure. From them, by most delicate chemical processing, he obtained traces of a new element which he named *europium*.

Carl Auer von Welsbach

The French investigators did not have the field of the rare earth elements quite to themselves. Their great and powerful rival happened to be the famous Dr. Auer von Welsbach, of Berlin, the man who first managed to turn one or two of the rare earth elements into a commercial proposition. Von Welsbach, in the year 1885, by means of the fractional crystallisation of a nitric acid solution of didymium ammonio-nitrate, obtained traces of two other new "rare earth" metals which he named *neodymium* (Greek, *neos*, "new") and *praseodymium* (Greek, *prasinos*, "green"), and which long and unwieldy names, despite many protests at various times, have stuck to these rare metallic elements ever since.

In 1907 Georges Urbain, another Frenchman chemist, who was also a pianist and a composer of music, a painter and a sculptor, discovered *lutecium*, which he named from *Lutetia*, an ancient title for Paris. Metallic lutecium has not yet been isolated. Only the oxide, chloride and sulphate of this element have been prepared and studied.

The list of the rare earth metals has apparently been completed by Hopkins, Yntema and Harris, members of the University of Illinois, who, as previously mentioned, in 1926 succeeded in obtaining spectroscope indications of the presence of a new metallic element to which the name *illinium* (after the University and State of Illinois, U.S.A.) was given. Other workers have since proved conclusively the existence of illinium, but, to this day, the metal and its salts are quite unknown in the pure state.

The investigation of the "rare earth" elements has ever called for the highest

precision methods of which chemical science is capable. The greatest riddle concerning them has always been bound up with the problem of adequately separating them one from another. Added to this has been the fact that most of these rare earths have only been discovered in the rarest of rare minerals, and that the available quantities of such natural material have been of the smallest order.

It follows, therefore, that the gradual sorting out of the fifteen rare earth elements and the subsequent study of their compounds constitutes a veritable triumph of chemical research, the more so, perhaps, because such work has not been spectacular in any way. Even at the present day, "rare earths" is still very much the subject of the chemical specialist, and doubtless it will remain so until more economic uses are found for some of these strange, almost unseen metals and their compounds.

It is not possible here to give a complete picture of the mode of separation and purification of the various rare earth compounds. In general, however, the mode of procedure is on the following lines.

"Opening-up" a Mineral

First of all, the specimen of rare earth mineral is chemically "opened up." This operation comprises the pulverisation of the mineral into a fine powder and the treatment of the powder with hot dilute sulphuric or hydrochloric acid. The acid-treatment removes all the foreign matter and leaves an insoluble mass, which consists more or less of the mixed oxides of the various rare earth metals contained in that sample of mineral.

The residue from the preliminary acid treatment is subjected to the action of hot concentrated sulphuric acid over a number of hours, the purified residue of mixed rare earth oxides being "digested" in the hot acid. A solution containing the sulphates of rare earth metals results. This is further chemically purified. Finally, it is treated with oxalic acid, by which means it is possible to sort out the resulting rare earth oxalates into three groups of varying solubility.

After this, each of the above groups is subjected separately to the process of fractional crystallisation. This means that one rare earth salt will be very slightly less soluble than another rare earth salt of the same group. Consequently, the first crop of crystals which is obtained will be slightly richer in the less soluble rare earth salt.

By this very slow and exceedingly delicate and tedious means it is, by conducting hundreds of separate crystallisations, possible gradually but surely to sort the mixed rare earth salts out until each particular group of crystals becomes purer and purer, finally attaining almost a hundred per cent. standard of purity. The process of fractional crystallisation, which often takes many months to complete, may be likened to a sort of chemical comb, whereby one particular rare earth salt is pulled out this way, another that way, a third in still another way, and so on until at last the whole intensely complicated bag of tricks has been systematised and reduced to its elementary constituents.

Fractional Precipitation

An analagous process is that of "fractional precipitation." In such a process a very weak solution of a precipitating agent, such as ammonia, is added to a very dilute solution of the mixed "rare earths." As a result, the more insoluble of the rare earths tend to become preferentially precipitated. By collecting this precipitate and re-dissolving it, and then afterwards re-precipitating it, the precipitate is made richer in one or more particular rare earth compounds. This process is, as in the case of fractional crystallisation, repeated again and again over a period of months, the eventual result being that gradually a collection of precipitates is obtained, each being specifically rich in one particular rare earth metal.

The Rare Earth Metals at a Glance.

Metal	Symbol	Atomic Number	Atomic Weight	Discoverer	Year
Lanthanum	La	57	138.92	Mosander	1839
Cerium	Ce	58	140.13	Klaproth	1803
Praseodymium	Pr	59	140.92	Welsbach	1885
Neodymium	Nd	60	144.27	Welsbach	1885
Illinium	Il	61	146 (?)	Hopkins	1926
Samarium	Sm(Sa)	62	150.43	Lecoq de Boisbaudran	1879
Europium	Eu	63	152.00	Demarcay	1901
Gadolinium	Gd	64	157.30	Marignac	1880
Terbium	Tb	65	159.2	Mosander	1843
Dysprosium	Dy	66	162.46	Lecoq de Boisbaudran	1886
Holmium	Ho	67	163.40	Cleve	1879
Erbium	Er	68	167.64	Mosander	1843
Thulium	Tm	69	169.4	Cleve	1879
Ytterbium	Yb	70	173.04	Marignac	1878
Lutecium	Lu	71	175.0	Urbain	1908

Meta Elements

For a considerable number of years it was doubted whether many of these rare earth elements were really elements at all. The famous Sir William Crookes suggested that some of them at least might be considered as being merely fractions of or different phases of one and the same element, and to such fractions, as he supposed them to be, he applied the name "meta elements."

But Crookes' "meta element" theory did not solve the riddle of the rare earths. The majority of chemists still clung to the belief that they were essentially separate and individual elementary bodies. The matter was brought to a head in 1913 when H. C. J. Moseley, of Manchester University, devised a most ingenious spectrographic method of examining the properties of the various elements and their compounds and by means of which he proved conclusively that the various rare earth elements were definitely true elements and not, as it were, various fragments or modifications of the same element.

Moseley was unknown at that time. When, in 1914, the European war commenced, he joined up with the Forces, and, at the early age of 27, met his death during the ill-fated Gallipoli expedition. The enduring nature of his scientific work remained to be realised later.

Although, in a purified state, the rare earth metals are so exceedingly scarce, the mixed metals have, in our days, become increasingly common. This apparent paradox came about in the following way.

When Dr. Auer von Welsbach was trying out his hand at sorting out the various rare earths he hit upon the idea of impregnating a cotton or linen thread with a solution of rare earth salt and then of holding the thread in a non-luminous bunsen flame. The thread itself quickly burnt away, leaving a filament of rare earth oxide which glowed brightly just as a lump of lime will glow when held in an oxy-hydrogen flame.

Welsbach found that his rare earth thread would glow vividly at temperatures much below that of the oxy-hydrogen flame, and that it would, in fact, glow in an ordinary non-luminous gas flame. He discovered that the best glowing agent comprised a mixture of 99 per cent. thorium oxide and 1 per cent. cerium oxide.

Seeking to commercialise his discovery in the manufacture of incandescent gas mantles, Welsbach found that his best source for thorium and cerium lay in monazite, a widely scattered mineral. But since monazite contains much more cerium than thoria, Welsbach soon found that his cerium compounds accumulated in unwanted amounts.

Lighter Flints

His next problem therefore was to find a method of utilising the excess cerium products which accumulated in his incandescent mantle factory. He converted the cerium-containing residues to metallic form, and, apparently accidentally, he ascertained that the resulting complex alloy of rare earth metals gave off a shower of sparks when struck with a hammer.

Thus was born the present-day lighter "flint," which consists essentially of an alloy of iron with the cerium group of rare earth metals obtained from monazite. An alloy containing from 30 to 35 per cent. of pure iron gives the best sparking results, and has been adopted as a standard throughout the world.

It is therefore not of small interest to remember the fact that some of the rare earth metals, which, in their pure state, have up to the present remained almost totally unknown, are present in small amount in the nowadays universal petrol or automatic lighter flints. Cerium, lanthanum, scandium, praseodymium, neodymium and samarium are present (in addition to iron and other metals) in these miniature metallic lighter "flints," but, of course, their individual amounts are so small that only the highest of expert chemical skill would suffice for their detection and identification.

Carbide Tipped Tools

WE understand that the Ministry of Supply has advised firms that greater use should be made of Carbide Tipped Tools in view of the higher cutting speeds and the greatly increased production which result from their use. This instruction was issued quite recently, and we have since investigated the position and found that nearly every manufacturer of the sintered carbides is over-stocked with orders and delivery is not too rapid. In view of the labour situation, and the fact that greatly increased output will be expected in the coming offensive from a gradually diminishing personnel, we have set up a Tungsten Carbide Tipped Tool Advisory Service, and we welcome inquiries from manufacturers on this subject. Most of the firms supplying Carbide Tipped Tools, which permit higher cutting speeds than was hitherto thought possible, are inundated with orders, and therefore firms who are now intending to turn over to this inevitable development in cutting tool practice may wish to be advised as to where they can obtain quick deliveries of Carbide Tips, and high speed steel. Letters should be addressed to us, and envelopes should be marked "Carbide Tips," c/o The Editor, PRACTICAL MECHANICS, Geo. Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2.

Sound-on-film Amplifier Designs

Practical Circuits for Reproducing Film Sound Tracks

By DONALD W. ALDOUS, M.Inst.E.

THE essential elements required for the transformation of a film record into its electrical image consist of an exciter lamp, a lens system and a photo-electric cell. (See Fig. 1.) Thence considerable amplification is required to raise the feeble output of the photo-electric cell to a power-level sufficient for operating a loudspeaker.

The exciter, or exciting lamp, is the source

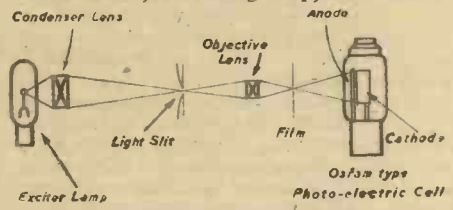


Fig. 1.—Sound-head optical unit. The condenser, slit and objective are all sealed in a small tube, with focusing adjustment sometimes provided for the objective.

of the pencil of light projected upon the film sound track moving at a constant speed through the sound-head. The light is thereby modulated, and falls upon the photo-electric cell. This exciter is a low-voltage lamp with single-coil bar filament, fed either from batteries or more usually from a circuit in the amplifier providing raw A.C. at the correct voltage. To prevent the light flickering with the A.C. pulsations, causing undesired modulations in the photo-electric cell circuit, it is necessary that the filament possesses sufficient thermal inertia, i.e., it does not heat and cool too rapidly, and so generally the exciter lamp has a thick filament consuming 7.5 amps. or 5 amps. at 10 volts. It might be mentioned that motor-car head-lamp bulbs, of either 6 or 12 volts, can be used with success. For really high-grade sound reproduction, however, rectification is used to provide a smoothed D.C. supply. Fig 2 shows a circuit, employing a metal rectifier, designed for this purpose.

Essentials

The essential characteristic of the photo-electric cell is that it must emit electrons at a rate proportional, within certain predetermined limits, to the incident light. The cell comprises two electrodes, one, the cathode (a photo-active alkali metal, e.g., cæsium, rubidium, potassium, or sodium) and the other, the anode, whose sole function can be regarded as an electrical conductor. (See Fig. 3.)

An inert gas at a low pressure is introduced into the bulb of the photo-electric cell, and the cathode-emitted electrons ionise this residual gas so that, when a sufficient voltage is applied, the current is amplified within the cell itself. The amount of this amplification is limited by the ionisation voltage, that is, the voltage at which a visible glow discharge takes place, as this "blue-glow" effect is self-perpetuating and injurious to the photo-cell.

Polarising Voltage

A polarising voltage of between 90 and 120 volts, dependent upon the type of cell, is placed across the cell through a high-value resistance, so that in operation the cell produces, across this resistance, a voltage

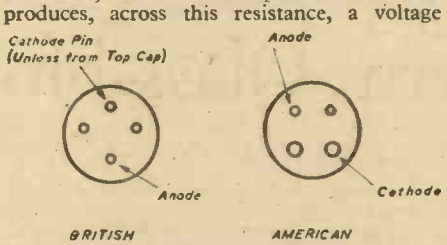


Fig. 3.—Photo-cell base connections, as seen from underside. Most cells fit ordinary British or American valve-holders; others are carried in a clamp.

that is proportional to the incident light. The photo-cell can be considered as a resistance which varies directly with the quantity of light falling on it.

The basic photo-electric cell circuit is shown in Fig. 4. In a high impedance circuit such as this, interference is readily picked up and, if not excluded, will cause serious distortion in the reproduction. As the energy level is so small, the induced currents may be appreciable in comparison with the sound currents themselves. Because of the low level of this power, it is unwise to transmit it any great distance before amplification. Therefore, an amplifier, known as a P.E.C. or pre-amplifier, is usually placed immediately adjacent to the photo-cell circuit to amplify the power to a level at which it can be safely transmitted.

Pre-amplifier Circuit

A suggested mains-driven pre-amplifier circuit, using an H.F. pentode, is shown in

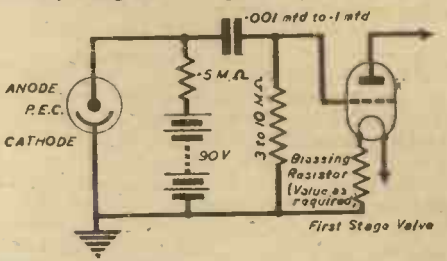


Fig. 4.—The basic photo-electric cell circuit, showing coupling to first valve of the pre-amplifier.

Fig. 5. It is generally necessary to follow the preliminary amplifier with a main or power amplifier, which latter feeds the loudspeaker. Amateur "talkie" constructors may wish, however, to utilise an existing amplifier for this purpose, e.g., radio-set or radio-gramophone To ascertain whether the gain of such an amplifier is sufficient the photo-cell can be coupled to the pick-up sockets in the following manner. Take a very short lead, preferably screened and braiding earthed, from the anode pin of the cell to the 90-volt positive tapping of an H.T. battery. Then join a 0.5 megohm resistor in series with a 0.001 to 0.006 mfd. non-inductive condenser. Join the mid-point to the cathode pin of the photo-cell. Plug the free end of the resistance into the negative socket of the H.T. battery, and with another very short lead, connect this minus socket also to the earthed pick-up terminal of the radio-set, etc. The free end of the condenser should then be plugged into the pick-up terminal connected internally to the grid of the valve in the radio-set, etc. All leads must be very short, not more than 3in. or 4in., which necessitates the cell and battery being placed adjacent to the back of the radio-set, etc.

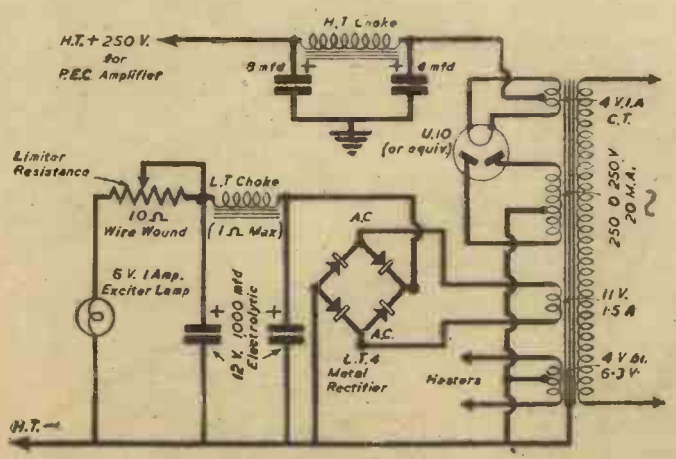


Fig. 2.—Smoothed D.C. power supply for exciter lamp, using L.T.4 Westinghouse metal rectifier. The limiter resistance should be adjusted, after 10 mins. operation, to pass 5.9 volts.

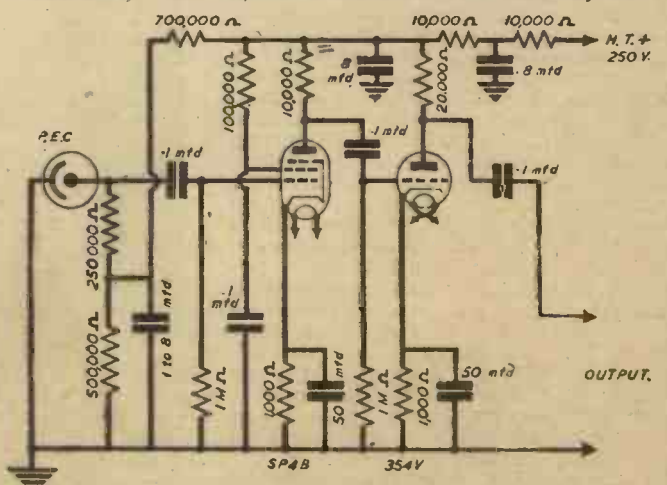


Fig. 5.—A mains-driven pre-amplifier circuit, using Mullard SP4B (H.F. pentode) and 354V valves.

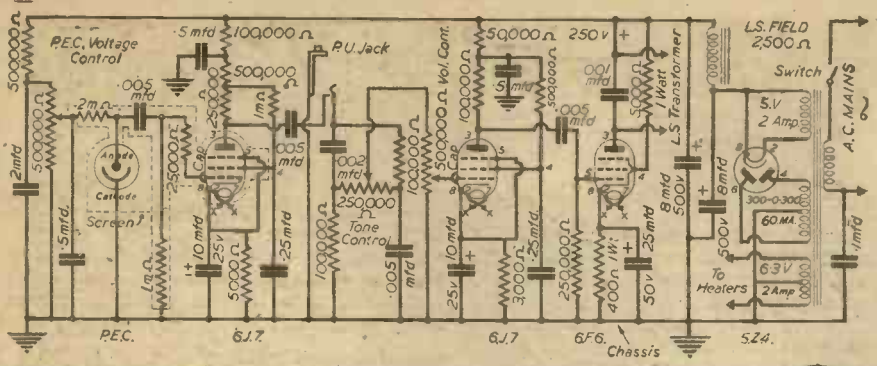


Fig. 6.—Circuit diagram for A.C. mains-operated sound-film amplifier using the following International octal type valves—two 6J7's, feeding 6F6 pentode output, with 5Z4 rectifier. The International octal base, with key to valve base numbering, as seen from underside, is shown in the insert.

Sound-film Amplifier

A recommended circuit, with values of components, etc., for a complete A.C. mains-operated sound-film amplifier, is shown in Fig. 6. Two H.F. pentodes (6J7's) are used, giving an overall gain of about 7,000. These valves are preferred to high-gain triodes on account of their freedom from microphonic troubles. The controls include volume, tone and P.E.C. voltage and provision is made for inserting a pick-up. Bass or treble lift is possible with the tone control. All resistors can be of the 0.5 watt type, unless otherwise indicated, and condensers should be of the paper type, test voltage 400 at least, unless electrolytic types are indicated by the usual plus sign on the positive side. The output stage and power supply use a 6F6, giving about 3.5 watts, and a 5Z4 rectifying valve respectively. An energised loudspeaker of approximately the stated field resistance should be used in conjunction with this amplifier.

It is very important that the pre-amplifier stage be carefully screened, so it is advisable to enclose the first valve (6J7) completely, with its grid connection, in a screening-can. The 25,000 ohm resistor should also be inside this can, close up against the valve grid-cap. A perforated metal box to contain the entire amplifier is very helpful, but a metal or metal-lined chassis at least is essential. Suitable alternative valves to those shown in Fig. 6 are two Osram KTZ63's feeding KT63, with U.50 rectifier. Cetron CE-1 to CE-7 and Osram CMG8 or CMG22 type photo-electric cells are recommended.

The main features to which special attention should be paid are (a) keep grid leads as short as possible, preferably using co-axial screened wire, with earthing, to grid connections (top cap of valves); (b) keep high-tension leads well away from the photo-cell part of the circuit; (c) run the output leads, of separate pre-amplifier designs, e.g., Fig. 5, which go to the input terminals of the radio-set or main amplifier, in earthed screened wire. To summarise, careful arrangement of the components allows short direct wiring and prevents interference between the various stages.

Modern Glass-blowing

The Triumph of Mechanisation in an Age-old Industry

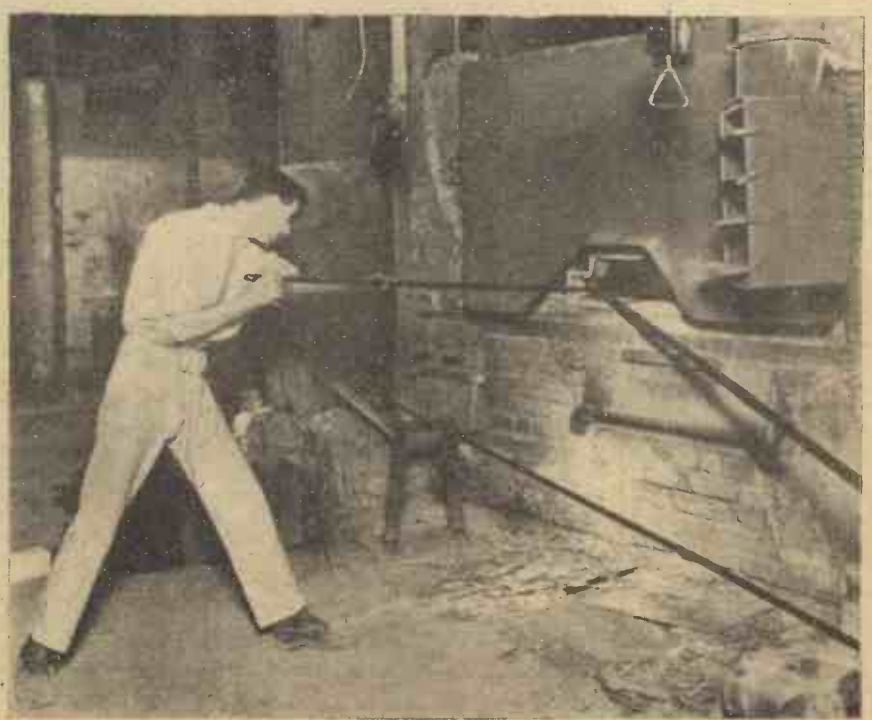
THE art of glass-blowing is as old as the glass industry itself. That is to say, it dates back some thousands of years, for glass-production, at least for ornamental purposes, is one of the oldest of arts, glass-workers being represented on some of the ancient Egyptian hieroglyphic monuments. All the go-ahead nations of antiquity have practised the once very difficult process of blowing molten glass or glass-substance into bottles, vases, and other shapely vessels, ornamental and utilitarian alike, and, indeed, it is only within comparatively recent times that the centuries-old technique of the traditional glass-blower has been materially altered.

The glass industry is a large one, having many ramifications and divisions. Glass, even in these modern days of colourless and transparent synthetic resins, is such a ubiquitous and indispensable material that its technology forms a highly important branch of applied science. Yet, chemically speaking, glass is a relatively simple material, whose composition is well known, and whose properties, thanks to the activities of a generation or more of glass technologists, can now be controlled with great exactitude.

Essentially, glass consists of a mixture of metallic silicates which, in its simplest form, is produced by fusing together a mixture of soda, lime, and clean sand in the correct proportions. Bottle glass, with whose production we are mainly concerned in this article, is produced from sand, limestone and soda ash, the latter being nearly pure carbonate of soda. For the finest types of transparent bottle and container glass, very pure sand must be used, and it is an unfortunate fact that Britain is not too well supplied with such material. For the making of a high-grade container glass, a sand containing not more than about 0.02 per cent. of iron oxide is required. Since the war began, the British resources of such high-grade sands have been carefully reviewed and conserved, and some additional ones have been opened up, as, for example, the soft, powdery sandstone deposits of Loch Aline, in Argyllshire. Glass of lower quality for bottle making may, of course, be manufactured from the cheaper, more plentiful and lower grade sands which are contaminated with iron and other elements.

Bottle Glass Manufacture

In principle, the chemical production of ordinary bottle glass is a simple operation. The raw materials of the glass are weighed in their necessary proportions, and they are charged mechanically or by hand into the furnaces or "pots" in which they are melted up. In nearly every case a quantity of old and broken-up glass, called "cullet," is admixed with the raw materials of the glass, the resulting mixture which is fed to the furnaces being known as the glass "batch." Frequently, the "batch," before being charged into the furnace, is run over a magnetic separator, which picks out any particles of iron which the "batch" may contain, thereby guarding the final colour of the glass.



An operative at work.

As previously remarked, sand of high purity is usually needed for the manufacture of a good, transparent glass, but it is possible, in the instance of slightly iron-contaminated sand, to add to the "batch" certain chemical decolourising agents which will tend to neutralise the effect of the iron, and which will, therefore, aid directly in the production of a clear glass. The best decolouriser for glassware is arsenic oxide, and this is used to a large extent. Other decolourisers are cobalt oxide, selenium and sodium selenite, and also manganese dioxide.

Owing to the fact that flints were originally used in place of sand to make the clear types of glass, such varieties are still known as "flint" glass, despite the fact that flints have long ago been displaced by high-grade sand for this purpose. Such material contains lead oxide, and is used for thin-blown and heavy cut-glass table wear. Imitations can be made of this type of glass, and these, too, are known as "flint" glasses.

By adding to the "batch" which is charged into the glass furnaces certain other chemical substances, mainly metallic oxides, it is readily possible to "dye" or stain the glass almost any desired colour. Blue glass, for example, can be produced by adding as little as 0.02 per cent. of cobalt oxide to the "batch," while "bottle green" glass is produced by admixing iron and manganese oxides (sometimes up to 5 per cent. of each) with the "batch."

Common brown bottle glass is made by adding some variety of carbon material, with or without admixture with sulphur, to the batch. Mixtures of this type are often of secret composition.

Furnace Operation

Present-day furnaces for the production of glass fall into two divisions—"pot" furnaces and "tank" furnaces, the former comprising specially-constructed crucible-like containers made from specially-chosen, highly-refractory clays. "Pot" furnaces are used for the more specialised forms of glass production, and not for bottle making.

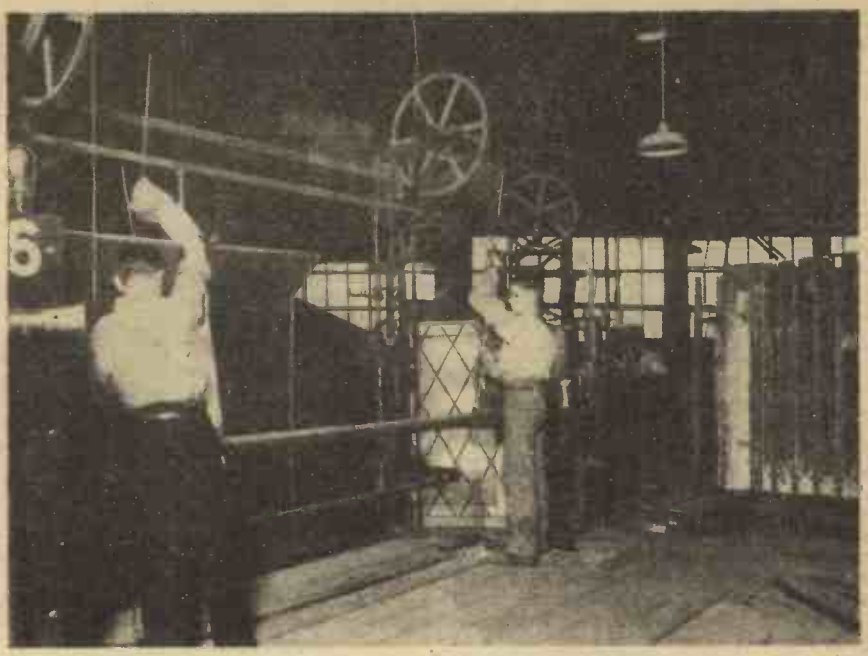
The "tank" glass furnaces, which are used for the manufacture of all the coarser glasses, consist essentially of large containers capable of holding from 100 to 200 tons of molten glass. They are built up from bricks baked from refractory clays, and usually they are erected in batteries. In nearly every case the large "tank" furnaces are mechanically charged with the "batch," the latter being fed to them either continuously or at frequent intervals. Such furnaces operate continuously, the molten glass being discharged without intermission at the "working end" of the furnace, which is the end opposite the charging end.

In the continuous-working "tank" furnace for glass bottle manufacture, a dividing wall is built across the furnace, this wall being nearer to the "working end" of the furnace than to its charging end. The dividing wall separates the furnace into two portions—known technically as the "melting end," and the "working end." In the dividing wall (known as the "bridge") there exists a tunnel-like aperture (called the "throat") through which glass from the "charging end" of the furnace slowly runs to the "working end."

The heating of the average tank furnace for glass production is usually done on the well-known regenerative principle, the flames playing directly down on to the molten material in the furnace. Producer-gas firing is usually employed, this fuel being cleanly and cheap, and the furnace is fired from opposite sides alternately, a reversal of the firing side taking place about every half hour.

Glass "Refining"

During the operation of a glass furnace, care is taken to ensure that the molten glass has had ample time to "refine." This means that the small air bubbles which form in the molten glass must have been allowed to rise to the surface of the material. Sometimes this "refining" is allowed to take place in the working end of the tank furnace, but, because this latter end is usually at a lower temperature than the melting end of the furnace, the refining should have been accomplished before the glass reaches the latter portion of the furnace.



The sheet being cut off at the top of the annealing tower into the required lengths by an electrically-operated cutter.

In past times, bottles, jars, and other glass containers were made by "hand" blowing, and, to a small extent, this method is still practised nowadays. In the hand blowing of bottles, the working end of the furnace is provided with a number of small orifices through which the molten glass can be withdrawn. These are known as "working holes." The glass-blower takes a long iron tube, known as a "blowing iron," pushes it through one of the "working holes" of the furnace, and into the molten glass therein, giving the tube a slight twist so that a globular mass of thick, molten glass is collected on the end of the implement. Quickly withdrawing the tube from the furnace, the operative blows down the pipe, thereby forcing the viscid glass into a bulbous form. Next comes the operation or "marvering," which consists of rolling the newly-formed glass bulb backwards and forwards on an iron plate or bed, this operation improving the shape of the glass bulb. Finally, the "marvered" bulb is rapidly inserted, whilst still on the end of the blowing iron, into a divided iron mould which can be opened and closed by the foot of the worker. A final blowing is given to the bulb, and this, combined with the restricting effect of the mould, results in the production of a bottle-shaped container on the end of the blowing iron. After its solidification, the bottle, still on the end of the blowing iron, is removed from the mould, and the bottle is then severed from the blowing iron by applying to it a cold iron tool just above its neck. This cracks the neck across, leaving the freed bottle with a jagged neck, which is smoothed off and finished subsequently by hand in various ways.

Very little "hand" bottle and bulb blowing is carried out nowadays, for the bottle blowing trade is nowadays almost completely mechanised.

Bottle-blowing Machines

A bottle-blowing machine is a marvel of modern mechanism, far too complicated in detail to be capable of precise description within the space of a column or two of print. There are several types of these machines, differing in principle, some semi-automatic, some completely self-operating. The fully automatic machines, which are capable of working at high speed for bottle production and for the making of electric lamp bulbs, such the molten glass into moulds by the operation of a vacuum. The glass is then blown into shape by means of compressed air, and even the age-old operation of "marvering" is imitated. Finally, from the first forming-moulds, known as "blank" moulds, the initially-formed bottles are mechanically transferred by various means into "finishing" moulds in which they are blown into their final and accurate shape.

A few mechanical glass-blowing plants operate by compressing the molten glass rather than by blowing it, the charges of molten glass being sucked into the "blank" moulds by the influence of a vacuum and then compressed therein.

After bottles or bulbs have been made either by "hand" or by means of a machine, it is very necessary for them to be annealed. If the bottles were allowed to cool down to normal temperatures very rapidly they would develop internal strains which would frequently cause them to crack, splinter, and even to fly to pieces on the slightest touch or provocation. In order to prevent such occurrences, the bottles and other articles of blown glassware are annealed by passage through a "lehr," or annealing furnace.

In its modern form, the "lehr" is not a furnace at all. It consists of a very long tunnel through which the blown glass is mechanically conveyed at a slow speed. The first part of the lehr is well insulated thermally. In it, the bottles attain a uniform temperature. The remainder of the lehr is not insulated, so that, during their slow progress through it, the bottles are cooled down to an almost normal temperature. At the discharging end of the lehr, workers quickly remove the bottles from the conveyor belt, rapidly examine them for flaws, separating the rejected bottles, which are subsequently broken and recharged to the glass furnace as "cullet."

Making a Success of Your Photography

Portraits and Groups

By JOHN J. CURTIS, A.R.P.S.

THE "Snapshots from Home" League of the Y.M.C.A. has turned many of us into amateur "professional photographers." We have been asked to take portraits of the relations of men serving in the Forces and have had the privilege of entering their homes and in most cases taking a family group.

Many have undoubtedly gained much experience by doing this and there may be some who have got well beyond the errors which I am going to mention, but which, unfortunately, are still very common in this type of amateur camera work.

A short while ago when staying at a guest house in the country, I found a small group of six of the guests standing in a straight row in front of another who was about to make a snap; they were all staring at the person taking them and the usual funny remarks were being passed round causing much amusement and also movement.

Being in time I offered to take the group with the owner of the camera in it, if they would allow me to arrange the members in my way. Assent was given, so I soon split the party into two groups; one of four, the other of three, and with a space of about 2ft. between the groups. A chair was used in the first for a fairly tall person to sit in, on the right of this a short person sat on the grass and on the left was placed one tall and then one of medium height. Two feet space, and then the small group was arranged, all standing, but in the order of medium, tall and short. These three were turning towards each other as the centre one was talking; in the case of the four, the one on the grass was engaging the attention of the other three. The arrangement of the individuals was on the lines of that known as "triangular" composition; the interest in the two speakers gave the idea of a "conversational" piece or setting and more particularly to prevent any one being "camera conscious." If that group had been taken as originally arranged, each member would have been striving to "look pleasant, please," and the result would have suggested a row of window models in a showroom.

A pleasing photograph of an unposed group.

Natural Expressions

The best possible *likeness* that can be taken of a person is obviously one where a natural expression is depicted and this must be one that is frequently to be seen on his or her face. Many professional photographers work on this, and in order to get that familiar expression will engage in general conversation for a few minutes before making the exposure, and they will also use some artifice to attract the eyes away from the lens of the camera. This, then, should be your aim when taking your friends; those happy records we often make on a ramble, picnic, on the beach or in the garden can be made quite pictorial if we give just a little more thought in the arranging.

Assuming you are on a walk in the country with four friends; here is a stile, so get one of the party to sit on this, another leaning on it but slightly turned to face the person on the stile, a third can be standing looking at the fourth who should be sitting on the grass, and they should be centring their interest on possibly the one who is leaning on the stile.

If the party is of three only, cut out the standing one, having one on stile, one leaning on it, and the other sitting on the grass. You will have gathered sufficient to recognise that where all are of the same height you must break up the top and base lines to prevent straight regular lines.

Now let us give a little thought to another familiar portrait study. A friend with a dog or cat. Here again your aim should be to get a natural pose. Place your friend at the right distance from the camera taking care to get his feet and some space in the foreground in the viewfinder, or on the focusing screen, and then ask him to entice the dog to his side and to speak to the animal so that its head is lifted up. Should your friend be a lady, and the animal a cat, let the lady be sitting down and she should entice the cat to be looking at her.

Quite a number of this type of photograph are spoiled by the person holding the cat facing the camera, or rolled up as a bundle on the lap, and often fast asleep.

Should the animal be a horse, then have the person standing at its head either talking to it or feeding it with a choice "tit-bit" out of his or her hand.

Single Portraits

When taking a portrait of a single individual, avoid, if possible, strong, hard lighting such as direct sunlight; usually the most natural position is a half-profile. Focus on the eyes and be sure that the distance scale is correctly set if you have to rely on your view-finder. Remember that you cannot focus with the view-finder; this will only indicate whether or not you are including the whole of the subject on your film, therefore if your distance is wrong you will get a result that is fuzzy and may not yield the result you would like. The features should be allowed to relax; do not permit too much of a smile. Glasses are a drawback, but the difficulties of light reflection can sometimes be avoided by a slight turn or movement of the head. If the subject is a lady who is in the habit of using lipstick, you will be well advised in asking her to remove it; usually it is of such a colour as to appear black in the final print.

A "natural" snap of two persons.

Large Groups

When taking large groups of 30 or more persons, it is impossible to avoid arranging them in rows, but here again care should be taken to prevent numbers of short or tall individuals sitting or standing together. Mix them as much as you can and thus avoid repetition of straight lines.

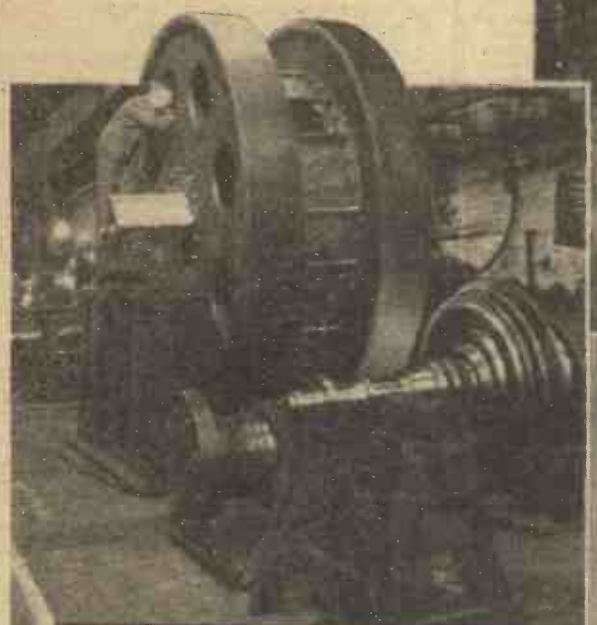
Apart from arranging the folks that are being photographed in a pleasing and artistic manner, the main idea which the photographer should have in mind is to avoid camera consciousness in his subjects, a fault that spoils many an otherwise good study and yet is so easy to prevent, either by a few words on an engrossing and interesting topic, or by attracting the eyes away from the lens. Do not keep your friends waiting too long before you make the exposure, as this is often the cause of a look of annoyance or weariness; wherever possible have all the preliminary preparations made beforehand and remember the first thing to be done after the exposure is to change the film. I mention this piece of advice because often one's attention is diverted immediately these "portrait" exposures are made, by one of the group asking a question and the film consequently remains unchanged.

I will conclude by suggesting that when you are out with a couple of friends a most interesting portrait study can be obtained by taking them standing in a country road in earnest conversation, discussing some object or even examining a map or signpost—if in normal times; offering a light for a cigarette or pipe provides a good position for two persons.

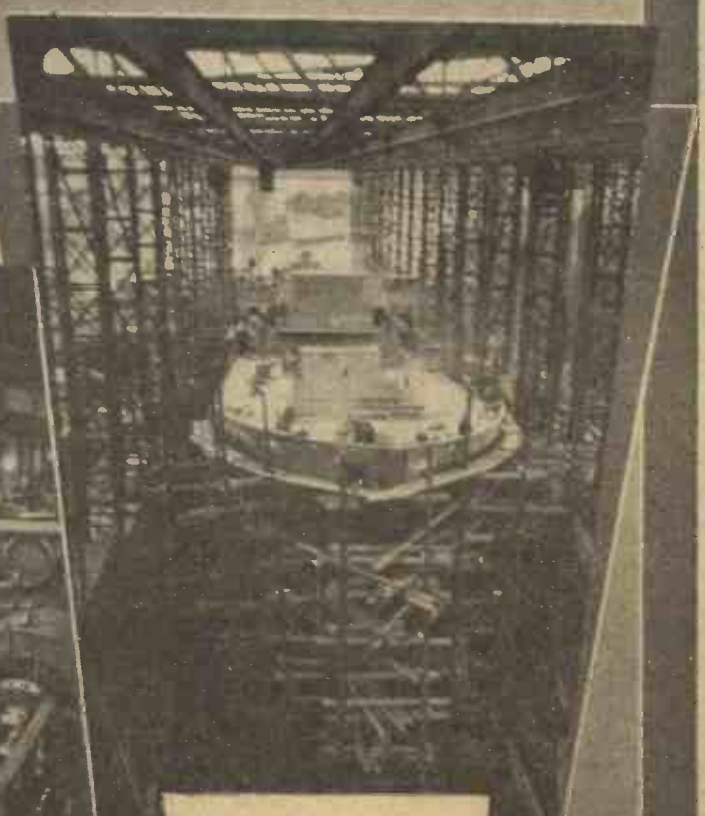
Building Our New Cargo Ships

To combat the U-boat peril the shipyards of this country are busy building cargo ships to replace those lost by enemy action. In the words of Lord Leathers, Minister of War Transport, our ship construction policy is to build as quickly as possible fast ships which would carry the maximum of cargo with the greatest measure of safety. These pictures were taken in a British shipyard and show the continuous nature of the work.

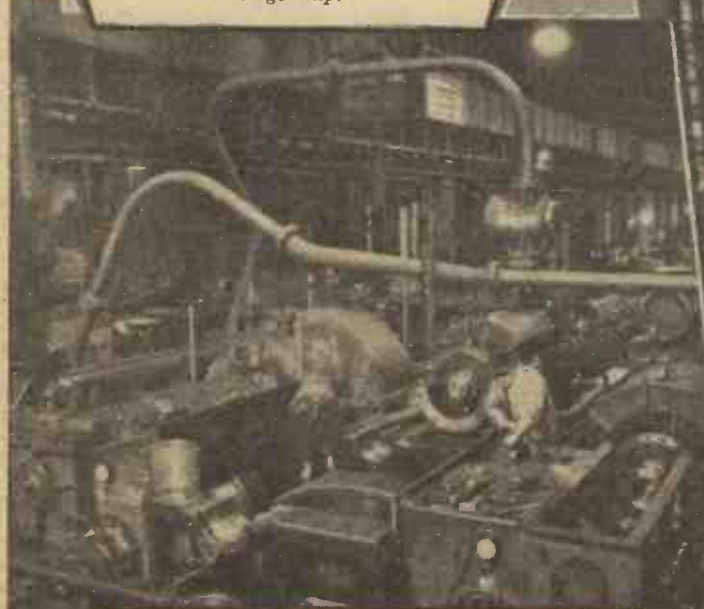
In the centre foreground is seen the keel of a new ship and on either side are vessels in different stages of construction with two new ships in the fitting-out basin beyond.



A scene in one of the workshops showing a gear wheel of one of the engines for a new, fast 10,000-ton cargo ship.



A 10,000-ton cargo ship on the slips ready for launching.



Men at work on machinery for a 10,000-ton cargo ship.

Our Busy Inventors

By "Dynamo"

Anti-vibration Seat

TO prevent inconvenient and harmful jolts and jars to drivers of vehicles and passengers is the *raison d'être* of a newly devised seat. This resiliently mounted chair is designed for use in buses, locomotive cabs, cars, etc. Its aim is to cushion the driver and other occupants of a vehicle against vibration caused by uneven roads and rails. The proposed seat is also available for use in boats or on vibratory stationary machinery.

The inventor of this anti-vibration seat remarks that vehicles with conventional leaf-spring suspensions, even when furnished with shock-absorbers, are at times extremely uncomfortable. This is especially the case when a light load is being carried, he points out, as the vibrations occasioned when the vehicle passes over an uneven road or railway track are not effectively absorbed by the suspensions.

The seat has a chair frame yieldingly restrained against undue movement, and its resilient support has rapid loading and unloading characteristics beyond the normal range of movement of the seat, the direction of the movement being controlled.

The chief resilient support for the chair frame is in the form of inexpensive metal springs, which permit the production of a quantity of such seats at very low cost.

Other features of the device are a chair frame so constructed as to allow of its use in the curtailed space in a truck cab and a seat, strong and durable, which will operate smoothly and easily without attention. Further characteristics are that it is light in weight and has moving parts adequately guarded, so that there is no danger of the sitter suffering injury.

Conductive Footwear

THE same motive which actuated some inventor of long ago to devise a lightning conductor has impelled the invention of footwear of a conductive nature. This is so designed that static electrical charges are not readily gathered by the human body. And, if gathered, such electrical charges are practically instantaneously discharged through the shoe directly to the supporting surface. This surface constitutes an electrical ground or discharge body for the condenser action of the human body.

Footwear of this description is useful in certain industrial plants, such as those in powder factories. It is also valuable in gunnery turrets, powder magazines, on board warships, and in other places where extreme caution is required to prevent accumulation and accidental discharge of electrical charges from the body or clothing of the wearer.

This type of footwear will be found to be advantageous by surgeons, nurses and other attendants in operating rooms, where the fumes of ether and like combustible vapours or gases are apt to be present.

Advertisement Tubes

A SURVEY of recently accepted applications to the British Patent Office reveals the fact that war inventions do not bulk as largely as one might expect. Very many ideas have been conceived with a view to the piping times of peace which hope eagerly anticipates.

An invention that would be useful both in war and peace embodies improvements in illuminated advertisements or signalling devices.

Owing to the black-out, luminous advertising displays have been compelled to suspend their brilliant publicity. But the time will arrive when these displays, which are akin to a Brock's Benefit show at the ill-fated Crystal Palace, will again glow in Piccadilly Circus.

We are all familiar with the type of sign made up of high-voltage gaseous tubing. An inventor who has devoted his attention to this subject states that one objection to the kind of illumination referred to is its fragility. He asserts that, owing to the fact that the tubing is comparatively small in cross section and also to its length, it cannot withstand rough usage or very serious jars.

Dr. J. B. Hanson, of Balliol College, Oxford, has designed and made a small two-seater car which needs no petrol and is constructed partly from three bicycles. It has two wheels in front and three behind, all from bicycles, two sets of pedals and a gear-wheel from the same source. The wood from which the foundation of the bonnet is made was once a tea chest. The illustration shows Dr. Hanson with his wife about to go for a ride on the new cycle-car.

Publicity Protector

THE improved device consists of tubing of the description mentioned embedded in a chemical known as polystyrene. This is moulded about the tubing to form a protective envelope, it being adapted to absorb shocks or jars, thereby preventing fractures. And the polystyrene constitutes a substantial portion of the exterior of the device.

The tubing is incorporated in a plastic carrier of polystyrene, which, before it is cured, is in a liquid or semi-liquid form. Consequently, neither great heat nor pressure is necessary for the curing process.

When the lights go up, this invention will have its opportunity as a glowing advertising medium.

Also attached to an aeroplane it will be capable of producing a signal light which will be useful both in war and peace.

Modern Armour

THE present world conflict has been well defined as a war of engineering. In the days of chivalry armour was extensively used to protect the combatants. It also plays in modern warfare an indispensable part.

A recent application for a patent in this country relates to armour plating of mechanical vehicles, aircraft, tanks, etc., against high-velocity projectiles by means of deflection.

The armour comprises a front layer of granite chippings or shingle, enclosed between steel armour plates, and a rear cushioning layer of sponge rubber or metal shavings. And there is a backing of metal plate or stretched skin.

Bomb and Shell Cases

A PATENT has been applied for concerning a war invention relating to shells. The device concerns the production of cup-like metal articles such as the hollow and usually tapering ends of shells and bomb cases.

The primary object of this invention is to make these articles with the aid of press tools from starting materials of light section. The resulting product is of a strength comparable with that of the correspondingly heavy section articles hitherto produced by forging or turning from rough castings.

In accordance with the invention, the ends of shells and bomb cases are formed from a number of parts separately shaped by pressing, and are assembled and welded together to make a composite structure having great strength of wall.

This device renders possible the production from mild steel plate of light section of ends for projectiles for piercing armour.

The Danger of Dry Rot

Woodwork's Persistent Parasite—Its Causes and Eradication

A portion of a wooden floorboard in an advanced stage of dry rot. Note the cracks and fissures in the wood, and the dry, powdery nature of the timber.

Roof joists which have been rendered completely useless by dry rot.

GOVERNMENT scientists have recently been drawing attention to the hidden but nevertheless enormous and widespread ravages in woodwork and structural timbers of all types which are brought about by that persistent pest, the fungus of dry rot.

It has been estimated that more than a million pounds worth of damage since the war began has been caused to the timbers of empty and semi-ruined houses in this country, and, in particular, to the timbers of bomb-damaged buildings which, owing to lack of adequate care and protection, have been exposed more or less continually to damp and humid conditions.

Quite apart from this type of damage, however, there is to be considered the ever-present year-by-year destruction which the "disease" of dry rot works up and down our land in buildings and structural edifices of all varieties. This we may term the "normal" damage, and it is over and above this that the damage resulting from the dry-rot infection of bombed buildings has taken place.

A Malignant Destroyer

Dry rot is a deadly enemy of woodwork, its malignancy being all the more serious in view of the insidiousness of its attacks. The rot is a rapid destroyer of woodwork of all kinds. Once in the grip of dry rot, there is little hope for an infected area of timber because the creeping tentacles of the rot fungus penetrate into the wood cells themselves, feeding upon their substance and quickly weakening them beyond all hope of regeneration.

It is commonly supposed that dry rot attacks only unseasoned timber. This, however, is a fallacy. The rot fungus, whilst showing a preference, in many instances, for such kinds of woodwork, will infest any variety of timber, seasoned or unseasoned, if it is given the right conditions under which to act. Even the hardest of oak is by no means immune from the fateful fungus. All wood cells provide food for the ever-advancing dry rot filaments, and hence there is no wood which can be said to be permanently immune from dry rot attack.

There are several species of fungus which can give rise to the symptoms of dry rot in woodwork, but by far the commonest and most universal of these is the fungus to which is given the scientific name, *Merulius lachrymans*. We shall see the implication of this name later.

Fungoidal Filaments

Like all fungi, the dry rot fungus can be propagated by means of its own "spores," or microscopic seeds, or by means of its fine, white, creeping filaments. Sometimes, in the workshop, dry rot infected woodwork is cut through with a saw and the inner filaments of the fungus are scattered on to fresh woodwork, the result being that the latter may become infected. The spores and the filaments of the dry rot fungus are also blown about by air currents, carried from place to place on the soles and heels of our footwear and by devious other means, so that, considering all factors together, it is an exceedingly simple matter for an area of new woodwork to pick up dry rot infection, provided always that it is exposed to the right conditions.

The term "dry rot" has probably been applied to this infection of woodwork in view of the fact that the fungus causes the wood to fall into the state of a dry, crumbly powder. Actually, however, the fungus is anything but a lover of dryness. Indeed, it cannot make any headway in timber which is perfectly dry. Nor, on the other hand, can it succeed in timber which

The havoc of dry rot. Showing a room floor completely disintegrated by dry rot infestation, the white fungus of the rot thickly covering the floor joists.

A perfect example of the pancake-like "flower" of the dry rot fungus. In this example, filaments of the fungus have actually penetrated the mortar of the brick wall from infected woodwork behind and have given rise to the mature "flower" form of the fungus, which, from its convoluted surfaces, scatters countless millions of seeds.

A colony of dry rot fungus filaments protruding from a decayed twig. (Magnified view.)

A dry rot affected plank. It powders up at the slightest touch of a scraping tool.

is really wet. In order to flourish, the dry rot fungus must have timber and surroundings which have a certain optimum amount of moisture, neither too much nor too little. That is why the fungus does not attack deep-mine props which are surrounded by dry, warm atmospheres, and that, also, is why the dry rot fungus *does* thrive exceedingly well in the timbers of houses, and particularly in cellars, where the atmosphere is humid and not too cold.

Under the attack of dry rot, woodwork of all kinds rapidly loses its nature. It becomes dry and crumbly, weaker, more brittle and less resilient. It also becomes lighter in weight. At a fairly advanced stage of the attack, the wood gives rise to a muffled, "dead" sound when it is struck. At this stage, the wood begins to show fissures and cracks, which grow in depth and in extent as the ravages of the fungus proceed. Usually these cracks align themselves at right angles to the grain of the wood and they give to the infected timber a very characteristic appearance. At this stage, too, the wood emits a peculiar earthy smell which is also characteristic of the fungoid attack.

The dry rot fungus belongs to the same fungoid family as the common mushrooms and toadstools. Indeed, given the right conditions of growth, this enemy of woodwork will itself actually develop a sort of mushroom-like flower, which may be seen at times flourishing in the cellars and basement passages of badly dry rot-infected houses. These dry rot "flowers" sometimes attain the size of a dinner plate, and, like the latter, are flat and round. They are yellowish, orange and purple in colour, and their flat outer surfaces are deeply convoluted or, in other words, crinkled.

Weeping Fungus

Growing on the ceilings of cellars, these dry rot "flowers" scatter countless millions of dry rot "spores" or seeds which fall to the floor of the cellar as a brown dust. The fungus "flowers" also slowly drip drops of a yellowish-red fluid (consisting mostly of water abstracted from the woodwork of their surroundings) which give them a very striking and a somewhat ghastly appearance. Hence the name of the fungus, *Lachrymans* (from the Latin, "lacrymo," "I weep") as if the flower of the fungus were weeping with regret for the damage it has caused.

The filaments of the fungus are the parts which do the damage to woodwork. Technically, they are termed *hyphae* (the name, a Greek one, signifying the strands of a web), and, through the microscope, they are seen to comprise very fine, jointed tubes which are more or less full of fluid. These penetrate the wood and they tunnel themselves through the wood cells, feeding as they go, gathering strength and energy, and not infrequently branching into side filaments which, before long, fill the wood completely.

On the outside of the affected wood, these *hyphae* or filaments flourish in a less organised condition. They usually cluster themselves together, forming white, woolly areas on the surface of the timber, not unlike large masses of fresh cobwebs in appearance.

These dry rot filaments growing on the surface of infected woodwork possess almost a strange intelligence of their own, for they often protrude themselves outward from the ends of beams and joists which they have infected and actually creep over the surface of bricks and other non-wooden structural bodies in order to reach a wooden member some distance away. Having thus arrived at the latter, they rapidly penetrate it, and again extrude themselves across non-wooden surfaces in search of other wooden members.

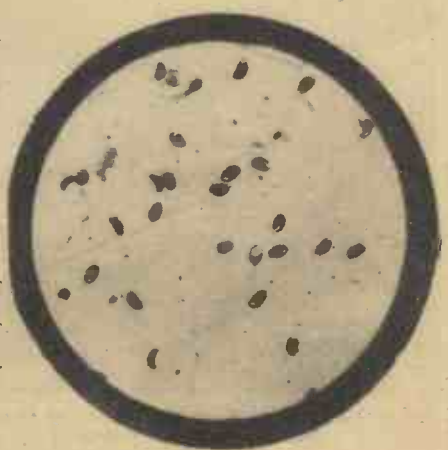
Furthermore, if these wandering filaments happen to meet with an area of woodwork which is normally in surroundings which are too dry to give sustenance to the creeping fungus, the deadly and malignant filaments will quickly suck moisture from the damp areas of their first origin and growth and will convey it through themselves to the dry areas of woodwork, the result being that the latter areas at once become damp and so provide a fertile ground for the further progress of the fungus.

Dry rot fungus, or, rather, its glistening white *hyphae* or filaments will commonly penetrate through the mortar of brick walls in order to reach woodwork on the opposite sides of the walls.

Such is the dry rot enemy of woodwork. Cold does not kill the fungus, nor, for that matter, does an absence of moisture, for woodwork infected by the filaments of the fungus has been carefully dried and kept for months, after which time it has again been exposed to moist conditions, whereupon the fungus filaments have promptly continued their development.

The fungus filaments are, however, definitely killed by heat, any temperature exceeding 50 degrees centigrade sufficing for this purpose. For dealing with surface filaments, therefore, a painter's blowlamp can destroy a great deal of this infection.

Chemically impregnating rope previous to its use in a damp situation. Woodwork and sandbags may be treated similarly, as described in this article. (Left.)



The "spores," or seeds, of the dry rot fungus. Very highly magnified. Each of these minute bodies is capable of infecting a large area of woodwork and of destroying it. (Right.)

Eliminating the Rot

Generally speaking, dry rot eradication is a task calling for radical measures. It is utterly useless to deal with the trouble merely by cutting out the infected area of woodwork and by replacing it with fresh timber, for, after a while (and, usually, with great rapidity) the fresh timber will become infected and it will go precisely the same way as the cut-out portion.

The man who hopes to eradicate permamently any attack of dry rot must start from the standpoint of the certain fact that this insidious fungus cannot gain a hold upon any woodwork which is well aired, that is to say, which is exposed to free air currents. True it is, as previously mentioned, that dry rot filaments can—and do—actually convey their required water from wet timbers to dry timbers, but, obviously, when setting about the elimination of the rot the investigator will naturally endeavour to see that all sources of dampness in the woodwork are done away with.

If dry rot has appeared in any house structure, the only radical measures for its treatment are to investigate the cause of the prevailing dampness and to eliminate such dampness; and, secondly, to replace *all* the infected timber with sound, new stuff, care being taken at once to burn the damaged woodwork.

No hard and fast rules can be enumerated for dealing with damp conditions in houses. It is obvious, in such instances, that consideration must be given to the effectiveness of dampcourses and to the possibility of hidden water leakages, defective drainage systems, and so forth. Care must be taken to see that there is no unwanted condensation of water in the neighbourhood of structural timbers. Roofings must be good and leak-proof. Window casements must be inspected to see that they do not allow rain water to collect under them. Above all things, structural timbers of all varieties and forms *must*, for their well-being and preservation, be placed in surroundings in which an ample amount of air currents are able to impinge on them

Although the dry rot fungus needs oxygen for its development and is killed by exposure to carbonic acid gas (carbon dioxide), the fungus will not develop in a wood which is well exposed to air currents for the reason that such air circulations remove from the wood any accumulations of dampness which would otherwise form a fertile field for the inroads of the fungoidal pest. All attempts, therefore, at eliminating dry rot attacks must necessarily begin by improving the air circulation around the areas of woodwork which have been or which are likely to be infected.

Objection to Oilcloth

In a damp house, it is not advisable to lay oilcloth or linoleum on a ground floor, since this covering will often effectively seal off the upper sides of the wooden floorboards from effective contact with the air. The lino covering will thereby hold down the dampness and will provide truly excellent conditions for the flourishing of dry rot filaments

Treatment of woodwork with antiseptics and fungicides is valuable, but only in conjunction with the removal of infected timber and due attention to the airiness of the woodwork surroundings.

Creosote is the best and the cheapest of these chemical materials which kill the dry rot organism. Dinitrophenol is another material which has been used effectively, but in wartime it is ordinarily unobtainable.

Copper sulphate, zinc chloride and sodium fluoride are other saline substances which can be dissolved in water to make up solutions for spraying purposes. Usually, however, these solutions lack sufficient power of penetration into healthy wood, although they are able to penetrate deeply into dry rot affected woodwork.

B.S.S. Creosote

For most fungicidal purposes in connection with dry rot eradication, ordinary creosote is the best material to use. It should not be the black, tarry material which is often passed off as creosote. The "British Standard Specification" (B.S.S.) creosote should be demanded, this being a much cleaner material altogether.

The objections to creosote for the above purpose are to be seen in its odour and its staining power. Usually, the latter effect is of no consequence, whilst the powerful, sometimes pungent smell of the liquid is fairly rapidly dissipated within the space of a day or two.

It is, indeed, a wise plan to brush light creosote over all areas, wooden, brick, or of other materials, to which it is suspected that the long white fungoidal filaments of dry rot may have had access, for creosote is a penetrating material and its presence spells death to any parasitic fungus with which it may eventually come into contact.

A Simplified Clock Mechanism

A Driving Arrangement for Use in Synchronous or Pendulum Clocks

By C. T. DRUMMOND

THIS simple arrangement can be used with advantage between the spindle that revolves once per minute and that which revolves once per hour in synchronous or pendulum electric clocks and between the spindle in a synchronous clock that revolves once every second or second and a half.

Fig. 1 shows the arrangement in detail, and Fig. 2 an alternative way for the drive to the spindle carrying the seconds hand.

Referring to Fig. 1.

The seconds spindle is shown at 1, and the wheel at 2. 3 is the cam which is snail-shaped. 4 is a lever pivoted at 5. Pivoted to 4 is the pawl 7, resting on stop 8. The spindle for the minute hand is shown at 9 and the wheel at 10. The retaining rollers 11 and 13 and springs 12 and 14. 6 is a spring adjusted to give a slight pressure on to lever 4.

The snail 3 is fixed to the spindle, but if a roller is used at 4A to rest on the snail instead of the actual lever, the snail is loosely mounted and is carried round by a pin on wheel 2, shown in hole drilled in 3 at A3. It will be found in practice that when the tip of the snail reaches the curvature of the roller the snail will move forward without carrying the wheel and spindle with it. As soon as the wheel is further rotated the snail will regain its original position owing to the roller resting against the snail.

The pawl 7 can be made to strike the wheel 10, and be so shaped that it acts as a locking device, preventing the wheel 10 moving more than one tooth forward movement of lever 4.

It will be understood that the seconds hand is settable using this arrangement, and the minute hand settable in either direction without the use of the usual tension spring.

An added advantage with synchronous clocks is that the seconds hand moves as in ordinary clockwork, and the fact that the hand cannot go backwards since that will go forward whichever way the rotor goes.

Referring to Fig. 2, it will be understood that 15 is the pusher mounted to pivot 16 on wheel 17, that is in turn mounted to one of the revolving spindles in a synchronous clock.

If the arrangement as shown in Fig. 1 is used in a synchronous clock between the spindle revolving at, say, once per second to that which revolves once per minute the cam 3 should be fixed to the spindle and be eccentric in shape. In this case spring 6 will have to be adjusted to give slightly more pressure on the lever 4.

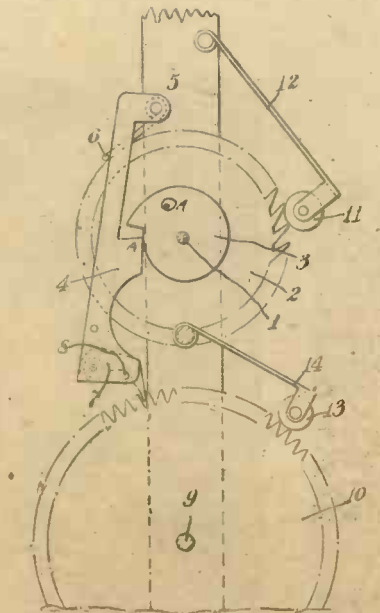


Fig. 1.—Details of the mechanism described in the text.

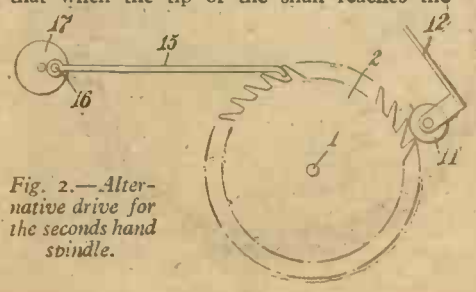


Fig. 2.—Alternative drive for the seconds hand spindle.

IT'S A SMALL WORLD!

A Model that Took Fifteen Years to Build

By "MOTILUS"

EVERY year in pre-war days there was a most popular exhibition held at the Horticultural Hall, in London, organised by Mr. Percival Marshall, of the *Model Engineer*. As readers will remember, it was an exhibition of amateur work of every description—models both working and static, and there was also a splendid display by the various professional model manufacturers and allied trades. It was, in fact, the annual "Mecca" of model enthusiasts.

Fig. 1. — (left) Front view of true-to-scale model of post windmill — scale 1in. to 1ft., i.e., 1/12th full-size.

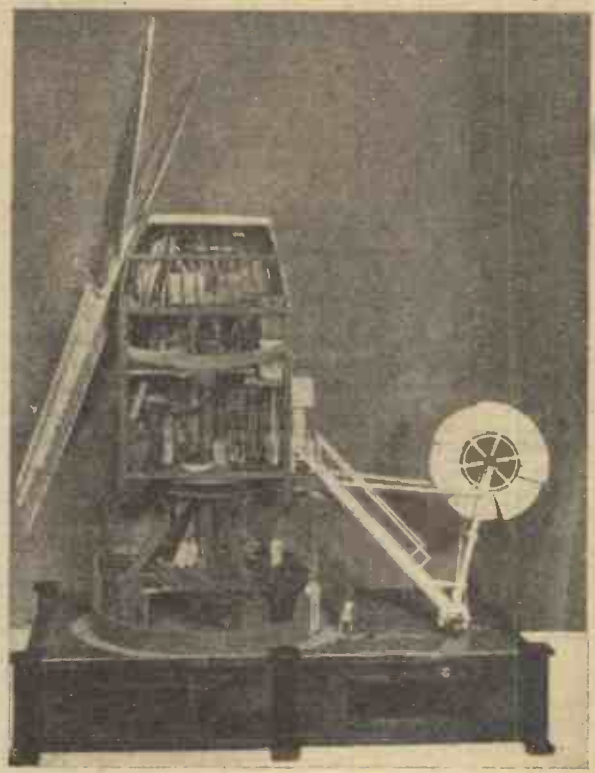


Fig. 2. — (right) View showing the model windmill in section.

At each exhibition there was usually one model looked upon as the "feature," and I have no doubt the model I am going to describe in this article would have been the outstanding exhibit of the 1939 exhibition, which unfortunately had to be abandoned owing to the outbreak of war.

The model represents a mill standing until recently on the Sprowston Road, Norwich, and I have the permission of the model-maker, Mr. H. O. Clark, of Norwich, to publish photographs and give a full description of the work in it, which was done over a period of 15 years. Commenced on June 21, 1924, it was completed in midsummer, 1939, but work was not continuous as time had to be found for sundry small contributions to the *M.E.* and other shows. The model is 1in. to 1ft. absolutely to scale, including cracks and mistakes, and all measurements were made on the spot, from which a scale drawing was made of every detail. The mill was destroyed by fire in May, 1934, only a few days before reparations were to be started from a fund raised by Mr. Clark and his friends. Some parts were not measured—for example, the sack hoist—before its destruction by fire, but the débris and photos gave sufficient information.

Mr. Clark tells me this is the mill shown on Crome's painting in the National Gallery, but without the tail fan, round house and patent sails, which were more recent additions. In Crome's day the mill had an open sub-structure, plain tail pole and common cloth sails.

These are four in number, Cubitts patent, with a total of 192 moving vanes operated by a cross and a clothing rod running through the centre of the windshaft. The sailframes are double-sided, and each sailframe, with its 48 vanes, is a separate unit bolted to the stocks. Each pair of sailframes, together with its stock, is further reinforced by two oak clamping plates outside the box end of the windshaft.

The windshaft is a casting in gunmetal with a hole bored right through. The box end, which carried the sail, had to be made a separate piece for reasons of portability. The thrust at the tail end is a separate coupling piece spigoted and bolted to the main shaft. The windshaft is supported by a half brass (neck bearing) at the head, and a combined thrust and journal box at the tail.

The head wheel is of the clasp-arm pattern in oak, staked on to squares on the windshaft by 12 pairs of folding wedges. The 93 teeth in the face of the wheel are of lancewood, mortised right through and secured by lynch pins at the back. The wheel rim is trued to receive the brake band, made in eight segments of lancewood, connected by pairs of metal straps let in flush. The brake lever extends almost the length of the mill house, and is overweighted so as to be always "on." It is worked from the lowest floor by a rope and triple block.

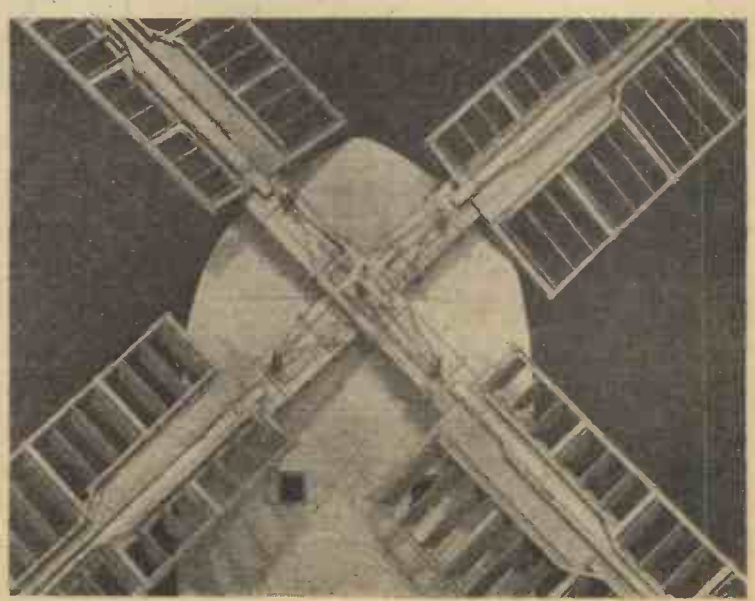


Fig. 3. — Close-up of the sails of the windmill.

Fig. 4.—Close-up of the body of the windmill showing all the fine details which the maker, Mr. H. O. Clark, has incorporated in the model.

Top Floor

The top or dust floor contains the sack hoist and belt transmission gear for the bolter. This shaft is driven by a 25-tooth wheel engaging in the head wheel teeth. On the same shaft is a belt pulley driving downwards a counter shaft on the floor below. This top floor is covered by a Gothic roof of bent ash rafters with a nine-light window. This floor has three corn hoppers and removable covers over the windshaft. There is also a large meal bin running the full width of the mill.

Intermediate Floor

The intermediate (or stone) floor has two fixed single lights in front, and at each side a six-light opening casement with setoffs. The wallower which engages with the head wheel is a bevel metal wheel with 31 teeth, fixed to a square at the end of the vertical main shaft. In the head are two pairs of stones under-driven and enclosed in portable cases (vats) of lancewood, with damsels of metal—bearer frames—shoes—hoppers and canvas stockings to grain hoppers overhead. A cutoff slide regulates the flow of grain and is adjusted by a hand rope below. A similar hand rope adjusts the inclination of the shoe and is also operated from below. In the tail of the mill is a third pair of stones left dismantled for redressing. Tools are shown for this process, namely, a folded sack for arm rest, mill drift or holder for the bills, a selection of bills, a boxwood straight-edge and a steel proof in case for trueing the straight-edge. The stones are made of steel properly furrowed and with the working faces hardened and ground. Steel was adopted, as no stone, marble or concrete has sufficient weight, neither would they retain the edge for any length of time.

On the right side of the mill, just below the sprattle beam, is a counter carrying two pulleys of wood, one driving the flour bolter and the other taking the drive from the hoist shaft. The supply of meal to the bolter is from a hopper, thence to a chute to the underside of the bolter reel. The chute has a shaking action by a four-part cam, and the meal supply is regulated by a metal slide on the hopper. The main inspection door on the front of the bolter has been glazed to expose the working.

Lowest Floor

In the head of the mill are two meal bins with inclined meal shoots with hinged traps from the stones above. The lower end of the main vertical shaft runs in an adjustable foot step bearing-box bolted to an oak beam. The main spur wheel has 84 teeth, machine cut from solid metal, and drives two mortised pinions (stone nuts), each with 26 lancewood teeth. These fit on to the two stone spindles or quants.

Lightering Gear

This differs slightly with all three pairs of stones, but is in each case linked to governors, which decrease the gap between the stones as the speed increases.

Mill Body

Made of oak throughout. The crown tree has a concealed gear-box containing a pair of 2 : 1 bevel wheels for the auxillary running gear.

Round House and Other Details

The outer wall is a cylinder of wood built up in segments, and the longitudinal and vertical indents are formed on inner and outer surfaces to simulate brickwork. Outside the mortar joints are white and the brick surfaces red, inside the whole simulates whitewashed unplastered brickwork.

The main post—first 16-sided, then eight-sided, then square, is of oak, drilled throughout its length for the auxiliary driving shaft. The middle part is cracked and bonded as on the original. At the lower floor level the post has a ball-bearing containing 52 $^{3}/_{16}$in. balls. In the original this bearing has 2¼in. balls of rough cast iron and is considered one of the earliest applications of the ball bearing. The round-house floor is reinforced concrete, and the upper floor contains four hatches for sack hoist, also a wagon loading hatch with hinged door, a dead light with iron doors and hinged storm cover. The ground floor has two doors with hinges and locking bars.

The tail ladder has treads of oak, patched and plated as on the original. The tail vane has six blades mounted on a square axle, running in plummer blocks on top of the carriage posts. The fan shaft has a reducing bevel gear on top of a vertical shaft with a muff coupling and bevel gear at the base. This drives a horizontal shaft with reversing gear midway to bevel gears on the carriage wheels, and at platform level is a bevel wheel with sliding pinion for hand operation.

The outside of the mill body has a roof of weatherboarding, the left side and half the round house being left open to show the interior. The mill is mounted on a stout mahogany frame with four access doors to the driving gear. This is all contained in the wood base and comprises a ¼ h.p. Universal motor bolted to a counter shaft with a jockey pulley. The counter shaft has a hand gear at one end for slow motion, at the other end a 4 : 1 bevel gear on the vertical shaft passing through the post.

Mr. Clark mentions that, although described as a working model, this is not quite correct. Grinding grain requires weight in the stones, thus the actual stones weigh 2,600lb. each; in the model they are a mere 1¼lb. It would be a working model if wheat grains were reduced in proportion, but unfortunately this is not the case! Personally *I* call it an outstanding piece of work, whether viewed as an exhibition model or as a mechanical model, and I hope it will grace many model exhibitions after the war.

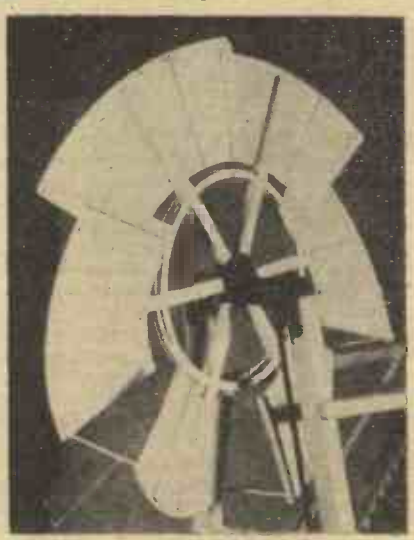


Fig. 6.—The details of the tail vane.

Fig. 5.—Some of the little items which are included in the mill.

Repairing Alarm Clocks—5

Principles of the Escapement

By G. F. LEECHMAN

(*Continued from page 414, September issue.*)

BEFORE the assembly of the escapement is undertaken it is necessary that the principle on which it works should be understood. In the first place it is double-acting—it performs two functions—one to hold up the train so that it does not run down faster than the regulated speed, nor faster than the balance wheel will let it, in fact, and two, to keep the balance wheel moving. For this purpose the teeth of the 'scape wheel (or in some models, the pallets) have two bearing surfaces each (see Fig. 1)

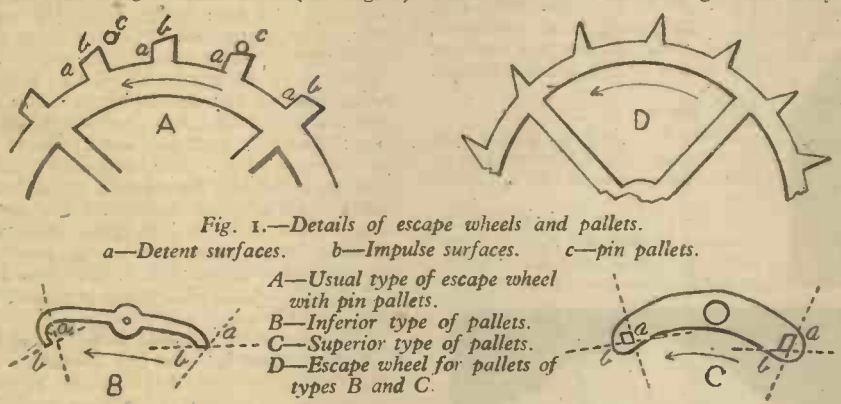


Fig. 1.—Details of escape wheels and pallets.
a—Detent surfaces. b—Impulse surfaces. c—pin pallets.
A—Usual type of escape wheel with pin pallets.
B—Inferior type of pallets.
C—Superior type of pallets.
D—Escape wheel for pallets of types B and C.

one surface to effect the stopping of the wheel from turning, thus holding up the whole train; and an adjacent one to push the pallet over when the stop is released and the wheel is permitted to turn. As it turns it forces the pallet outwards from the centre of the 'scape wheel, this being accomplished by arranging the impulse surface at a small angle with the circumference of the 'scape wheel, so that it acts as a sort of wedge forcing its way past. The other, the detention or detent surface, is made radial to the 'scape wheel so that while the pallet is keeping this part in contact the stoppage of the wheel is complete. The pallets are mounted on a piece known as the lever, at the other end of which is a fork; the whole turns back and forth on its staff, so that the lever is moved to right and left as first one pallet and then the other is pushed outward by the wedge-like action of the 'scape wheel. As the fork moves it actuates the small pin on the balance wheel which has already been referred to when talking of the hair-spring, driving this pin first to one side and then to the other, which has the effect of swinging the balance wheel alternately clockwise and anti-clockwise. If it had no hair-spring (or the hair-spring were not attached by its outer end to the framework of the clock) it would not return, but the hair-spring keeps trying to regain its normal position and in doing so turns the balance wheel back as well. The normal position is such that the pin (or impulse pin as it is termed in the trade) lies on the line joining the centre of the balance staff with the centre of the lever staff (see Fig. 2). If the balance wheel is put in place and the hair-spring pinned in as it should be it will take up this position and on being swung will return to it after vibrating from side to side at a fixed speed. This speed depends upon the weight of the balance wheel and staff, etc. (including the hair-spring) and also upon the length, other dimensions and composition of the hair-spring itself, the whole being designed to give so many vibrations per minute (usually 96, 108 or 120). When the lever is put into place correctly and the mainspring partly wound up pressure is imposed on the 'scape wheel to make it turn; if one of the pallets happens to be bearing on the impulse surface the 'scape wheel will push past it, shouldering the pallet out of the way so to speak, and in so doing will cause the fork at the other end of the lever to give the ruby pin an impulse so that the balance wheel is driven to one side. Owing to the elasticity of the hair-spring, the balance wheel, of course, carries on under its "moment of inertia," so that the ruby pin comes away from the fork and travels round to the other side of the balance staff. Meanwhile, the other pallet pin has been steadily holding up the 'scape wheel from turning, since when the first pallet was pushed out the other had to move inwards and thus made contact with the detent surface of the next 'scape wheel tooth, restraining it and keeping it waiting until the balance wheel in returning will replace the ruby pin in the fork of the lever and carry the lever back to the central position; but now the lever, in moving partly over, has moved the pallet so that the pressure is no longer on the detent surface but is on the impulse surface; so that the 'scape wheel is no longer detained and moves, giving the pallet an impulse as before. This impulse the lever fork transfers to the ruby pin so that the balance wheel is impelled forward, that is, the motion it already has, by means of which it returned the lever to the normal position, is now increased by the lever pushing it on in the same direction so that it travels on while the other pallet now holds the 'scape wheel waiting for the balance to return. Obviously the length of time it has to wait depends on the hair-spring and it can be adjusted by pinning the hair-spring in so that its effective length is correct and the clock will not go too fast or too slow. Regularity is thus ensured, since the hair-spring always vibrates in exactly the same time whether it swings through a large arc or a small one—in this alone it resembles the pendulum. The double acting principle should now be obvious: The lever fork under the control of the pallets first pushes the balance wheel one way, then waits for it to return, then pushes it the other way and then waits again. Bearing these points in mind it will be easy to assemble the escapement correctly.

Assembling Balance Wheel

The next piece to be put in place after the 'scape wheel is the balance wheel in order that it may be adjusted exactly to the normal position already referred to and it is not so easy to do this if the lever is already in place. The points of the balance staff will have been cleaned by soaking in the cleansing fluid and the subsequent polishing with pith; they should, of course, be needle sharp, if they are blunted they must be turned up in the lathe, the hair-spring having been removed after marking on the rim of the balance wheel exactly where the end of the hair-spring is to come when it is put back. Remove the hair-spring by holding the balance staff (not too strongly) in the vice, taking care not to damage the impulse pin, while the hair-spring must, of course, be uppermost. Place the tips of the small pliers under the collet (i.e., little collar of brass) of the hair-spring, taking care that nothing slips or irrepairable damage may be done. If the collet seems too loose on the staff it may be tightened by carefully closing it a little. It is easy to break the balance staff by exerting undue pressure, so take great care and treat it gently. When the points of the staff have been made "like new," replace the hair-spring, having the end pointing the same way as it was before—it is easy to put it on backwards, so make sure by means of a suitable mark. It is also necessary that the hair-spring end should be exactly where it was originally or else, to get the pin in the normal position, the hair-spring will have to be pinned in longer or shorter than it should be, which would make the time keeping of the clock wrong. It is possible to turn the collet of the hair-spring on the staff after it is in position in its bearings, by inserting a fine screwdriver in the slit, or else by holding the collet in a fine pair of pliers while the rim of the wheel is gently but firmly turned the required amount, but in any case it is a dangerous operation in which a slip may be fatal. If a new balance staff has to be made have it a shade longer than the old one in order to allow a little for subsequent wear and polishing and also for wear in the bearings or sockets it runs in. These sockets must be well cleaned out with peg wood, and if they are badly worn they must be shaped up again inside and repolished or the clock will not run satisfactorily. The best way to polish them inside is to put a suitably shaped piece of wood in the drill and load the pointed end with coarse brass polish; holding the small socket in the vice, it should be worked at until a good polish is obtained; the effect of well polished balance points and bearings is very considerable and often overlooked. Take care that these screw sockets, when assembled, are sufficiently loose not to press on the sharp points of the balance wheel either before or when the plates of the clock are screwed down tight; there should be quite enough "end shake" (longitudinal play) in all wheels to be plainly felt, perhaps $^1/_{32}$ in. for the balance wheel is not too much so long as there is only a small amount of "side shake" (that is free movement sideways); too much

would interfere with the action of the fork on the impulse pin, as well as wear away the points of the balance staff very quickly; they and the sockets should be oiled and then the oil cleaned away again so as to leave a sort of greasy effect only; this also applies to the impulse pin, and oil must on no account be allowed to spread over the hair-spring; if the latter is very rusty and a new one cannot be obtained, it might be permissible to put a little oil on to prevent further damage from the rust, but all excess must be carefully removed by means of a piece of pith.

The Hair-spring and Regulator

The hair-spring may now be pinned into place—according to where the mark was made when first taking the clock down. Pass the ends through the pins of the regulator (cleaned and straightened up, if necessary) and then through the hole in the lug in the plate. The pin is then placed very loosely in the hole and one finger kept on the rim of the balance wheel to hold it so that the ruby pin is exactly in the normal position; the hair-spring is then gently adjusted until it is correctly in position so that it lies flat and tidy with the impulse pin exactly in line between the balance staff and where the lever staff will come. When this is correct, press the pin quite firmly, taking care that no slip occurs to damage the hair-spring; at the same time, under certain circumstances, it is quite possible to press the pin in so hard that the hair-spring may be accidentally severed. The next step is to gently and slowly test the regulator, a sudden movement may bend the spring badly as it may not slide freely between the pins if they are not far enough apart; they must not be too loose, however, or they will not restrict the hair-spring enough to be effective. They are designed to make the working length of the hair-spring adjustable and should control it as firmly as convenient without any risk of its getting jammed between them. The curve of the hair-spring near them should be smooth and nearly an arc of the circle centered where the regulator is centred and of the same radius; it should not be necessary to bend the hair-spring to obtain this curve, but if it is, note that doing so may move the impulse pin to one side or other of the normal position, this error will then require further correction by repinning the end of the hair-spring. At the same time, do not move the hair-spring much—a difference of $\frac{1}{10}$in. may put the clock wrong by ten minutes a day. If the hair-spring will not readily lie flat, probably either the pin or the hole or the spring is not smooth and needs touching up, otherwise a slight turn of the pin in the hole may improve matters. If the collet is the right distance down the balance staff the hair-spring should lie flat readily without coming into contact with any part of the movement—particularly the inner side of the lug or else the fourth wheel. If it does touch use the fine tweezers carefully and bend it until it is right, and it must also be ensured that the extreme end of the hair-spring cannot interfere with any of the train wheels. The spring is fairly tough and will not break if handled reasonably. The regulator itself is usually held by one of the balance staff bearing sockets, and if this is screwed too tight it will not be possible to move the indicating arm over smoothly, so that the other bearing screw should be used to adjust the balance staff for end shake, while that one near the regulator should be set to hold it so that it moves smoothly and not at all tight. It is generally arranged that the total effect of the regulator should cover an extreme range of fifteen to twenty minutes a day, the effect of the pins being much less than is obtained by pinning the end of the hair-spring in a slightly different place; it is best, however, if the clock will keep fairly good time when the regulator is near its central position as shown by the indicator control arm. Frequently marks are stamped on the back of the case supposed to indicate one minute per day per mark, but they are not reliable in general, and, in any case, an alarm clock is not designed to be an accurate timekeeper, its true function is actually only to awake the sleeper at, approximately, the required hour, and if it varies two or three minutes irregularly from day to day, there is really little just cause for complaint.

The Lever

The balance wheel and hair-spring having been correctly assembled, the lever may now be taken in hand. It should be taken from the benzine and thoroughly cleaned with pith, particular attention being paid to the pivots, pallets and inside of the fork. Most alarm clocks have pin pallets, that is the pallets consist of two hardened steel pins mounted upright in a brass base, but some makes have hardened steel pallets of a different pattern based on what is known as the anchor escapement (see Fig. 1, two

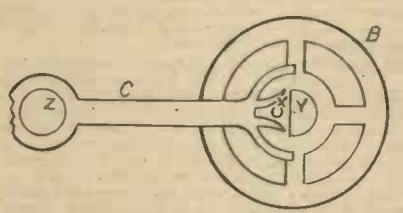


Fig. 2.—Usual layout of lever and balance of straight-line escapement.
X—Ruby pin.
Y—Centre of balance wheel B.
Z—Centre of lever C.

types of pallets and 'scape wheel teeth), it will be noticed that where pin pallets are adapted the 'scape wheel teeth provide the detent and impulse surfaces, but with the other escapement the teeth are pointed and the points bear against the detent and impulse faces on the pallets; the principle, however, is much the same and need not cause any anxiety. If the pallets are badly worn it may be possible to slide the brass base piece a very little way along its staff so that they may make contact in a different place, but care must be taken not to alter the setting of the relative angle between the teeth and the other end of the lever, as already explained. This is not so likely to happen if there are pin pallets mounted in the same base which forms a continuation of the fork; but if the pallets consist of, or are mounted on, a separate piece, the adjustment may easily be upset. Broken or damaged pallet pins having already been dealt with, it only remains to put the lever in place, and this is done by unscrewing the two nuts and gently separating the plates without opening them so far as to permit the 'scape wheel to fall out. It is quite likely that the balance wheel will come out, but this is of no consequence so long as no damage occurs to the hair-spring; indeed it is better that the balance wheel should come out for then not only have we more room to get the lever into place comfortably without straining the pallets or getting them inside the 'scape, but also it is much easier to get the roller into the fork without having to manipulate both ends of the lever at once; so long as the balance wheel is kept quite close to its proper position no damage will normally occur to the hair-spring. Taking the lever staff in the small pliers, hold it firmly and put the pivot furthest away from the pallets into its pivot hole first, then gently guide the other pivot into the other pivot hole and slightly close the plates, then take the balance wheel in the tweezers and put it back in position with the impulse pin in the fork of the lever. Further close the plates, making sure that all the staffs have adequate end shake, and be careful not to screw down tight if anything is out of position. One other piece that may require assembly now is a long lever sometimes fitted with an intermittent alarm system, this will lie near the balance wheel and should present little difficulty in reassembling. The lever being in position and all nuts screwed up tight, it should be ascertained that the pallets enter the correct depth into the 'scape wheel; it is obvious from what has been said about the theory of the escapement that one function of the pallets is to hold up the 'scape wheel by resting on the detent surface, but it is only required to catch the surface definitely and no more; therefore, examine carefully how deep into the 'scape wheel the pallets go at every tooth, if they have not been bent it may be assumed that they are probably correct, not shallow enough to let the 'scape wheel slip round several teeth at a time and not deep enough to cause an unnecessary friction when the impulse pin is trying to push the lever over in order to release the tooth. If this definitely requires adjusting most clocks have the pivot hole for the lever or for the 'scape wheel in a small lug (or sometimes two), that is one at each end of the staff, which may be bent so as to move the 'scape wheel and lever relatively closer together or further apart so that the pallet depth may be corrected, but this is rather a delicate adjustment and should not be undertaken merely for the sake of experiment. Some alarm clocks are fitted with what is termed a silent escapement and this may be either of two types. In some the "silence" is effected by making the whole of the lever (with the exception of the steel pin pallets) and the 'scape wheel of a substance resembling bakelite or other plastic, so that the metallic tick of the pallets and of the steel pin in the work is avoided, otherwise this system does not differ appreciably from the usual type of escapement, and as far as repairs are concerned, there is little to be said, for that reason. If the pallets are badly worn or broken they may be dealt with on the same lines as already explained, but if the 'scape wheel is badly damaged there is probably little that can be done. Should the arm of the lever, which is rather fragile, be broken, it may be possible to effect a temporary repair by joining the two parts with strong adhesive, but it is not advisable to add much weight by reinforcing it in any way unless with a very light strip of metal over the fracture, since binding it with fine wire would upset the balance of the piece. It should be pointed out that any lever is always designed so that the weight on each side of the staff is equal (in many cases a balancing piece is stamped out in one with the lever arm) therefore, if any increase of weight is made at one side it must be counterbalanced by a corresponding addition to the other side. In another silent design the whole arrangement has been considerably varied, although the principle remains the same. There is, however, only one pallet, which is of the pin type, and, one might almost say, two escape wheels, although actually they are both mounted on the same staff; the inner wheel is similar to the 'scape wheel usually found.

(To be continued.)

QUERIES and ENQUIRIES

A stamped addressed envelope, three penny stamps, and the query coupon from the current issue, which appears on back cover must be enclosed with every letter containing a query. Every query and drawing which is sent must bear the name and address of the reader. Send your queries to the Editor, PRACTICAL MECHANICS, Geo. Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2.

Dividing Apparatus for Small Lathe

I HAVE a 3½in. lathe and I would like to make a small dividing head for same. As dividing by master gear is not accurate enough for my purpose, I thought of using a 40-teeth worm wheel with single-start worm. Can you advise me and give an address where I can purchase the required gears?—M. Cann (Hereford).

GOOD results can be obtained from an accurately drilled division plate fastened to the front gear and locked by a spring peg. Circles of holes can be made to suit a large number of spacings. For a worm and wheel outfit there might not be enough space to get in the wheel, but if there is you would need a bracket bolted to the headstock to carry the spindle of the division-plate, and this would have the usual slotted arm and index-peg. The spindle is carried in an eccentric sleeve to adjust for backlash, and also to put into and out of mesh as required. Among lathe makers, Henry Milnes, Ingleby Works, Bradford, Yorks, is the most likely to supply the equipment.

Igniting Flash Powder

I AM interested in making an apparatus whereby photographic flash powder can be fired electrically from a torch dry battery. Could you kindly tell me what kind of fusing wire I would need and also a rough idea of cost and, if possible, where obtainable? Is it possible to work this apparatus with a wire simply getting red hot and being usable again? — J. L. Hammond (Birmingham).

IT is very doubtful if you would be able to obtain sufficient current from torch batteries to ignite the flash powder owing to the comparatively high internal resistance of the cells. You might try using a twin cell battery of the cycle lamp type with about 3in. of 30 s.w.g. tin (not tinned copper) fuse wire which you could no doubt obtain locally. If one battery does not prove sufficient you could try using two in parallel. It would not be practicable to use a resistance wire to fire the powder by heating. You would, of course, obtain very much better results with an accumulator, which is capable of passing a very heavy discharge current.

Magnesium from Sea Water

I UNDERSTAND that it is possible to obtain magnesium from sea water. Could you inform me how it is obtained, and how it could be carried out on a small scale in the home laboratory? Would the magnesium obtained be fairly pure? —G. C. Hall (Penarth).

THE extraction of magnesium from sea water is a process which, quite definitely, *cannot* be carried out on a small scale, and it is useless for you to attempt it. Such a process is worked in America. Tons of sea water are treated daily by chemical means. The small amounts of magnesium bromide and other magnesium salts in the sea water are selectively concentrated. Bromine is extracted from them by treatment with chlorine, after which the magnesium liquors are further concentrated. Finally the magnesium salt is fused and electrolysed, metallic magnesium being liberated at the cathode. No books have yet been published on this and analagous processes, which latter are only a few years old.

Lacquer Paint : Plaster Casts

I CARRY out extensive repairs of dolls and toys, and in the course of such work am constantly coming up against problems which puzzle me. What kind of paint is used for painting dolls? It seems much harder when dry than the enamel paint I have been using, and I notice that it has a very tough, hard finish. Where could a supply be obtained?

In moulding new arms and legs I have been using plaster of paris, but this cracks easily. Is there any means of strengthening the plaster of paris? I know gum arabic is effective, but this renders the mixture too slow for the mould.—W. Bishop-Stephens (Truro).

ORDINARILY, a thin lacquer paint is used for doll-making and other toy purposes, but we believe that the supply of this paint has now ceased. We suggest, however, that you communicate on this point with the Director of the Research Association of British Paint, Colour and Varnish Manufacturers, Waldegrave Road, Teddington, Middlesex, from which source you will receive an authoritative reply as to whether these toy paints are still being made. Alternatively, you could communicate with Messrs. Cowan Brothers, Colour Manufacturers, Stratford, London, E., who, before the war, were greatly interested in toy paints.

(2) You can make your plaster cast much more resilient in two ways, viz. :

(a) By dissolving gelatine in the water used for slaking the plaster. Dissolve up to, say, 4 per cent. of gelatine in the water (calculated on the weight of the water used).

(b) By incorporating some fibrous material with the plaster. Asbestos fibre is useful for this job, since it is light, cleanly and fireproof. Supplies of this material may be obtained from Messrs. Turner Brothers, Ltd., Rochdale, Lancs.

Your method of moulding is quite good and effective. You must, of course, see that the mould itself is well lubricated in order to avoid the sticking of the plaster casts to it.

We have not been able to trace a book on the moulding of tough plaster such as you desire, but we suggest that, in this connection, you write to either (or both) Messrs. W. and G. Foyle, Ltd., 119-125, Charing Cross Road, London, W.C.2, or Messrs. Wm. Bryce, Scientific Booksellers, 54 and 54a, Lothian Street, Edinburgh, requesting information regarding any works (English or American) on moulded toy-making which they may be able to procure.

You may, perhaps, be aware of the fact that the manufacture of plaster-moulded toys is likely to stop after the war, since the technology of plastics is now making it possible to produce dolls and other toys which are more or less completely unbreakable.

Polaroid Glass

CAN you give me some information about polaroid glass or screens?

Where could I obtain two small pieces about 4in. by 4in. for experimental purposes?—C. W. Ridley (Burley-in-Wharfedale).

POLAROID screens comprise a specially treated gelatine film cemented between optical glass. The gelatine film contains microscopic crystals of certain organic compounds, which material has been so crystallised that its crystal axes all lie in the one direction. These screens are American-made, and we very much doubt whether you could obtain new ones nowadays. Your only hope of obtaining a polaroid screen is to consult a dealer in photographic apparatus, such as Messrs. Wallace Heaton, New Bond Street, London, W.1. The screens are fairly expensive, and we think that you would find that a 4in. by 4in. screen would cost several pounds.

In practical photography, polaroid screens are most useful in cutting out unwanted reflections, which they do most efficiently.

Fireproofing Cotton Fabric

I SHALL be glad if you will answer me the following query: What is the chemical formula to use for making a piece of ordinary cotton material fireproof?—R. Peace (Hessle).

FIREPROOFING is rather a relative term, it being hardly possible to render an ordinary fabric completely incombustible, provided that sufficient heat is applied to it. It is, however, readily possible to make fabrics flame proof, that is to say, to render them highly resistant to naked flames and other inflammatory influences. This can be effected merely by soaking the fabric or cloth for about six hours in any of the following solutions and afterwards drying the material without rinsing :

(1)	Ammonium sulphate	2 lbs.
	Ammonium chloride	4 lbs.
	Water	3 gals.
(2)	Di-ammonium phosphate ..	1 lb.
	Ammonium chloride	2 lbs.
	Water	1½ gals
(3)	Boric acid	1¼ lbs.
	Borax	1¾ lbs.
	Water	3 gals.
(4)	Sodium tungstate	4 lbs.
	Di-ammonium phosphate ..	1 lb.
	Water	2 gals.

Formula No. 4 is, perhaps, the most efficient.

A Perfect Vacuum ! Earth's Heat

I SHALL be glad if you will give me some information on the following points :

1. Is it possible to create a *perfect* vacuum? (It has been said that this is impossible to get, let alone to keep.)

2. How is it that the earth is warmer in summer although the sun is farther away? Also, how is it that the warmth of the sun's rays decreases as one approaches the sun?—E. W. Copas (Hayes).

STRICTLY speaking, it is quite impossible to produce an entirely perfect vacuum, an absolute state of nothingness, for when a high degree of vacuum is obtained, traces of gases leak into the vacuous space from the walls of the containing vessel, and it has even been suggested that small amounts of air molecules actually pass through the walls of the container from the external atmosphere.

Although a perfect vacuum is an impossibility, very high approximations of such a degree of vacuum are possible by modern methods. The space above the mercury level in a barometer tube at very low temperatures constitutes a very high degree of vacuum.

(2) Winter and summer are due to the fact that the earth's rotational axis does not stand perfectly upright in the earth's orbit or path of travel round the sun. One pole of this axis always leans about 23 degrees towards the north of the heavens, whilst, of course, the other pole leans as much to the south. Thus, when the earth is on the north side of the sun, the earth's north pole and its northern hemisphere are turned towards the sun, while the earth's southern regions are turned away from the sun. It is, therefore, summer in the earth's northern regions and winter in its southern regions. Six months later, the position is reversed, and it is summer in the south and winter in the north.

(3) The question of the apparent decrease in temperature with increase in height above the earth's surface is still a very vexed one, and it has not yet been clearly and positively settled. It is true, of course, that, up to certain limits, as we travel above the earth's surface we find a fairly regular decrease in temperature, despite the fact that we are approaching slightly nearer the sun. This is explained by the fact that the air receives most of its heat from the heated earth and that the farther we travel from the earth's surface the colder the air becomes.

Beyond a certain limit, of course, the temperature must undergo a steady rise as we travel farther and farther away from the earth's surface. It has been proved that the sun's rays are intensely powerful in the upper regions of the air, but exactly at what height above the earth's surface the temperature first becomes steady with increasing height and afterwards begins to rise is, as yet, not known with any certainty.

Fixing Pencil Drawings

PLEASE could you tell me of some method by which I can prevent the lead from rubbing off lead-pencil drawings? The drawings are on white paper, and, if possible, I wish to preserve the whiteness of the paper.—John E. Castell (Grove Hill).

IN order to fix pencil drawings so that they will not rub off from paper, obtain an ounce of pure cooking gelatine or isinglass from your local druggist or provision dealer. Dissolve five parts (by weight) of this material in 95 parts of warm water. A clear solution will result. Saturate a clean sponge with this gelatine solution and gently wipe it over the surface of the paper containing the pencil drawing so that the whole paper surface is moistened. Allow the paper to dry without heat, and then finally iron the paper flat with a domestic iron. It will be found that the gelatine will have impregnated the pores of the paper and will have permanently fixed the pencil drawings, rendering it extremely difficult and almost impossible for it to be rubbed off, even with a hard rubber. Provided that the purest gelatine is obtained, the paper will not be discoloured.

The gelatine solution will not keep for more than a few days without going mouldy. Hence, only a small amount of it should be made up at a time.

Electric Motor for Model Loco

I HAVE recently completed a model O gauge locomotive, which I contemplate running on 20 volts A.C. I have built a motor, the dimensions

of which are the maximum permitted to fit inside the main frames of the loco. My stumbling block is the gauge of wire and the number of turns that are necessary to get the maximum power from the motor (tri-polar armature). I don't mind if the current consumed runs up to 2.5 amps. providing I get that extra power as the model is heavier than the average scale loco. Is a reduction gearing of 16 : 1 suitable to take up the drive to 1¾in. wheels ?—W. McMaster (Liverpool).

IT is not possible to estimate the amount of space allowable for the field windings, which will obviously overhang the frame, and their size will be limited by the amount of room required for the inside bearing.

Small motors of this type are largely experimental, and you might try winding the armature with 23 s.w.g. wire, using as many turns as can be accommodated, and using the same number of turns on each section of the armature. Enamelled wire will enable the maximum amount of copper to be used. For the series field winding you will require heavier wire, say 20 s.w.g., and again you will probably need as many turns as can be fitted.

It is not possible to say if the proposed reduction gearing of 16 : 1 ratio will be suitable from the information given. Actually, an increased number of field turns will cause the motor torque to be increased and the speed to be reduced, and vice versa.

Rotary Converter

I UNDERSTAND there are three principal methods of rectifying A.C. current—Westinghouse, valve and rotary converter.

Can you tell me if the rotary commutator method is used ? This, I understand, consists of a permanent magnet motor with either two, four or eight poles to the armature running in step with the 50 cycle supply. There are two slip rings and a special type of commutator with alternate dead and live bars. This acts as a rotary C.O. switch.

I have thought of making one as I have a lot of spare gear I could use, but am not quite certain about the spacing of the combars. Must the bushes be of a special width or rather thickness to make a quick break ? They would have to be mounted on a rocker to adjust to the neutral point of break, otherwise sparking would be too excessive. The motor merely serves as switch rotor.—A. J. Wilkinson (Bordon).

THE methods of rectifying alternating current you mention, namely by dry copper-oxide rectifier, by thermionic valves, and by rotary converter, are among the most commonly used, but by no means comprehensive. The method you particularly refer to is simply a rotating commutator driven by a synchronous motor, and when running in step with the frequency of the supply current automatically changes the connections to the slip-rings like a two-way switch. It is not a popular type, partly because it is useless without a truly synchronous motor running free from "slip," and partly because there are two zero points where the A.C. voltage reverses direction, making it unsuitable for accumulator charging, unless an intermediate "dead" segment is interposed interrupting the current before the voltage has reached so low a point as to endanger the accumulator discharging. As the latter is a variable quantity according to the state of the charge and back E.M.F. of the cells, it is difficult to adjust such a rectifier to practical running conditions, and severe sparking at the rectifier segments is almost unavoidable. The more general method is to employ a D.C. generator driven independently by an A.C. motor, running irrespective of frequency conditions, the voltage of the charging current being regulated by a variable resistance in the shunt field of the dynamo.

Rewinding an Electric Drill

I HAVE an electric drill (burnt out) which was originally wound for 110 volts. Is it possible for me to rewind same for 230 volts 50 ~ A.C. ? If so, can you please tell me what gauge wire to use, also details of windings for armature and fields, connections, etc. Details are as follow : Fields, 2 pole ; armature : 19/16in. diameter, 12 poles, each 2 7/16in. long, 24 part commutator.—H. C. (Wakefield).

THESE motors are usually wound to run at a very high speed, such as 8,000 to 10,000 r.p.m., operating as "universal" motors on either D.C. or A.C. without change of connections. The recommended winding for a motor of the size named will be :

Armature.—24 former-wound coils each with 36 turns of No. 28 s.w.g. double silk covered copper, coil span from slot 1 to slot 6, coils grouped two per slot, and connected to 24-part commutator.

Fields.—2 coils, each containing 280 turns of No. 23 s.w.g. d.s.c. copper, in series with one another and with the armature.

This winding should run satisfactorily on 200-230 volts D.C. or on 50 cycle A.C. of the same voltage.

Electric Fire

I HAVE recently bought a small electric fire for use in my home. On connecting it to the main circuit, the fire works well enough, but after it has been on for about two hours the switch on the wall, which has a metal cover, seems to get warm. The details of the fire are as follows : Volts, 230-250 ; watts, 750. My circuit runs on a voltage of 210 D.C. From this, I presume that some alteration is needed to the resistance wire of the fire, which is about 3ft. long of 3/16in. diameter coiling. Could you tell me what I should do to rectify and prevent the switch on the wall getting warm ? Connected in parallel off the same pair of wires to the fire is a 40-watt electric light bulb.—R. E. Woodroffe (Stafford).

IF an electric fire designed for 230-250 volt circuit is run on 210 volts it will not reach full normal heat, and to rectify this about 10 per cent. of the turns in the heating coil would have to be taken off. As your heater is of the coiled-wire type, the spirals must be stretched out evenly again after the length has been shortened, otherwise uneven heating will result, the turns which are closest together getting hotter than those more widely spaced. As to the wall switch overheating, this appears to be due to excess current. The fire ought not to have been installed on a lighting circuit, and wiring rules specify that all fires should be run on circuits separately supplied from the distribution fuseboard and controlled by separate switches, the wiring being calculated of suitable size to carry up to 15 amperes. Switches with metal covers are now quite obsolete, bakelite moulded insulating covers having taken their place, these being shock-proof.

Reducing Voltage of Circuit

WHAT resistance must I use to lower 250 volts A.C. to 130 volts, the voltage of my electric-motor ? Also what should be the resistance to lower 250 volts A.C. to 240, the voltage of my transformer ? Could I work my transformer from 250 volts or would it cause heating of the laminated core ?—A. Millar (Blantyre).

THE terminal voltage of the electric mains cannot be reduced by the addition of resistance, but a fall of potential can be brought about at the motor or other instrument in use by causing the current to pass through a resistance before reaching it. In order to calculate the necessary amount of resistance, however, the current normally taken by the apparatus in circuit must first be known, since the "volt-drop" depends just as much on the current flowing as it does on the resistance encountered. When the current is known the required resistance is found by first subtracting the voltage required at the motor or other apparatus from the full voltage of the main supply, and then dividing by the current required by the apparatus, the result being ohms required in series. For instance, if the main circuit is 250 volts, and a motor taking 2 amperes is required to work on this circuit, but which has been designed for running on 130 volts, the calculation is made by first ascertaining the volt-drop necessary, namely, 250 − 130 = 120 volts. The value of the required series resistance in ohms is then ascertained by dividing the volt-drop by the current, namely, 130 divided by 2=65 ohms. A 240-volt transformer might be expected to work quite well on a 250-volt circuit without additional resistance, but would give a slightly higher voltage on the secondary than normal.

Electron Microscope

I AM attempting to construct a working model of an electron microscope and should be glad to have information on one or two points. Is there a book on the subject ? What is the formula for lengths of tube required for a standard X-ray tube 6in. diameter as supplied by "Electradix Radios" ?

What are voltages around the three coils ? Also are the coils adjustable vertically so as to obtain proper focus, and is the object to be magnified placed on a specially prepared plate ?—R. S. Trowell (Newport, I.O.W.).

VERY little in the way of practical constructional details has been published on the subject of electron microscopes, and, so far as we are aware, no book on the subject has yet appeared either in this country or in America. There is no English firm which has had experience of electron microscope making. Most of these instruments are American produced, although a number of them have been made at the Siemens-Halske factory in Berlin.

The best we can do to aid you in this very difficult subject is to refer you to a paper on "The Electron Microscope," which appeared in "Chemistry and Industry" for May 3rd, 1941. This paper gives a fairly comprehensive mathematical treatment of the subject, although it does not answer all your constructional queries. Furthermore, we would advise you to get into touch with Professor L. C. Martin, of the University of London and the Imperial College of Science and Technology, South Kensington, who is one of the few experts on electron microscopy. We feel sure that he will be interested to learn of your proposal to build an electron microscope, and he may be able to give you valuable working details.

Dynamo Polarity

I RECENTLY purchased a secondhand 12v. 10a. C.A.V. motor-car dynamo, to charge my own accumulators. The dynamo is in perfect working order but terminals are not marked with their polarity (+ and −). Please tell me of a reliable method to determine this.—D. S. Wilstead (Windsor).

IF you possess a voltmeter of the "moving-coil" type the simplest way to test for polarity is to connect the instrument to the dynamo while running and note whether the deflection of the needle is in the right direction or otherwise. If it moves towards the right of the scale the dynamo terminal which is connected to the left-hand terminal of the voltmeter will be the positive. If the needle tends to turn to the left and read the wrong side of zero, it will be the negative wire from the dynamo that has been attached to the left-hand instrument terminal.

Another method of testing is to dip a piece of white blotting paper in a weak solution of starch in which a few crystals of potassium iodide have been dissolved. Allow the paper to dry and it can be cut up into small strips for testing purposes. To use it, moisten one edge with the tongue and apply the two wires from the dynamo or battery to the margin of the moistened portion.

A dark stain will show itself around the wire coming from the positive, the negative being unaffected. Blotting paper dipped into a solution of phenolphthalein and dried will also give polarity indications, but in this case it is the negative which stains the paper a pink colour, the positive not affecting it.

Sun Lamp

I AM endeavouring to construct a sun lamp, and am using horizontally-opposed 14 millimeter tungsten-cored carbons on an A.C. voltage of 230 v. 50 c. single-phase supply. My trouble is that using a 750 watt electric fire as the resistance, the biggest arc obtainable is approximately ¼in. and the flame tends to travel round the carbon points and frequently splutters and goes out. Even by varying the resistance this trouble still persists. Can you suggest what the trouble might be ?—A. A. Trowse (Norwich).

WANDERING of the arc is often occasioned by the current being too restricted to suit the diameter of carbons employed, and this may well be the cause in your case. If you are using a 750 watt electric fire as a series resistance with the arc on 230 volts, the actual current passing may not reach even three amperes, which is far too little for a stable arc on carbons of 14 millimetres diameter. The carbons arranged horizontally again would be more liable to a wandering arc than if arranged vertically. Try reducing the amount of resistance in circuit, or else substitute carbons of 8 millimetre diameter.

Inductor-type Generators

COULD you tell me the advantages and disadvantages of the "inductor" type of generator ? Could it be used with a D.C. generator ?

The "inductor," I understand, is shaped like the spokes of a wheel and revolves between the field magnet and the armature.—B. G. Harrington (Bude).

THE "inductor" type of generator is generally considered more suitable for alternating current work, and particularly for high voltages, owing to the fact that the windings are stationary and do not rotate, hence they are not subject to the same stresses that are present with wound rotors.

The absence of commutator and brushes is another point in its favour, and it is a design largely adopted for high tension ignition magnetos. In large units for power purposes their use as direct current generators would be open to several objections, since a system of revolving brushes would be necessary to convert the alternating E.M.F. into direct.

The inductor or rotating element would again be far heavier in design than the orthodox type of wound armature, and in almost all structural details the cost of the inductor type would compare unfavourably with that of the salient-pole rotating-armature type for equal outputs. A study of the various types of inductor generators may be made by reference to Prof. S. P. Thompson's "Dynamo Electric Machinery," Part II, also in the case of ignition magnetos to A. P. Young's "Magnetos."

Demagnetiser for Small Tools

I SHOULD be grateful if you could oblige me with instructions for constructing a demagnetiser to work on 230 volt 50 cycle A.C. current. I wish to use it for demagnetising small tools.—J. T. Williams (Liverpool).

A USEFUL demagnetiser for treating small tools can be made up with a U-shaped laminated core, the section of the two limbs and bottom yoke being 1 sq. in., and the winding length on each of the upright limbs 3in.

Each limb requires a coil containing approximately ¼lb. of No. 36 S.W.G. d.s.c. copper, the two coils being in series for a 230-volt 50-cycle A.C. circuit. The tools to be demagnetised are placed in a wooden box or other non-magnetic receptacle near the top open end of the magnet and the current switched on for a few seconds, while the box is gradually withdrawn vertically out of the influence of the magnet.

Another method is to leave the box stationary and reduce the strength of the magnetising current gradually by means of a variable resistance in series with the windings. As this entails a rather large and expensive resistance if made of wire, a liquid resistance consisting of two iron plates dipping in a solution of washing soda might be substituted, but great care must be paid to insulating the resistance thoroughly in order to avoid unpleasant shocks.

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Comments of the Month

Wanted—A Plan

By F. J. C.

IF we are not to return to the bad old days preceding the present war, when motoring bodies, cycling bodies, and pedestrians were each concerned for their own particular welfare, without any consideration as to whether the recommendations they made would make road conditions more onerous for others, the time is ripe for the production of a co-ordinated post-war road plan. The Minister of Transport is there to listen to reason, and will listen to reason. He cannot, however, possibly amalgamate opposing viewpoints. If motorists are in favour of cycle paths and cyclists are not, or if motorists want cyclists to carry rear lights, and the post-war cyclist is opposed to them, or if cyclists are opposed to registration, and motorists think they should be registered, the Minister of Transport is justified in saying, in effect: You are quarrelling among yourselves as road users. I cannot satisfy both of you, and therefore I shall make up my own mind.

When opposition was raised to the petrol tax it was the difference of opinion between two motoring bodies which brought it about. The motorists require the roads to be designed for their convenience. The cyclists have made representations as to how they think our roads should be remodelled after the war, and, of course, the pedestrians also have a plan. It may be that on some points all bodies are agreed, but they need to be agreed on all points, and that is why we suggest that their differences should be hammered out in the committee room, and not exhibited to the Minister of Transport, to whom a concerted front should be presented. The Roadfarers' Club, representing all road users, has been asked by the Ministry of Transport to prepare a memorandum, for presentation to the Committee on the Design and Layout of Roads in Built-up Areas, on the general question of the design and layout of roads. It will carefully prepare this memorandum without prejudice to the ideas of any body, and it will endeavour to bring about co-ordination between those bodies. As the Committee investigating the matter is constructed of those representing motorists, cyclists, and pedestrians, in equal proportions, its memorandum should be worth the close attention of the Ministry, for this club is non-sectarian, and it has no particular axe to grind.

By-pass Roads

The fact is that we have not had a road policy hitherto. Our roads have developed in haphazard fashion. Even the new by-pass roads which have been constructed have chiefly benefited speculators, who, learning that a new road was to be cut, have promptly bought up adjacent land cheaply, sold it at enormous profits to speculative builders, and, of course, brought about the plethora of spur roads which cut into them and destroy the very object of the by-pass, in that it merely adds a further batch of danger spots, namely, cross-roads, to a road which should have avoided them.

When we reflect upon the ingenuity displayed in the planning of London's underground railways, one wistfully desires that someone with equal ingenuity should do for the surface of the roads what someone has done beneath them.

But no! Our road policy consists of making regulations, and creating lists of technical offences (there are 2,000 of them). Is there a parking problem? Then fine people for parking! Do not grapple with the problem and create parking places. Fill the police courts and impose vicious fines for offences which road users cannot help committing, and the causes of which they have heavily paid to have remedied. Are too many vehicles coming on to the road? Then erect barriers and dams in the form of islands and traffic signals to make quite sure the roads are rendered more dangerous by the congestion which mechanical obstruction brings about. Make quite certain that the traffic stream overflows its banks, and pushes cyclists into the gutter, and pedestrians into the mortuary.

Introduce speed limits. Spend thousands of pounds each year providing the police with cars to chase at high speeds any high-speed motorist. Then you will hear the fantastic charge, perhaps, of driving to the common danger! Apparently the chasing police car does not drive to the common danger!

Post-war Plans

Those preparing post-war plans might usefully bear in mind a number of points which contribute to the road and traffic problem. Horse-drawn vehicles cause congestion, and thereby promote danger. They are a slow-moving barrage. Buses should stop, not on the nearside of traffic lights, but remote from them. Islands should be abolished in narrow roads. Large numbers of traffic lights should be dispensed with. The speed limit should be abolished, and with it the designation of built-up areas. Local limits should also be abolished. A greater number of public parking places should be provided for cycles as well as cars. The amber light should be abolished, and the American system instituted. Pedestrian crossings should be abolished, and where possible over-bridges should be erected. A standard road surface should be decided upon, both as to the nature of the surface and its colour. There should be standardised street lighting, and flashing signs should be made illegal. Experiments should be made with car lighting, with the object of finding a system which would avoid dazzle. These are but a few of the problems to be solved before we can produce a post-war plan.

Massed-start Cycle Races

The Home Secretary, after consultation with the Minister of War Transport, has circularised chief officers of police, calling their attention to the growing practice of holding massed-start cycle races on the highway. The official view is that these races are likely, not only to cause obstruction to traffic, but to be a source of danger both to the public and to the racers, particularly over roads containing dangerous hills or difficult bends, and this danger will be considerably increased when more normal road conditions return. A further objection to these races in present conditions is the considerable waste of police time involved.

We shall comment fully on this matter next month.

Cycling at Brackley, Northants.

PARAGRAMS

John o' Groat's 1943—devoid of traffic!

Yorkshire D.F.M. Missing

TWO days after he had been awarded the D.F.M., J. T. Wilkinson, Yorkshire Road Club, was reported missing. He was joint holder with N. Reade and C. Hepplestone of the 12-hour team race record.

He's in the Navy Now!

AFTER winning his first open event—the Wisbech Wheelers' "25"—R. E. Hawkes, Cambridge Town and County and St. Neots C.C., was called for service in the Royal Navy.

Brilliant Century

BY winning the West of Scotland Clarion "100" with a ride of 4hrs. 25mins. 5 secs., A. Hendry, Glasgow Wheelers, recorded the fastest unpaced 100 since the war.

Plymouth Loss

WELL-KNOWN member of the Plymouth C.C., Frank Pridham has died. He was serving with the Royal Air Force, but his death was not due to enemy action.

For Services Rendered

SOUTHGATE Cycling Club have honoured Vice-President L. J. Meyers (holder of the end-to-end unpaced tricycle record) by presenting him with the "Fred Cook" trophy for meritorious service. Meyers served for 16 consecutive years on the club's committee, and was chairman for several years.

East Anglian News

EIGHTEEN months ago Montford Bird, Colchester Rovers, was reported missing in the Far East. Later he was stated to be a prisoner of war, but news is now to hand that he died in a Japanese camp. He was 35, and had been a clubman for nearly 20 years.

One of Six Brothers

JOHN TWEED, Colchester Rovers, one of six brothers serving in the Forces (four being in the Colchester Rovers), is reported missing following an operational sortie over enemy territory. He was a sergeant-pilot.

Earwicker's New Rôle

ONE of Barnet Cycling Club's most outstanding riders, Victor Earwicker, has joined the Royal Navy.

Allondon Revival

ALLONDON Road Club, one of the strongest pre-war Eastern road clubs, may be revived. So many members were called to the Forces at the outbreak of hostilities that activities ceased.

Rural Rider Killed

WHILE cycling in one of the Eastern counties a farm labourer rode over an anti-personnel bomb, and was killed.

A Cyclist's Dozen

WHILE on patrol during the occupation of Sicily, a cycling scout of the Black Watch took a dozen prisoners of war. They were sheltering in a farmhouse.

A Fine Record

NO fewer than 135 members of the Grimsby Clarion C.C. are serving with the Forces.

Nondescript Collection

OVER 10 London and provincial clubs are represented in the R.A.F. Paragon Road Club. Thirteen riders entered for a road 25-mile time trial.

Highlander at Sea

A MEMBER of the Caledonia C.C. of Glasgow (Sergeant-pilot John Rice) has been commended for his part in locating a U-boat while on Atlantic patrol.

Killed in Action

AFTER being reported missing it is now known that Ralph Muskett, a member of the St. Helen's Section, C.T.C., lost his life while on an operational sortie with the R.A.F. over Holland.

Cyclist's New Rôle

AN Italian report states that two British paratroops were captured while cycling in Northern Italy.

Manchester Officials Abroad

THOMAS FLETCHER, former District Council treasurer of the Manchester R.T.T.C., is now in North Africa, and the Council's former secretary (J. G. Veale) is in the Outer Hebrides.

Police Cyclists

F. H. MORSE won the Metropolitan Police 880 yards championship with L. E. Copping second. Copping is a member of the North Road C.C. and a National Record holder.

Cycling in Bermuda

FOR years cyclists have reigned supreme in Bermuda where motor transport was prohibited. The ban on motor vehicles has, however, been lifted for the duration.

In Japanese Hands

JACK STARLING, King's Lynn C.C., is a prisoner of war in Japanese hands.

Western T.T.A. Revived

THE Western Time Trials Association has been reformed under the secretaryship of H. G. Mitchell, 9, Seymour Road, Staple Hill, Bristol.

Death of A. F. Merrin

MR. A. F. MERRIN, for many years sales manager of Messrs. Perry and Co., Ltd., and Messrs. Bayliss Wiley, Ltd., has died.

Studs to Go?

THE National Committee on Cycling are pressing for the removal of all "cat's eye" studs which lie too close together or project too high above the road surface.

Tom Hughes's Birthday

TOM HUGHES, well-known Wigan veteran wheeler, was enthusiastically fêted by over 50 comrades of the wheel on the occasion of his 77th birthday.

Clubman in North Africa

L/CPRL. H. VANDERLOO, King's Lynn C.C., and holder of several club records in addition to the Fenland R.R.A. 100, is in North Africa.

North Roader Wins at Bath

A. B. SMITH, North Road C.C., rode in a veterans' 25-mile handicap at Bath and, on a machine geared to 88, won the handicap with 13 minutes' allowance.

Rutland C.C. Loss

RUTLAND C.C. lost one of its most promising members when Keith Rowan died as the result of an accident while cycling. A stylish rider, he clocked 1.7.24 in an open "25" only a few days before his death.

Midlander in Sicily

DENNIS CLAMP, Doncaster Wheelers, is with the Forces in Sicily.

New Bridge Over Mersey?

THE Widnes Corporation have applied to Lancashire County Council for a new toll-free high-level bridge over the Mersey. It is to replace the famous transporter well known to tourists.

Bicycle Polo in Scotland

A MOVE is afoot to revive bicycle polo in Scotland. Several Glasgow clubs are interested.

Swindon Old-timer Dies

PRESIDENT ARTHUR EDGINGTON, of the Swindon Wheelers, has died. He was 81, and 50 years ago completed a "hat-trick" of wins in the club's 50-mile championship. A year before he died he covered 10,000 miles awheel.

Tandem-Tricycle Record Broken

L. E. COPPING and J. M. Sloper, North Road C.C., have broken the R.R.A. 50-mile tandem-tricycle record with a ride of 1.52.41. The previous best was put up some years ago by D. F. Nash and H. J. Scutchings (Poly C.C.).

Fleet Air Arm Sports

THREE cycling events were included in a sports meeting arranged by the Fleet Air Arm at a base "somewhere in Scotland."

End of Crossings?

THE abolition of all level crossings is to be considered, says the Minister of Town and Country Planning.

Open This Winter

THE following youth hostels in North Wales are to keep open throughout the winter: Cwm, Cynwyd, Delamere, Maeshafn, and Idwal.

Revival at Perth

THE Perth Thistle C.C. has revived active cycling in the Perthshire capital, and has taken over open events from declining Dundee clubs.

Welsh Light Railway

PLANNING authorities in North Wales have proposed that the Festiniog Narrow Gauge Railway, well known to tourists in the Principality, should be reopened for passenger traffic.

Plymouth Official Dies

FRANK PRIDHAM, of the Plymouth Corinthians, has died while in the R.A.F.

Ken Jones in R.A.F.

KEN JONES, London Clarion, massed-start rider and time trialist, joined the R.A.F. during September.

Sharing Rooms

THE Ivy C.C. and the Belle Star R.C. are sharing clubrooms in Summerton Road, Govan, Glasgow, S.W.1.

Checks on Courses

THE Scottish Amateur C.A. is taking steps to ensure that only registered courses are used in future time trials.

Barnsley Winner

SURPRISE victor in the Barnsley R.C. open "50" was David Scott, Crawick Wheelers, who clocked 2 hrs. 12 mins. 37 secs., and beat the local cracks.

Married in Edinburgh

SGT.-PILOT WILLIAM WILSON and Miss Barbara Spence, both keen officials of the White Heather C.C. in pre-war days, were married recently.

Armour Returns

JACK ARMOUR, Scotland's best rider in 1941 and 1942, returned to form towards the end of this season, when he won the Mid-Scotland T.T.A. "25" with 1 hr. 3 mins. 14 secs.

Elected

THE Bicycle Polo Association of Great Britain has been unanimously elected a constituent member of the Central Council of Recreative Physical Training.

Around the Wheelworld

By ICARUS

Roadfarers' Club A.G.M.

THE annual general meeting of the Roadfarers' Club was held at the Holborn Restaurant, on the 27th August, and it was preceded by a dinner. Nearly 50 members were present, under the chairmanship of C. G. Grey. After just over one year's working the club finds itself in a strong position, and from the experience gained the council had prepared draft rules to guide the future policy of the club. The approval of these rules was the main item on the agenda.

Lord Brabazon of Tara, the president, who was unable to be present, sent the following message:

"A year has shown that the Roadfarers' Club fills a need. The idea of a community of the road, rather than a scramble for it, is long overdue. It is our function to weld together all users of the road within our fold, so that when we give an opinion we command instant attention and respect, for we speak for all and not for a factional section. No similar body exists to-day. We have a long way to go. Our first general meeting will be an important one, in that our constitution is to be decided. The club has begun well. It has great work to do, and as it grows older so it will speak with a growing influential voice. Good luck to you."

The following were elected as vice-presidents: Marquess of Donegall, Lord Iliffe, Lord Kenilworth, Sir George Beharrel, Sir Harold Bowden, J. D. Daymond, W. G. James, and A. H. Bentley.

The following were elected to the council: Major H. R. Watling, O.B.E., J.P., Lieut.-Col. Charles Jarrott, O.B.E., Lieut.-Col. Mervyn O'Gorman, Lieut.-Col. J. A. A. Pickard, D.S.O. (Royal Society for Prevention of Accidents), F. J. Urry, Harold W. Eley, Major Frank Bale, O.B.E., Mr. J. A. Masters (Secretary, M.C.C.), Mr. C. G. Grey (Secretary of Council), Col. T. W. Loughborough (Secretary of the Auto Cycle Union), Prof. A. M. Low, Mr. J. Dudley Daymond, A. Percy Bradley, and F. J. Camm.

It will thus be seen that every section of road user is represented. All members elected during the first year, that is to say, from July 18th, 1942, to June 30th, 1943, become Fellows of the Club.

The objects of the club, as set out in the rules, are to consider road problems, and road policy; to frame resolutions in the form of memoranda, after full discussion between all sections of road users represented by the membership, for submission to the Minister of Transport or any other body interested in road welfare and kindred matters; to appoint delegates to represent the Club in discussions with the Minister of Transport and other national bodies; to provide frequent opportunities of meeting men with kindred interests; to promote debates on all aspects of roads and road travel; to bring about a better understanding between all road users; and to appoint technical committees to investigate road problems, their cause and cure.

The Gold Medal of the Club will be awarded to those (members or otherwise) who have performed during the year meritorious service in the interests of road travel as the occasion warrants.

Thus the Club has successfully passed its first year and is well and truly launched.

Letters concerning this important Club have been received from all over the world. Here is one from India: "I follow the reports of the Roadfarers' Club with the greatest of interest. I am convinced that this is the way to road safety, and not a continuation and intensification of cyclists' and motorists' warfare."

The Speed of Cyclists

IT is of general interest to remember that the speed of a cycle can be calculated from the ticks of the cyclometer. For example, if the machine has 28in. tyres, the number of ticks given by the cyclometer in five secs. is exactly equivalent to the speed in miles per hour. If a cyclometer is not fitted it should be possible to improvise a striker on one of the spokes contacting with a light reed of steel attached to the forks.

Special Message to Cyclists

MR. P. W. HOWARD, Chairman of the Cycle and Motor-cycle Tyre Group of the Tyre Manufacturers' Conference, in a special message to cyclists, said: "Cyclists will obtain greater satisfaction and much longer wear from their war-grade cycle tyres if they will keep them inflated hard. It is true that there is, for the time being, a shortage of inflaters, but this difficulty can be overcome if cyclists will borrow pumps from one another.

"One other suggestion: if cyclists will repair inner tubes as long as possible, and when compelled to buy a new tube, they will be good enough to hand in the old tube to their dealer, this will enable both the rubber and the metal valve to be salvaged."

J. Dudley Daymond.

Francis Lewcock.

R. G. Sparkes.

T. D. Osborn.

A. H. Bentley.

E. Coles Webb and Leonard Ellis.

R. A. West (secretary).

J. Dudley Daymond, C. G. Grey (chairman) and Sir Arrol Moir.

Sheepstor, Dartmoor village.

Wayside Thoughts

by F. J. URRY

Holiday Philosophy

IT was in the early part of July, in the company of two companions (one of whom was over 60 and cycle touring for the first time for 30 years), that we visited the Central Highlands of Scotland, and spent eight glorious days in that glorious countryside. The fact that one of the days was a real Scotch soaker with 12 hours of steady, straight rain, did not detract much from the joy of the journey, because that downpour set every rill at work, and the little cascades came down the mountains drunk and disorderly to calm their rioting in the sombre lochs and the more truly rivers; and that sight of the mighty hills after rain, when the azure distances are crystal clear in the shy sunshine, makes a vision which no fine weather period can paint. Another thing that wet day proved to the returnee in our midst was the fact that one can ride all day in pouring rain without discomfort, and at the end of a 50-mile trek need no other change than a pair of dry stockings and slippers. That happened to prove the point I have often made. Good macs, easy riding and a cheerful mood, and a wet day in the midst of a holiday is certainly not wasted time. We are too apt to criticise wet weather, call it vile and remain indoors and feel disgruntled. Why? Rain is a natural element without which we could not live, and if the wet day is used aright, then it has its own particular type of enjoyment, and I for one can and do enjoy such times. It is, I think, all a question of right equipment and philosophic approach, for if you start on a wet journey with a sense of annoyance that the elements are at enmity with you, you are in danger of losing the poise of the holiday spirit and spoiling that precious leisure time you have been fortunate enough to inherit.

Drumming-up

SOME Scottish friends convoyed us out of Glasgow to Loch Lomondside, and stayed with us over the week-end, introducing my friends to the art of "drumming-up," a Scotch cycling institution born of necessity and brought to perfection by long habit. For Scotland does not possess the hosts of wayside calling places as is the case in England and Wales, and the distances between hotels are often considerable, so that the need for refreshment en route is sometimes urgent and is provided by the travellers, and excellently provided too. On this journey our first tea was taken north of Luss, on Lomondside; the pocket primus boiled the billy in 10 minutes, and with tomato and egg sandwiches, cakes, rolls and jam, the eating was of ambrosial splendour, taken in an outdoor spot as fair as one would conceive Paradise to be. It was a revelation to one member of the party, who wanted to know why we could not adopt the fashion; and actually we could have done had I known my companions would have preferred the gipsy life, for I have all the necessary equipment in the camping kit. Anyhow, we did the next best thing in the absence of a primus stove, for during those eight days we carried our lunch, collected extras from friendly farmers and shopkeepers to supplement the catables we had brought with us, and borrowed the aid of friendly cottagers to make our tea and cook whatever we had managed to collect from the land. Never were we refused, and always the good folk resisted any kind of payment, so that the long-held impression was definitely proven on this occasion, that the average Scot is a most hospitable individual, once that native dourness has been overcome with a friendly smile and word. Perhaps the "drumming-up" habit will become popular south of the Border; it is certainly good fun and cheerfully economical.

The Way to Know

ON that journey of 350 miles, mainly in the comely shire of Perth, we had one puncture, a tube nipped on a descent over a rough stretch of road, and that was the only mishap, very quickly cured. A little oil on chains and in hub bearings after our rainy day, a little air in the tyres and one broken bag strap was all the attention the machines had or needed. And I would once more like to stress the value of very moderate gearing. All the machines had normal ratios of 60in., with low gears of 45in. or less, and those modest combinations allowed us to ride many of the long slopes in easy comfort, and were of real benefit during that wet day when we did a couple of hill crossings. Accommodation in Scotland was difficult in many places, which was the main reason we made Pitlochry a centre for three nights, and feeding—from the cyclist's point of view, at any rate—was on the meagre side, so that our outdoor lunches, and the little supplements we brought with us and acquired along the road, made valuable additions to our cuisine. For your information, the three of us took a tin of salmon, a tin of beef, a glass of tongue, half a pound of butter, a quarter-pound of tea, half a pound of sugar, and a pound of cheese, and we managed finely with a few extras the land and the cake shops provided. Yes, cycle touring on these lines can still be undertaken with a considerable degree of comfort and not a little adventure; but it is wise to seek night accommodation fairly early, and if possible telephone early in the morning to secure it. We did that on several occasions and found it answer admirably, so much so indeed, that we had to cut out Killin as a stopping place because we couldn't find a roof to shelter us, the burg being chock-a-block with holiday makers. My elder comrade who had visited Scotland scores of times by car said he never knew the land was so lovely until this fleeting visit by bicycle. And that remark is true and sound as I know full well from my own experience of car and bicycle travel, and it is the main reason why I remain, and shall remain, a cyclist.

Exercise Care

THAT the difficulties of supply in the way of cycle equipment and replacement parts are increasing and will increase, is a fact that needs no emphasis. Obviously the right thing to do is to take every possible care of the goods we possess and treat them as precious things—as indeed they are. Yet I see an awful lot of carelessness in the use of bicycles and their components, and all the warning in the world does not seem to have much effect. Only an hour ago I saw one of our young men blow up a tyre and burst his pump connection in the process, just because he did the necessary job without thinking out the best way to hold a pump end steady during its exercise. Slip a finger round a spoke adjacent to the valve and you have a fulcrum wherewith to steady the stroke and prevent the waggling of the connection, which is the final ruin of many a pump connection. Pedals, too, are very difficult to replace, wholly or in part. Many a thousand pedals are ruined by sheer neglect, such as failure to tighten the nuts securing the rod that carries the blocks, with the result that the side-plates become distorted, and the pedal is literally trodden to pieces. Pedal adjustment and oiling is another main cause of unnecessary wear, and the operations are so simple one would have thought such care would result owing to the present shortage, both of pedals, replacement cones and blocks. And we are not likely to have any more week-end bags, certainly none of sturdy make, for the material is not available, or rather the M.O.S. will not release it for that purpose. So make the best of those you possess, and get your wife, mother or sister to patch them and improvise straps until you cannot recognise the original article. That is my only remedy, and though my bags look most disreputable, they at least serve their purpose. The other day I successfully repaired a pump which had developed a leak near the end of the barrel, by winding electrician's tape round the puncture, and it did the job and seems fit enough for another long run of useful work. Do not allow your saddle leather to get slack. There is a tensioning nut under the nose of the seat; tighten it before the leather sags on the wire frame and makes seating accommodation uncomfortable. These are but a few of the small attentions you can undertake to preserve the running ease and comfort of cycling, and while they are always valuable, to-day they are essential, for you cannot replace many of the components named without a lot of searching, and in some cases they are not available.

Prices and Values

THE price of second-hand bicycles seems to be soaring, and as a rider of the best types of machine, candidly I do not wonder at it. I saw a 15-years-old tandem sold for £40 the other day. It was certainly a first-class machine and had been well looked after, was fitted with a six-speed Cyclo and hub brakes, with an emergency rim brake on the rear wheel; but even so, after 15 years' wear, chain and wheels and bearings must have been in a condition suggestive of replacement—an impossible thing to do to-day. A James Ace model single, without speed gear, 12 years old, was sold for £12; and I have heard of other fantastic prices, or prices which would have seemed fantastic a year or so ago. Talking recently to a certain lightweight specialist, I was told he might be able to build a couple of tandems next season, but they would cost at least £35 each with single gears. When I said in 1940 that good bicycles—if obtainable—would run up to £20 each before this war was over, people laughed at me and thought I was romancing; even certain manufacturers thought I had gone mad, and took me to task for issuing such opinions. As a matter of fact, the only error I made in that prophecy was that the good goods went off the market entirely, and it is that fact that is now making the second-hand values of first-class pre-war machines so high. This tendency is surely a pointer that the market existing for first-class goods in the cycle industry should be a greatly expanding one in the post-war years. But do not expect the immediate return of the best directly the war is over, because it won't happen. In my opinion it will take at least a couple of years for the industry to recover that pre-war quickly-growing expansion, the popularising of the better type of bicycle. That it will come in greater and even greater volume I am convinced, and sincerely hope the trade is too.

The Growth of Cycling

I AM a trifle constrained to report any of the various promiscuous conversations I have enjoyed during the last month or so with people along the road. The gist of them has been highly favourable to cycling, so much so, indeed, that often enough I have been inclined to take the compliment to the pastime with a grain of salt, feeling that it was voiced as a compliment to the listener rather than to the wider sphere of cycling. But those contacts have become so common, I am stopped so frequently on the way by people who know me by sight, but whom I do not know, that I am rapidly becoming convinced a very considerable percentage of our modern riders have been surprised to discover the pastime of cycling is so varied and so enjoyable. This type of individual never gave the bicycle a thought as a vehicle of pleasure so long as a car was possible, and for some time after they were forced to ride or walk, resented the changed conditions. Then the spring came, and the summer, and holiday times; travel was difficult and most uncomfortable, walking limited horizons, but the bicycle—almost against the rider's will, to start with—took them into places they knew not of, or had passed by with a forty miles an hour glance without knowledge of beauty or interest. It is remarkable, and sometimes a trifle embarrassing, to have one's own words quoted in justification of the fine variety of pleasure instinct in cycling; yet this has happened to me on numerous occasions this summer, and its steady occurrence makes me wonder if the pastime will not find a completely new clientele among the hundreds of thousands of folk who perforce have had to ride for sheer convenience.

By Persuasion

IT has been the habit of most of us who claim to be keen cyclists that its advocates are divided into two classes, the folk who look upon cycling as a sport and pastime, and those who ride for utilitarian purposes. Probably we have made a mistake in adopting that attitude, which seems to me to have resulted in a lack of effort to win over the utilitarian to the joy of the pastime, and incidentally the better riding of the individual on his daily journeys. There is a faint taint of snobbery in some people because a man or woman is not astride the type of machine a "real cyclist" would buy. It is, in my judgment, a wrong approach to improvement; and I mention it here and now because the opportunity of making cycling a still greater pastime is with us, and we ought to be fully aware of the fact. Nor should I like to see the newcomers, restricted now in their choice of bicycle specification, treated other than as very welcome adherents to the pastime, and given advice, when asked for, with reasons to back it gently explained, and not fobbed off with a sneer that this, that and the other is "no good." We all had to learn, and one learns more happily and readily if the case is put without the introduction of that useless superiority, which too often I have heard given as advice. It isn't so much advice the average rider needs as persuasion, persuasion to try a method new to him, a method which has been evolved by tourists and club folk, not for the purpose of being different, but because by its adoption they ride easier, can sit on a saddle for long periods with comfort, and cover an annual mileage in pleasure riding often surpassing that of the motorist. This thing seems to me important to remember in these days.

My Point of View

BY "WAYFARER"

Quite New

DEFINITION of a pessimist: A cyclist who carries a supply of no-solution rubber patches *and* a tubo of solution.

Nine Days' Wonder

AT the moment of writing I am just back from a nine-day tour of Mid-Wales and its approaches—a veritable "nine days' wonder" holiday, which yielded 568 miles, tremendous enjoyment, many pre-war meals, and, in spite of not-too-settled weather, only 15 minutes under the protection of my cape. What a joy the whole thing was! Grand scenery, with hardly a flaw in it: seclusion along the road, with pleasant company at stopping places: gorgeous views of land and water: sublime mountains: rich woods: musical streams: painted skies: a bicycle running like oiled silk, and not requiring the slightest attention. This pastime of ours is a great game, especially for those of us—and I take second place to none in this respect who know how to obtain full advantage from it.

It may interest my readers to know that, despite the increase in the cost of living, I was able to carry out this tour at very little more than the 10s. per day which I fixed as my essential expenditure several years ago. The total expense amounted to just under £5, which, of course, was the gross cost of the holiday. Is there any other way in which a fiver can be so well spent? I doubt it. What a harvest of enjoyment and of benefit—of physical and mental health—accrues from a cycle tour. I have long known this, but I am to-day far more convinced of the fact than ever.

The subject of meals has been touched upon. Let it be added that between the first and last feed of the tour I did not taste margarine, butter being liberally supplied everywhere. I had all the eggs I wanted—though never more than five in a day! I had all the butcher's meat I desired. Home-cured bacon figured on every breakfast-table—what a change it is from the "lease-lend" stuff one now consumes normally! And, at most places, the confectionery approached peacetime standards, as to both quality and quantity. Altogether it was a grand tour, the memory of which will endure for many a day. My average mileage was 63 per day. How easy it all was, thanks to that practice which is said to make perfect!

Stay-at-home Holidays

CIRCUMSTANCES over which I had no control necessitated my remaining fairly near home at both Whitsuntide and August Bank Holiday week-ends, but I made the utmost use of the time available and had two thoroughly enjoyable holidays. I spent each day along the road and at no period was I much more than 40 miles from home. In the three days comprising my Whitsuntide holiday I scored a total mileage of 231, at a cost of 10s. 6d. In the evening and four days which made up the August week-end I accounted in all for 353 miles, the "damage" being 15s. Thus the aggregate expense of the two week-ends was £1 5s. 6d., and the total distance travelled was nearly 600 miles. Beyond carrying a small "iron ration," no food was taken from home. I am not a whale on sandwiches, preferring to rely on caterers for sit-down meals consumed in comfort under an alien, but friendly, roof.

This is not the place for discussing the general principle of stay-at-home holidays, as to which there is much to be said on both sides, in current circumstances. Cyclists, however, occupy a special position, and such holidays cause no hardship. In its pleasure content and possibilities, the stay-at-home holiday does not fall far short of the going-away holiday, and the cyclist who, for one reason or another, is compelled to take the former type of vacation needs no sympathy. To be sure, the necessity of having to traverse familiar suburban roads every morning and evening is a small nuisance. To set against that, however, is the fact that one can always travel light, and is always sure of a hot bath at the day's ending—an item of particular value if wet weather should be encountered. So I may fitly put a query which is but a variant of the inquiry already asked in the present contribution: In what other way could one obtain such admirable stay-at-home holidays at so grotesquely small an expense? In my view, the answer to that question is: "No other way."

Reverting to the purely personal aspect of this matter, it may be added, as a matter of possible interest, that on the hottest day of the year—a day when the sunshine was aided and abetted by a brisk wind which came, apparently, from the nether regions!—I did my longest journey, one of 93 miles. It must have been a warm day, because, as a very definite novelty, I cultivated a thirst!

Bank Holiday Sights

I MAY fittingly go on to make a further reference to those two holiday week-ends. On the morning of Whit Sunday I rode for some miles along what in normal times is one of the most popular roads in the Midlands—that which links Birmingham with Stratford-on-Avon. In pre-war days it was a road which cyclists liked to avoid at week-ends, so infested was it with hurrying motor-cars, but the aspect of things is now very different, and it was a great joy, on the occasion in question, to behold the hordes of cyclists making their way towards that picturesque town in which the author of Shakespeare's plays first saw the light of day. What a sight it was! Reminiscent of the crowds converging on Meriden for the annual service of commemoration—again in pre-war times. Boys and girls, of varying ages, on singles and tandems, with offspring sometimes carried in a side-car: boys and girls in trousers and shorts, in lumber jackets, ice-cream coats, jerseys—or coatless. A grand sight, supporting the view of some Extremely Observant Person that "cycling has come into its own again."

On the following evening I was back along that road again, to be confronted by more and more crowds of cyclists, all merry and bright. A joyous and impressive picture, which gave one cause for hope that the discovery of the bicycle by thousands of new cyclists will have permanent results on our glorious pastime. In between times, at Whitsuntide, I philandered in some of the lovely lanes of the Forest of Arden, and at one point was overtaken—quite an easy process!—by a really-real group of cyclists, with whom I rode for a short space. They evidently came from far afield, and one of them said, in a complimentary manner, that he was glad to have met me, I being the one thing lacking from the scenes through which the party had been travelling. My friend indicated that the picture was now complete.

Notes of a Highwayman

By LEONARD ELLIS

County Characteristics

MOST counties have characteristics which distinguish them from other counties, but the youngster's idea that the scenery changes abruptly as one crosses the boundary is not, of course, borne out in fact. The characteristics of any county are only a broad indication of its main features; it is obvious that every county possesses a dozen and one bits of scenery of widely differing types. There is, however, at least one spot where not only do the county characteristics change most suddenly, but to go further one can say that one minute we are in one country, England, and the next we are in Wales, real Wales. The scenery, as we follow the Holyhead Road to Chirk is typical Shropshire as far as the hill that drops down to the England-Wales border; and there in the bottom of the valley dashes the rocky-bedded Ceiriog, as Welsh a stream as you could wish for. It is true that the change is not maintained, for as we slowly climb the hill to Chirk we are conscious that although in Wales the scenery is of exactly the same type as that across the river However, having reached Chirk, let us proceed along the Highway to Wales, A5, the Holyhead Road, or the Watling Street. We shall find that although Chirk was quite English in style, the scene does rapidly become truly Welsh.

An Entrancing Valley

IN half a dozen miles we are in Llangollen, a most entrancing town and Welsh to the core. Enclosed by mountains, but not shut in sufficiently to be regarded as overwhelming, Llangollen has few equals as a centre for touring. Not only is there a tremendous amount of interest in the place itself, and within easy walking distance, but several good roads give access to other beauty spots; and the road back to Llangollen never palls. The River Dee runs right across the floor of the valley, which is spanned by several imposing viaducts and aqueducts. Here the Dee is a real, rushing, rocky river; a dozen miles away at Corwen it is placid as the Warwickshire Avon. The Dee has many charms and as the Llangollen canal begins a little west of the town and runs parallel with the river, there is a delightful walk along the banks of either. At the point where the canal is born we find the Horseshoe Falls, admittedly artificial, but very beautiful. Llangollen is fond of horseshoes and away to the north is the famous Horseshoe Pass over the mountains to Ruthin and Denbigh. On the way we shall pass Valle Crucis Abbey, a singularly lonely and beautiful ruin, one of the few ecclesiastical ruins that Wales has to show.

History and Interest

BACK in the town we see the old bridge over the Dee, sometimes erroneously called the Roman Bridge. It was, in fact, built by the Bishop of St. Asaph in 1345. This bridge is one of the so-called Seven Wonders of Wales. Perhaps the real show-place of Llangollen is Plas Newydd, or the New Hall. This is a magnificent specimen of black-and-white architecture standing in beautiful grounds and yet not really beyond the limits of the town. In the house and all over it there is a wonderful collection of carved oak, and the contents of the rooms are a veritable museum and treasure-house.

Plas Newydd, Llangollen.

CYCLORAMA

By H. W. ELEY

Steephill Cove, Isle of Wight.

EVEN the old-time cyclists with whom I have chatted during this harvest season cannot recall a year when there have been so many good fields of wheat, and barley, and oats to see and admire. Acres and acres of land under the plough which used to be pasture . . . and in some cases, pretty poor pasture too! We should take off our hats to the farmers of England (not forgetting those of Wales and Scotland!) for doing a wondrous job. And when we doff our hats, and give a toast to the farmers, let us have in special remembrance those grand girls of the Land Army—they have never received the praise and publicity which is their due, and I fancy that the W.L.A. is the least known of the Women's Services. But those who know and love the countryside, and have been watching those fields of golden corn, know how great is our debt to those splendid girls who have driven tractors, milked cows, cared for horses, and done the thousand and one things which are necessary if a farm is to be kept going. When the peace celebrations come (as they surely will) the Land Army girls must have a very special place in the procession of all those who have secured us the victory.

Good Old Days

WE hear much talk about the "good old days"—and sometimes one gets the impression that in those good old days, everything was perfect; old folks are fond of painting glowing pictures of the happy times of yore—and when I hear them, I always feel that it is necessary to get a true perspective on this matter. I admit that we have lost a good deal owing to the swift march of scientific progress; some of the romance of life has gone; we have less time to "stand and stare"; but there were bad things in the old days too! I thought of some of our gains in the realm of dress when, recently, I watched some girl cyclists dismount from their trim modern bikes, and enter an inn for refreshment. How sensibly they were clad! Strong limbs exposed to the good fresh air; light-weight clothing which permitted free movement; and I recalled the extraordinary muffling clothes of the period when cycling was a novelty—and when "lady cyclists" were looked upon askance. Oh! a great advance! I chatted to those three modern girls as they drank some mild ale from tankards in the little inn. Healthy girls—free girls—emancipated for ever from all the hampering restrictions of grandmother's day. They had ridden through many leafy Buckinghamshire lanes that day, and they were good cyclists—proud of their machines, and anxious to learn all they could of the countryside of old England.

The Small Man

I HAVE always loved the individual trader . . . the "small man" who has refused to be squeezed out by the big combines. I talked with a cycle dealer in a small town the other day, and admired his truly British spirit of independence. Owing to the war, he had had few machines to sell, and his stock of tyres was small indeed when compared with what he would have displayed in his window in the piping times of peace. But he held his head high, and he was planning for the good days to come, when once again he would scheme out a window display which would be a credit to his own powers of imagination, and a tremendous aid to the makers of the cycles for which he held the agencies. This is the type of "small trader" to whom our country owes much; in a sense, British industry has been built up, and maintained, by the brave "one-man" business, and it will be a sorry day for us when such businesses have been erased from the business scene. I trust they never *will* be erased, but that they will grow stronger in the new and better years to come.

When it is Necessary

"IS your journey really necessary?" was, to me, more than a Government suggestion . . . it was a command not to travel unless there was real and urgent necessity to take the train and add to the already heavy burdens of our railway personnel. But . . . there does come a time when it seems imperative to take a rest from war-work, and this applies particularly to our women-folk, who spend so much of their time dealing with those household duties which come round with monotonous regularity. For them . . . a week by the sea, free from washing-up, bed-making, meal-preparing, means more than one can say. And all this leads me to the point that a week ago I stole away to Wales, and found peace and contentment in a village some eight miles from Pwllheli. Its name is Dinas, and if you are interested in wild flowers, and butterflies, you will find the place a paradise. On the walk from Dinas to Tydweiliog, armed with butterfly net, killing-bottle, and temporary setting-boards, I captured some fine specimens of the Painted Lady, Clouded Yellow, and Peacock butterflies. And almost every yard one could have stepped on a Fritillary. For the keen entomologist, a bit of Heaven indeed . . . and one had the roads to oneself . . . and what good roads they are . . . thanks to the surveyor's department of Carnarvon County Council!

One morning I stumbled into a veritable hive of Nature's activities: first of all, I swept my net over a tangled patch of hedge-growth and captured a Painted Lady butterfly; then, I heard a squeaking and crying from the high bank, and, on exploring, discovered a weasel attacking a nest of baby rabbits; I beat off the lithe and savage attacker, restored a baby bunny to its mother, and turned back to the lane, to find an Elephant Hawk caterpillar making its leisurely way from one side of the road to the other. He now reposes in my larva case, feeding on suitable foliage, and I hope in due course to see him in chrysalis form, and, finally, emerge into the perfect moth. To the nature-lover, those few moments were packed with high adventure, and I walked home feeling very satisfied.

Wooden Pedals

WHAT has happened to the wooden pedal? We heard a good deal about the necessity of substituting beech, or chestnut, for rubber . . . but so far, I have yet to meet a cyclist whose machine is equipped with other than rubber or metal pedals. Maybe the timber controller has "had words" with the rubber controller! But I must say that the beech pedal blocks I inspected at a factory some months ago seemed good and practicable.

The Thief

THE cycle thief is still with us, and I often wonder why riders are so careless when leaving their machines outside inns and other places. A cycle-lock and key should be regarded as just as essential a part of our equipment as an inflator or a touring map.

Talking of maps, how good it is to find—in many an inn or hotel—that fine and massive volume the "Dunlop Book." It was first published, I fancy, round about 1916, and two famous men were associated with its compilation . . . Edward J. Burrow and A. J. Wilson. The former is no longer with us. He was a great lover of the English scene, and possessed a profound knowledge of geology, ancient earth-works, Roman remains, and curiosities of the countryside. A. J. Wilson—the immortal "Faed" is, happily, still alive, and dwells in peace in the Cotswolds. Together, they gave us a touring volume which is a mine of information for every man who loves to wander, and to whom the roads, and hills, and valleys of our land are the ever-magic lure.

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TUNGSTEN CONTACTS, 3/16in. dia., a pair mounted on spring blades, also two high quality pure silver contacts 3/16in. dia., also mounted on spring blades fit for heavy duty, new and unused; there is enough base to remove for other work. Price the set of four contacts, 5/-, post free.

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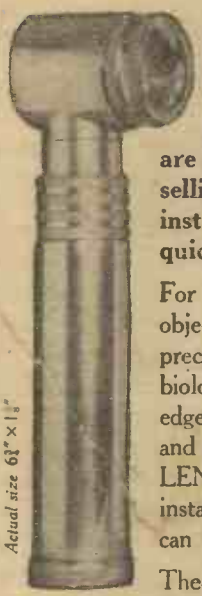

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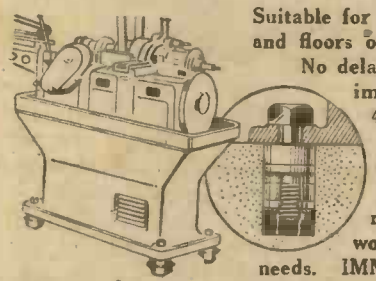

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