42 Beds

VARIABLE-PITCH AIRSCREWS

NEWNES

PRACTICAL MECHANICS

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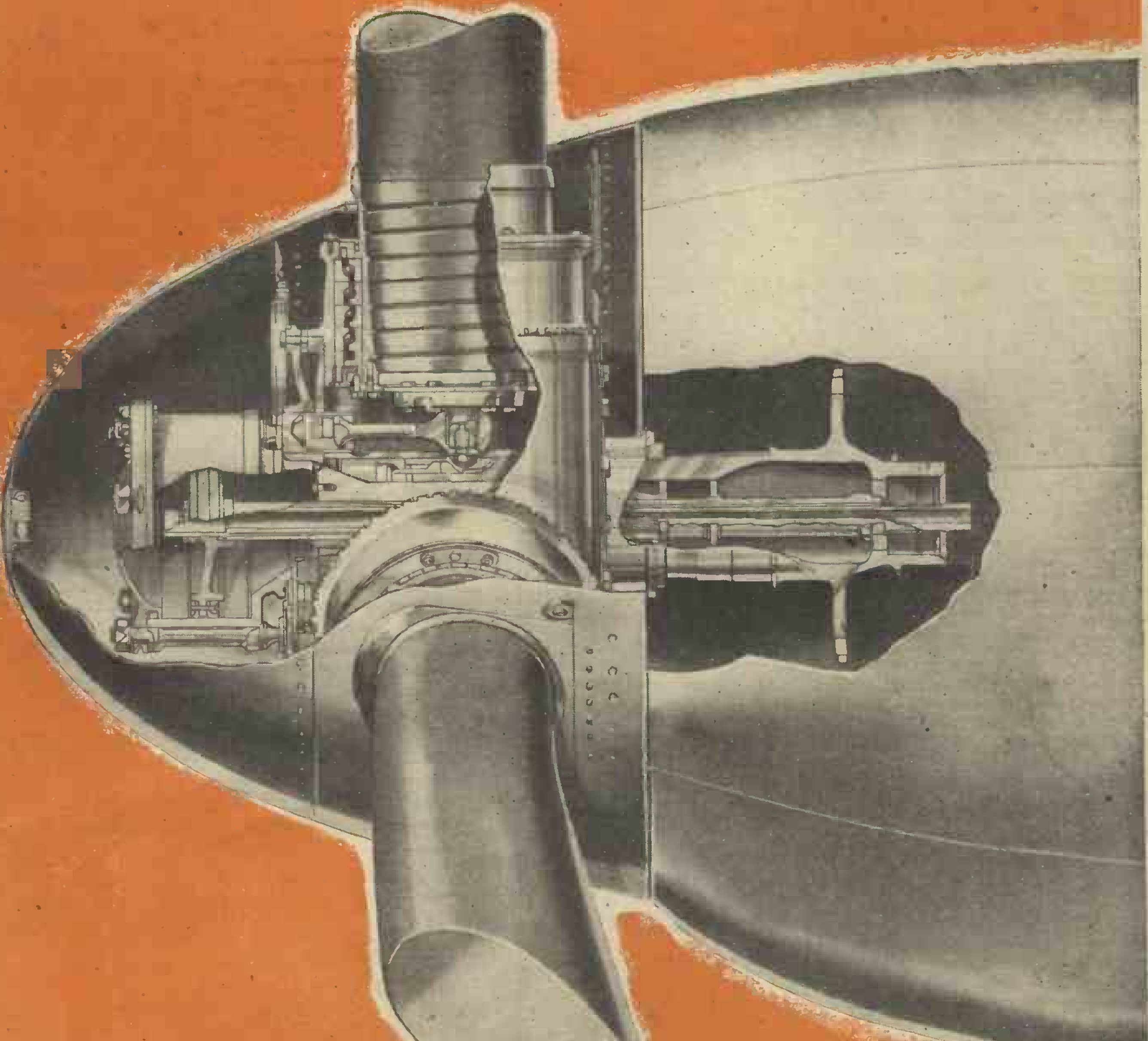
JUNE 1943



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Editor: F. J. CAMM

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FAIR COMMENT—BY THE EDITOR

Scheme for Education and Training

A SCHEME authorised by the Minister of Labour, The Board of Education, The Minister of Agriculture, and The Secretary of State for Scotland, dealing with further education and training after the war has just been announced.

Its application during the war to certain limited classes of men and women is also announced. The present war has interrupted the training and education of large numbers of young men and women who, at an age when they would normally be taking courses of general education or training for a business or professional career, are engaged in work of national importance. The Government recognises the importance of securing to the country after the war the service and influence of those highly trained in the humane studies such as history, philosophy, law, and the fine arts, and of ensuring an adequate supply of men and women equipped to occupy higher posts in industry, commerce and the professions. The Government has therefore approved plans for providing financial assistance to enable suitable qualified men and women on demobilisation to undertake or continue further education or training beyond the secondary school standard.

The Further Education Scheme will apply to men and women alike, and it is intended for the following categories: H.M. Armed Forces, including their Auxiliary and Nursing Services; Merchant Navy; Civil Defence Services; Police Auxiliaries and Civil Nursing Reserve. A certain number of places will also be available for suitable candidates whose further education and training has been prevented or interrupted by employment in work of national importance other than the types of service mentioned above.

Eligibility

THE primary condition of eligibility will be proof of a period of full-time effective service in work of national importance during the war. In addition to giving proof of such service, a candidate will be required to show that by reason of this service he has been unable to start training or has suffered interruption or diversion of a career; or of training for a career; or is unable to resume or continue a career; or requires a refresher course to enable him to follow his previous profession. Part-time service will not satisfy the primary condition of eligibility unless that part-time service has led to a disability which has rendered him unable to follow his normal occupation. Holders of State bursaries, language scholarships, or engineering cadetships, who are still undergoing training at the cessation of hostilities will be deemed to fulfil the primary conditions. The course of training provided under these schemes is not necessarily the course which the holder would otherwise have chosen, nor that which necessarily leads to the profession most suited to his abilities. The candidate must show capabilities or potentialities sufficient to suggest his training would justify expenditure of public money.

A man who before the war already held a post for which he had received adequate training, and who left that post to undertake temporary war work, will not thereby become eligible for training unless he is denied the opportunity of resuming his pre-war career. He might, however, qualify for a short refresher course in the profession for which he is trained. The courses will apply to those who entered on their war service before going to a university or entering on a course of training such as a technical college.

Educational Background

SUCH courses can only profitably be taken by those with an adequate educational background, although previous attendance at a secondary school or an equivalent will not be demanded. It is hoped that an opportunity may be found of making a university education available to some who are qualified to take advantage of it, but who might not have otherwise had access to it. No hard and fast rules can be laid down as to the type of work or profession for which candidates will be assisted to train. Generally, the criterion will be that a profession will be recognised for the purposes of a scheme if it is one which requires the attainment of a recognised standard as a condition of entry, or one in which technical training or higher education will materially improve an entrant's prospect of advancement. Where neither of these conditions is fulfilled, it will be for a candidate to make out a case for expenditure of public funds for his training, the basic principle being that such expenditure must be to the national advantage as well as to the advantage of [the applicant. Although an applicant must state the business or profession for which he is to train, the type of training given cannot be left to his undirected choice. By reason of the reservation system, certain professions have suffered less reduction than others in their annual intake during the war years, and there will consequently be less need for outside assistance to enable these professions to return to normality. Hence the absorptive capacity of the profession chosen must be taken into consideration, and the candidate may have to be advised to train for some other profession. The Government has formed a committee under Lord Hankey's chairmanship to give expert advice upon the number of persons who should be encouraged to enter the scheme. The conclusions will thus be available when at the end of the war the scheme comes into full operation.

Grants

THE award to a successful applicant will be in the form of a grant enabling him to take the full course of training which he may need, and the amount of the grant will vary according to his existing obligations, his financial resources, and the length and nature of the course approved. The amount of the award will be determined, in the case of a university student, by the scholarship assessment committee of the university in question, and the needs of married candidates will receive special consideration. Courses at Dominions or other overseas universities will be considered. Where the training desired is of a practical nature more complex considerations arise in assessing the amount of award, for the scheme does not envisage the mere subsidising of a beginner's wages. Continuance of an award will be dependent upon satisfactory conduct and progress, and will be conditional upon the passing of ordinary examinations associated with the course. In assessing the amount of the award the following general principles will be applied:

If the applicant is under 21 years of age, and unmarried at the date of application, his parents will be asked to state their income. If this is substantial, the amount of the award made to the applicant will be based on the assumption that the parents will make a suitable contribution to the cost of the applicant's further education;

If the applicant is over 21 years of age, or is married (whether over or under 21) he will be asked to state the occupation of his father and what contribution, if any, his parents or others are prepared to make.

A substantial proportion of the private income, if any, of a married applicant and the whole private income of an unmarried applicant will be taken into account when assessing the grant payable to the applicant, except that no account will be taken of personal disability pay or pension or war gratuity;

In the case of a married applicant a reasonable maintenance allowance will be paid in respect of his wife and children, if any, subject to some limitation if the applicant or his wife has an income.

Variable-pitch Airscrews

Their Function and Advantages

VARIABLE-PITCH airscrews have been evolved so as to allow the whole of the horse-power developed by the engine to be converted into thrust at all altitudes and speeds. A fixed blade airscrew is only efficient at one particular speed, one particular height, and one particular rate of revolution. The changing of the pitch of airscrew blades is equivalent to changing gears on a car and allows an immense improvement in the performance of the aircraft. All modern aircraft, both military and civil, no longer use the fixed blade type, which must now be regarded as a thing of the past, except for small light training or sporting machines.

The relative airflow past any particular section taken across an airscrew blade is the resultant of the forward velocity of the aircraft and the rotational velocity of the airscrew blade. Fig. 1 illustrates the relative directions. The blade section is similar to that of an aerofoil and is positioned at an angle to the airflow so as to obtain lift, i.e., thrust. As in the case of an aerofoil, drag is also developed and must be kept as small as possible. Due to the fact that at any particular moment the forward velocity is constant and that the rotational velocity varies from a minimum at the blade root to a maximum at the tip, it follows that the blade angle must vary from root to tip as shown in Fig. 2. From the two diagrams it will be seen that, should the revolutions per minute of the airscrew be altered, or the forward velocity of the aircraft varied, the airscrew will not be efficient, as the blade angles will not be correct for the new set of conditions.

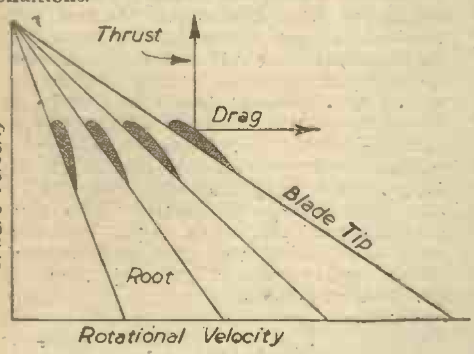


Fig. 2.—Variations of blade angle.

"Coarse" and "Fine" Pitch

Fig. 3 illustrates the effect of altering the blade angles from "coarse" to "fine." The coarse pitch, i.e., a large angle, is used for high-speed flight and the fine pitch for low speed flight when landing or taking-off. If the coarse pitch was used for take-off, a very heavy load would be imposed on the engine, which would not be able to develop its maximum revolutions and therefore its maximum output. By altering the pitch to the fine position, the revolutions are allowed to increase, thus reducing the load and increasing the revolutions. After taking-off, if the fine pitch was maintained, the engine would over-rev. itself, thus causing damage to the bearings, etc. By changing into coarse pitch the engine speed is reduced and the blades act at an efficient angle of incidence. For take-off, it is usual to run the engine at very high revolutions for the short period of time required to become airborne and this time is limited by the engine manufacturers, so that it is important that the pitch be changed as soon as possible. The changing from fine to coarse is equivalent to changing from low to high gear in a car when starting from rest. By using an airscrew with variable blade angles, smaller aerodromes may be used, a heavier pay-load carried and the rate of climb increased.

Constant Speed Airscrew

The next step from the two-pitch type was the constant speed airscrew. The coarse and

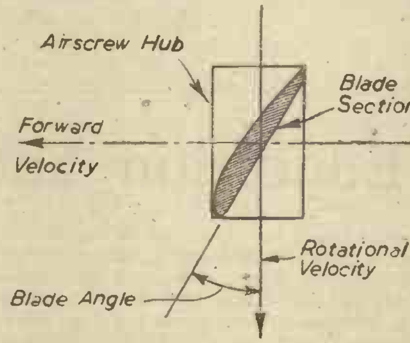


Fig. 1.—Relative directions of airflow.

fine pitch of the first type make the airscrew only efficient at take-off and one other speed. For the gap in between these two speeds they are inefficient, as the blades are acting at incorrect angles of incidence. By fitting a governor to the airscrew, the revolutions may

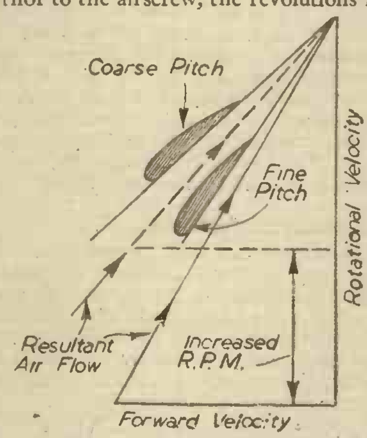


Fig. 3.—Effect of altering blade "pitch."

be kept constant and the blade angles altered automatically to their most efficient positions. The term "constant speed" is not strictly true and inclines to be misleading, as the revolutions are not kept constant for all conditions of flight. A control is fitted in the pilot's cockpit, which allows the rate of revolutions of the airscrew, and therefore those of the engine, to be altered to suit the altitude and throttle position at any given moment. This point will be made clearer by the fact that various allowable engine revolutions are quoted by the manufacturers for different altitudes and conditions of flight. Should the constant speed control be left in one position and the throttle opened, the r.p.m. would remain constant, but the blade angles would alter so as to absorb the extra power developed.

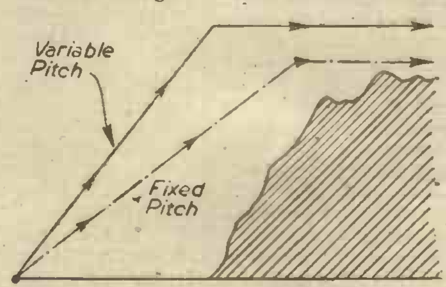


Fig. 4.—Illustrating one advantage of a variable-pitch airscrew.

By using a constant speed airscrew, the pilot's work is very much simplified and the danger of over-revving is avoided. The effect upon the performance of an aircraft when different types of airscrews are fitted is illustrated in Fig. 4. If a range of mountains has to be crossed, the aircraft which is fitted with v.p. airscrews will be able to climb more rapidly than if fixed pitch airscrews were used. The take-off run is reduced, being a good advantage when the aircraft is being operated from small aerodromes which may be situated at high altitudes. Should the aircraft be dived, the engine will not over-rev, as would happen in the case of a fixed pitch airscrew.

Feathering Airscrew

An important step forward in the design of variable-pitch airscrews was the development of a "feathering" airscrew, i.e., one in which the blades are capable of being turned end onwards to the airflow. Should the engine fail in flight and be allowed to keep on rotating, serious damage may be caused to the internal fittings. By feathering the airscrew blades as shown in Fig. 5 there is no tendency for the airscrew to windmill. At the same time the drag is considerably reduced, and this is extremely advantageous in the case of multi-engine aircraft. If the port engine fails on a twin-engine aircraft, there will be a tendency to turn to port. This tendency must be resisted by forcing the rudder hard over to starboard. When a feathering airscrew is fitted, the drag is reduced and the aircraft is far easier to fly when the blades are turned end on to the airflow. The rate of climb on one engine is also improved, and the length of flight extended. This is important as many bomber aircraft have managed to reach their bases in England after flying hundreds of miles over enemy territory with one or more of their engines out of action. There are some aircraft which are practically uncontrollable when one engine cuts out, but when feathering airscrews are installed they are rendered more stable and require less physical effort on the part of the pilot.

If one airscrew blade is damaged, vibration is liable to start, and may, unless checked, cause the wing to break away from the fuselage. By feathering the damaged airscrew the rotation is stopped, and also the vibration.

Reverse-pitch Airscrew

A further development of the variable-pitch

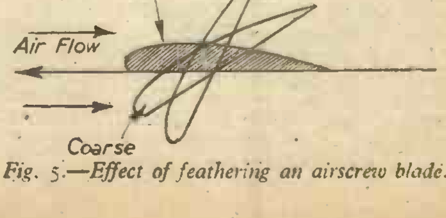


Fig. 5.—Effect of feathering an airscrew blade.

airscrew is that in which the blades can be rotated far enough round so that reverse thrust is developed. This may be turned to good account in the case of flying-boats, which normally require a large radius in which to turn when taxi-ing on the water. By reversing the airscrews on one side of the aircraft, the radius of turn is reduced and in fact it may turn in its own length. Where harbour facilities are restricted this is extremely helpful and the danger of collisions is lessened.

Another possible use of the reverse-pitch airscrew is that of manœuvring in flight, but the forces required to reverse the blade in flying conditions and the stresses involved are very high and further development is necessary before this idea becomes a practicable proposition. The present-day use of flaps for diving brakes to slow up the speed may be superseded by the use of a reversible airscrew. In this case the speed would be able to be controlled to close limits. Most modern aircraft have a very flat glide, due to the cleanness of their lines, and the length of the approach glide when landing could be considerably reduced by using the airscrew as a brake, i.e., reversing the airscrew so that the thrust is acting in the opposite direction to that which normally occurs.

Contra-rotating Airscrews

From the present trend of design the future airscrew will be contra-rotating and fully variable. Contra-rotating, i.e., two sets of airscrew blades mounted one behind the other and revolving in opposite directions, has been developed to reduce the diameter of airscrews. This type also has the advantage that the torque is cancelled out, thus increasing the manœuvrability of the aircraft and also reducing the stresses in structure surrounding the engine. The reason why the diameter must be kept within reasonable limits is the fact that when the blade tips travel at a greater speed than sound, the airflow is considerably altered, causing loss in thrust and possible vibration. Another factor is ground clearance, which is limited by the height of the undercarriage. By fitting airscrews with a reduced diameter, the tip speed is also reduced and by using contra-rotating airscrews the power developed by the engine may be absorbed very efficiently. The main disadvantage of this type is the added complications involved by the additional gearing.

Blade Turning Devices

Various mechanisms have been developed to enable airscrew blades to be rotated, and several of these methods will now be described.

Oil pressure is used in one type to force a piston along a cylinder. This forward and backward motion is converted into rotary motion by means of cams. The blade roots have a bevel gear fitted which engages with the cam gears and thus, when the piston is moved, the airscrew blades rotate. The oil required is tapped from the main supply system by means of a relief valve set at a predetermined pressure. The airscrew hub is used to house the operating mechanism.

When a constant speed unit is fitted, it usually takes the form of an ordinary centrifugal governor connected to a valve which allows oil to flow either from or to the opposite side of the piston which is utilised for the main pitch-changing oil. The oil pressure for operating the constant speed unit is greater than that used for the ordinary pitch-changing operation, and this higher pressure is gained by fitting a special gear pump which boosts up the pressure to the required level. The governor operates as follows. If the flyweights alter in position due to variation in the r.p.m., then the valve opens and oil is admitted to the operating mechanism, thus changing the pitch. Should the pitch be made greater, then the load on

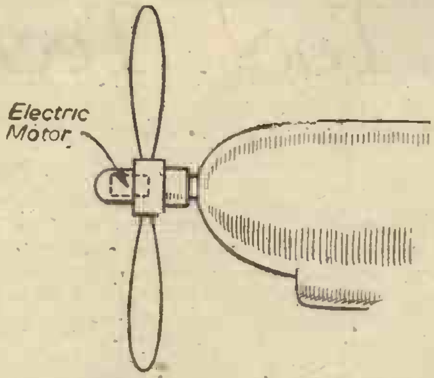


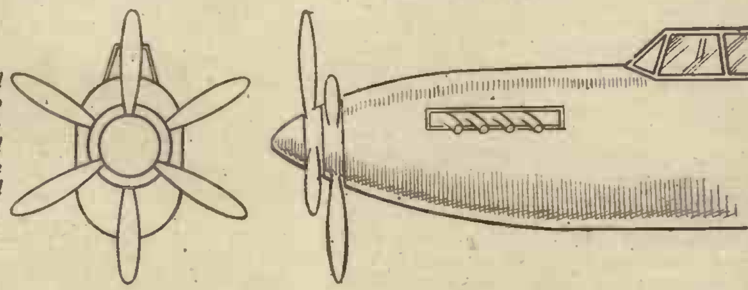
Fig. 6.—Position of electric motor used for pitch changing.

the engine will increase and the revolutions will drop. The oil will then flow back from the piston until the correct setting is obtained.

Various alternative methods of using oil pressure have been developed, e.g., the rotating of the blades by means of levers instead of cams and bevel gears.

A combination of oil pressure and centrifugal force has also been adopted, and in this method weights fitted at the blade roots tend to be thrown outward. The centrifugal force is utilised to change the pitch and oil pressure used to reverse the pitch, as the centrifugal force only acts outwards.

Fig. 7.—Method of mounting two three-bladed airscrews one behind the other to give a multi-bladed effect.



Electric Control Gear

Electrically operated v.p. airscrews have also been developed, especially in America and Germany, although they suffer from the disadvantage that a longer period of time elapses between the operation of the control in the cockpit and the actual movement of the blades than when hydraulic power is used.

The electric motor may be mounted in the airscrew hub or on the engine, being connected via a set of gears to the pitch-changing mechanism (see Fig. 6). Electric current from the ordinary power supply of the aircraft is utilised and when the motor is fitted in the hub the energy is conveyed from the engine nose via slip-rings and brushes. The electric motors are usually of the double field type to allow for reversal of movement, and the speed of rotation is brought down by means of planet gears. A governor is fitted which, when altered in position, allows current to flow via various circuits to either increase or decrease the blade angles.

To enable the airscrew to be feathered quickly, the current is boosted up when the control is placed in the feathering position, in some cases by as much as four times. Alternatively, to feather oil-operated v.p. airscrews a special pump, usually electrically operated, is fitted to provide the high pressure required to overcome the forces acting on the blades when they are rotating at high speed.

Various other methods of changing the pitch of airscrew blades have been designed, but very many of them suffer from the disadvantage of being far too complicated. One type incorporates a small diameter windmill arrangement, in front of the main airscrew, which is used to operate the mechanism.

From the above description of the various advantages and the various methods of operation of v.p. airscrews, it will be seen that their use on future aircraft is essential. As engine power increases, as it is doing at the present time, more use will be made of the variable-pitch, contra-rotating, multi-blade airscrew. The number of blades required to absorb the power may rise to six eight or even 12, resulting in a very complicated piece of mechanism requiring careful designing and construction (see Fig. 7). The possibility of variable diameter airscrews must not be overlooked, and also the fitting of gear-boxes to engines.

Books Received

Astronomical Air Navigation. By Squadron-Leader Ronald Hadingham, R.A.F.O. Published by The Technical Press, Ltd. 132 pages. Price 10s. 6d. net.

THIS comprehensive handbook explains the most up-to-date methods of navigation by reference to the heavenly bodies. The book fulfils a need for a complete reference manual on the subject, equally suitable for students, instructors, and all practical navigators. The book deals with Astro-navigation in the most practical way, and covers every aspect of the subject which is important to the air navigator. There are numerous illustrations, and also a useful appendix containing several tables.

Systematic Radio Servicing. By J. Bull. Published by V. E. S. Publications.

THIS handy booklet describes a service method which is intended to reduce the amount of supervision necessary with juniors in a service workshop. Notes on the testing of valves, electrolytics, resistances, rectifiers and switches are given, together with a useful layout for a job card.

Basic Electricity and Magnetism. By W. C. Frid, B.Sc. (Hons.). Published by Sir Isaac Pitman and Sons, Ltd., 40 pages. Price 1s. 6d. net.

THIS pocket handbook, which has been specially written for the Services and the A.T.C., explains the fundamental facts of electricity and magnetism, and how they are applied in the electrical appliances in common use. Although no previous knowledge of the subject is assumed, the treatment, while simple, is accurate, and forms a sound introduction to the more advanced works on electrical and radio theory. The worked examples and test questions form an important feature of the work.

Plastic Tool Technique

A New Method of Using Plastic Material for Forming Jigs and Dies Used for Aircraft Production

By M. D. BASOLO

TO meet the growing shortage in metals in the United States, the Lockheed Aircraft Corporation and the Vega Aircraft Corporation of California have been investigating the possibility of using plastics for tooling. As a result, two methods have been devised, one by each Corporation, for producing tools made of plastics. These include drilling jigs and forming dies which will stand up to 8,000 pounds pressure per square inch under hydraulic presses. It has been found that considerable time, amounting to several months in some cases, can be saved in vital production without bringing into the factory new equipment other than ordinary bakers' bread mixers and ovens and walnut shells which formerly were tossed into the garbage pail.

Research Work

The writer started the investigation at the Lockheed plant, and Mr. Carl Hill at the Vega works continued it along slightly different lines. I predicated my research upon the thesis that drilling jigs could be fabricated by securing the drill bushings to the master part, placing the part in a form and pouring a moulding of material around it. When the material had solidified, the bolts holding the bushings in position could be removed and the jig finished for use. The existing method of drill jig construction, using wood with inserted metal bushings, had three disadvantages. Operations involved in creating a three-dimensional contour in wood manually are slow and expensive; bushings presented a difficult lay-out problem; the wood, affected by moisture and soluble lubricating oils, might swell or shrink unless it received periodic surface treatment.

On the other hand, a satisfactory thermoplastic material could be cast at 225 deg. to 325 deg. F., with a softening point of 200 deg., permitting the casting of a jig from an aluminium alloy part without damaging the latter and without danger of softening the jig from the heat generated by drilling. A satisfactory plastic could be reclaimed cheaply and finished on standard wood-working tools, and would withstand shop handling because of its good impact strength. Added advantages were that it would not exhibit brittleness at low temperatures or after ageing, and would be resistant to lubricating oils and metallic chips.

Phenol Acetone

Of several materials studied, the Lockheed Corporation adopted a phenol acetone thermoplastic, while the Vega Corporation at present is using an acid phenol formaldehyde thermosetting composition made up of 25 to 30 per cent. ground walnut shell flour, used as a filler with resin and an acid catalyst or accelerator. Other good fillers include wood flour, masonite and scrap plastic. The investigations have brought to light several features of interest to both the company and the Government. Tools may be cast to a master part or plaster mould more quickly than by forming, milling, or hand fitting; duplicate tools may be made at less than the original, since the moulds are saved; and duplicate tools may be made more economically and quickly for transportation to other plants. The time factor is of great importance. At the Vega works the portion of the tooling programme on the "Flying Fortress," which was completed through the use of plastics, involving three months' work, would, it is estimated, have required five to six months if wood, duralumin and steel had been used.

The Vega Corporation has conducted experiments and research with both thermosetting and thermo-plastic materials. It has been found that plastics are applicable to drilling jigs, formed router blocks, shaper blocks, saw jigs, checking fixtures, hydraulic press form blocks, dies, punch jigs, forming dies for plexiglass, and for most jigs that involve contours. Plastics, however, were not found to have any particular advantage for jigs in which no contour is involved, except from the standpoint of conserving vital materials.

M. D. Basolo, Lockheed wood shop foreman, inventor of new plastic for drill jig, shown with form and metal for Lockheed "Lightning" P.38 wing-root fairing drill jig.

"Cerromatrix"

In cast phenolic drilling jig plates it was not found possible to cast the bushings directly in the drilling plate. The location of the bushings, however, is accomplished quickly and efficiently by casting "cerromatrix" around the bushings, which, in turn, are located on the master part or template by means of pins, oversize holes having been drilled in the plastic plate to accommodate the bushing and "cerromatrix." These bushings are of sufficient wall thickness to eliminate the possibility of their becoming overheated and losing their location. Incidentally, they are more quickly manufactured because of the fact that only the inside diameter is vital. On one drilling jig which the Vega Corporation made there was a saving of £14 5s. in the cost of bushings alone.

Router blocks, shaper blocks and saw jigs made of plastics are stated to have two particular points in their favour. One is that they can be cast to a contour; the other is their natural resistance to the oils used in the fabrication of parts. They do not warp or lose tolerance because of moisture absorption. With the addition of the acid catalyst to the base resin, the Vega Corporation is now able to set up and finish the average work in plastics in eight hours, work that would take from three days to two weeks by previous methods.

Maracaibo Wax

The tests of early compounds of the phenol acetone, thermo-plastic resins at the Lockheed works showed very favourable results, and immediate application appeared at first to be practicable. However, it was discovered that the material possessed definite undesirable ageing properties. The ageing appeared to be due to the crystallisation of the excess Maracaibo wax, which had been added to make the material more inert to soluble oil. This crystallisation precipitated wax fracture planes. Characteristic needle-like crystals consistently occurred in the fracture plane, being symmetrically oriented in the direction of shear.

The problem apparently has been solved by removing the major portion of the Maracaibo wax. Inertness to oil has not been adversely affected by decreasing the wax content by from 3 to 5 per cent. Having overcome this first difficulty, the problem became one of compromising between softening temperature and impact strength. Plastic materials having good impact strength tend to have too low a softening point. However, considerable variation can be obtained by varying the type and quantity of plasticiser used. The first compounds treated with liquid plasticisers had relatively low softening points, so that on very hot days clamping devices on a drilling jig made of these materials would sink into the surface.

A chemical company then succeeded in developing a solid plasticiser which raised the softening point from 150 deg. F. to approximately 250 deg. F. The resulting material had excellent casting characteristics, high softening point, etc., but was unsatisfactory in practice because of its brittleness. Hence, a compromise was reached by adopting a part liquid, part solid plasticiser, which resulted in a blend of resin with the desired properties.

Drilling Jigs

The development work has included not only the determination of a suitable plastic material, but also the perfection of a technique for fabricating the jig made from it. The type of part to which the process is best suited is an open contour, with or without joggles. The equipment required for making the drilling jigs of the material used by the Lockheed Corporation consists of a jacketed kettle equipped with a device for agitating the mixture. The jacket contains a liquid, which may be heated to maintain the desired temperature throughout the kettle. Without such a bath the maintenance of a uniform temperature is extremely difficult.

The only suitable alternative would be an electric heating element wrapped around the kettle. The agitating device should not consist merely of a paddle arrangement, but should be of such a nature as continuously to scrape the material from the side and bottom of the kettle. At the Vega works the thermosetting composition is mixed in an ordinary baker's bread mixer and then baked at 157 deg. F. in a baker's oven.

It should be understood that one plastic cannot do all jobs and that each has its limitations. Much depends on the tool itself and the work it has to do. The men who use the tools have given them a gratifying reception, which seems due partially to the psychological effect of their attractive appearance. They want to take care of them, and consequently cases of breakage or misuse have been very few.

The Vega Plastic Tool Process

To counteract the shortage of metals in the United States a new process has been evolved by the Vega Corporation and the Lockheed Aircraft Corporation, for producing tools made of plastics. The illustrations below show various operations in the making of the plastic material.

The resin is drawn from the barrel containers into the mixing vat which is mounted on scales. Measurements are by weight.

Ground walnut shell flour is poured into the mixer.

The catalyst is mixed with the resin in a standard dough mixer.

Milling plastic nesting block at Vega Aircraft Corporation plant.

These forming dies are stated to be the largest phenolics on the West Coast. These dies were made at a fraction of the usual cost.

Re-recording Sound for Motion Pictures

The Various Processes and Departments Involved

By D. W. ALDOUS

MR. L. T. GOLDSMITH, of Warner Bros. Pictures, Inc., in a paper presented before members of the Society of Motion Picture Engineers, at Hollywood, U.S.A., on the subject of sound recording in motion-picture production, said:

A division of the sound department of every major film-producing studio is known as the re-recording department, sometimes called the dupe or dubbing department. In the days before sound pictures it was common practice in the laboratory to make duplicate picture prints or "dupes," as they were called. Also, the special picture-effects department would often add foregrounds or backgrounds to a picture, a process termed "dubbing in," or "dubbing." So, in general, the duplicating process, with the finishing touches added, became known as duping or dubbing.

Sound Duplicating

The sound-duplicating process, especially since it is not photographic but electrical duplicating, is more properly known as re-recording. As the name implies, sound originally recorded on film in synchronism with the picture being shot on the set is recorded again from that film along with added sound-effects and music recordings to a second film. This film is a composite of all the desired sounds required for the picture. The composite sound-track is then printed on the same film as the corresponding picture, and projected in the theatres.

Suppose we take a typical picture as an example, and follow its progress through the re-recording department. After the shooting of the picture on the set has been finished, the picture editor assembles the daily prints of picture and sound-track in proper timing and continuity. These two prints are known as the cutting picture and cutting track. The producer who is responsible for this particular production runs the picture in this form with the editor, and indicates what changes he wishes made. When the picture is complete and the corresponding original dialogue sound-track is approved, the editor delivers the picture to the re-recording supervisor.

The film is received as separate picture and sound-track reels, which are close to 1,000ft. long. The sound-track consists almost entirely of dialogue, and any sound-effects that may have happened to be recorded at the same time. The supervisor assigns the picture to one of the re-recording crews, who check it reel by reel.

Sound Effects

The re-recording crew usually is made up of a re-recording mixer who acts as the crew chief, two sound-track editors who edit the music and further edit the dialogue track, a sound-effects editor who prepares appropriate sound-effects for the picture, and a projectionist. The sound-track editors usually split up the reels between them, each man taking every other reel. They check the reels for synchronism and for words of the dialogue that may have been cut off because of picture cuts. These will require an overlapping of two sound-tracks in re-recording.

As the reels are run one by one, the sound-effects editor makes notes as to what kinds of sound-effects are required and where they should go into the picture. Some sound-effects are recorded especially for the scene at the time the picture is shot. When such effects are made, the production mixer sends a memorandum to the re-recording department, identifying by scene and take number the effects that have been recorded, and noting where in the picture they are to be used.

The sound-track editors then run the sound-track and picture in a moviola and make notes in ink on the sound-track film, indicating for the laboratory negative cutters which scenes are to be extended, and what scenes and effects are to be removed. Additional prints of the required scenes are ordered from the laboratory, which are assembled into a secondary dialogue track to allow some of the dialogue sentences to overlap when it is re-recorded. At the same time, the sound effects editor orders the required number of sound-effects prints from the laboratory, both those made at the time the picture was shot and those made from sound-effects negatives kept in the sound-effects library.

An R.C.A. photophone recorder, as used in connection with talking pictures.

Dupe Prints

The picture and sound-track are then sent to the laboratory, where two composite sound-and-picture dupe prints are made. One of these dupe prints is sent to the music department, where it is used for checking the picture to determine where music must be scored. The other dupe print is sent to the re-recording department. The laboratory then cuts the original sound-track negative in accordance with the edge-numbers and inked instructions on the cutting sound-track, and makes a print. This may be called a primary dialogue print, and is the print used in the re-recording. It is necessary to re-record from this new primary dialogue track rather than from the original cutting track, because in the new track certain dialogue sequences have been extended or removed at the laboratory to take care of overlaps. Furthermore, the original track has become scratched from the many runnings in the picture editor's moviola, and the new track has been blooped at all splices. When the laboratory delivers to the re-recording department the new primary dialogue track, the additional prints of portions of the dialogue, the prints of sound-effects, the composite dupe print, and the original picture and sound-track prints, the sound-editors begin to prepare the reels for re-recording.

The sound-track editors, using the original cutting picture and cutting track as guides, prepare the secondary dialogue track which will cover the overlaps in conjunction with the primary dialogue track. At the same time, the sound-effects editor, using the dupe-picture print as a guide, cuts his sound-effects prints into reels to match the picture action. He may have the sound-effects on several reels, because often more than one effect is required at one time. In addition, there are usually several loops of sound-effects which run all the time during the re-recording of the reel, and can be mixed in as required. The loops are numbered and catalogued, and consist of the more frequently used sound-effects such as laughter, applause, crowd noise, street noise, etc.

If the music recordings or "takes" are now available, the sound-track editor prepares the music tracks for re-recording, using the cutting-picture as a guide and following the footage notes prepared for him by the music department as to what the music selections are and where they go into the reel. Several music tracks are often required, and here again additional prints may have to be ordered to take care of overlaps in the music. As soon as a reel has been prepared either with or without all the music and effects tracks, it is run once to check for synchronism, overlaps, effects, etc. If no music has been received for that particular reel, the sound-track editors then set it aside and prepare another reel.

Re-recording Mixer

The sound-track editors prepare a cue sheet for the re-recording mixer to use during the re-recording of each reel to indicate to him where the secondary dialogue and music tracks come in and go out. A similar cue sheet is prepared by the sound-effects editor for his own use when he assists the mixer in re-recording the reel. These cue sheets must be corrected as changes are made during the re-recording rehearsals, so that after the re-recording is made and the sheets are filed, they will be accurate if at some later time they are used again.

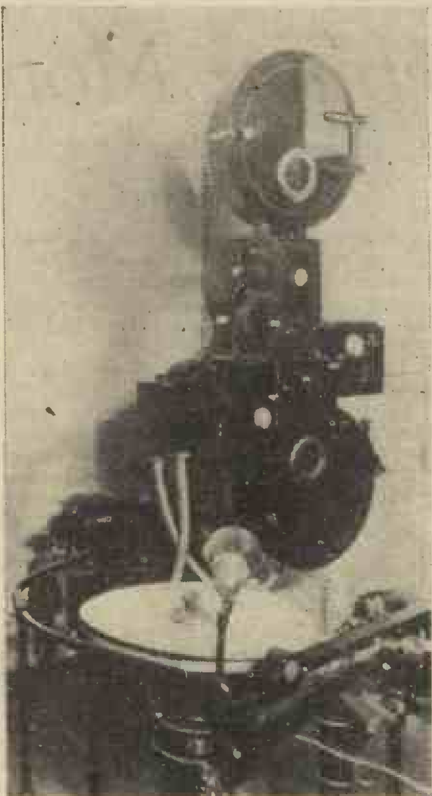
When all the tracks are prepared, the re-recording mixer and the sound-effects editor, acting as an assistant mixer, proceed to rehearse the reel for re-recording. The mixer usually handles the dialogue and music, and the assistant mixer handles the effects tracks. All the tracks, usually eight to twelve in number, are threaded on re-recording machines by machine-room attendants and the speech circuits patched to the desired mixer controls on the mixer console. The projectionist who has the cutting or dupe picture to project on the screen as a guide to the mixer threads his print on a silent projector. In addition to the picture screen for watching the action, the mixers have an illuminated footage indicator similar to a "veedor" counter, which is used with the picture for cueing the various sound-tracks. A peak-reading neon volume indicator and theatre-type loud speaker behind the screen serve as guides to the mixers as to the volume and balance of the dialogue, music and sound-effects tracks.

Rehearsals

After a number of rehearsals, depending upon the complexity of the reel, the re-recording supervisor is asked to approve a rehearsal. If he approves, a recording or "take" is made of the combined tracks on a film-recording machine. The film is sent to the laboratory as the re-recording crew proceeds to the next reel. (It might be mentioned here that a picture is not always re-recorded reel by reel consecutively, because some reels may take longer to prepare for duping than others.)

The following morning a checking print made from the sound negative is delivered by the laboratory to the sound department. This is run by the sound director in a review room with the cutting picture. It is carefully checked for synchronism, volume, quality, balance of sounds and quietness. If the re-recording is judged faulty in some respect, the entire reel or part of it is ordered to be re-recorded again. Usually the reel is satisfactory and the laboratory is notified that a composite picture and sound print of it can now be made. The laboratory first cuts the original picture negative in accordance with the cutting picture print edge-numbers, and then makes the composite print from this and the re-recorded sound negative. When all the reels have been re-recorded and a composite print made of each, the picture is pre-viewed in a neighbouring theatre.

If there are changes to be made after the pre-view, the picture editor makes the required changes in the cutting picture and sound-track, and again delivers the affected reels to the re-recording department. Sometimes the changes are such that the previously re-recorded sound-track negative need only be cut to match the picture cut, but more often a re-recording has to be made of the sections affected, usually one or more small sections of reels, sometimes entire reels. A checking print of the new sections or reels is approved by the sound director, and the



A sound film producing machine in the sound division of United Artists Studios, Hollywood. The machine is synchronised with the regular production machine that shoots pictures which correspond with the sound film.

picture is either pre-viewed a second time or is approved for making composite release prints.

In the meantime, the re-recording crew has usually received another picture and begun its preparation for re-recording in the same way. The re-recording department has several such crews, so that a number of pictures can be in various stages of re-recording at any one time.

Machine-room Personnel

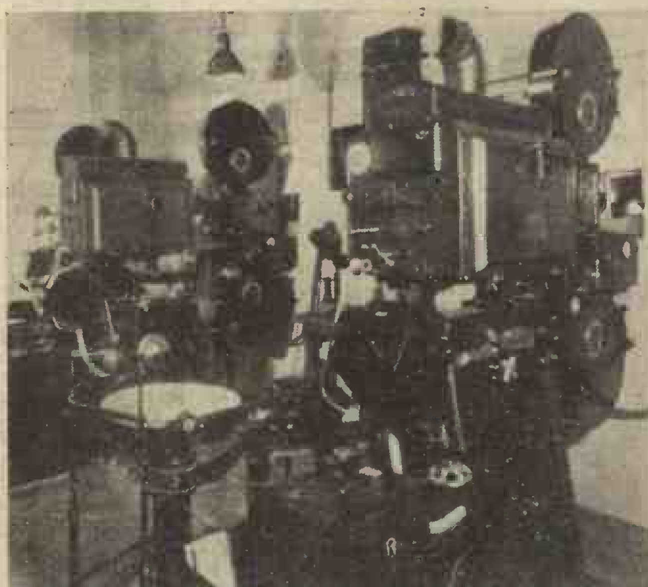
In addition to the re-recording crews that work directly on the picture, there are the machine-room personnel who thread up the re-recording machines, and a man who is responsible for the recording and operation of the recording machines. Often several machine-room men and a single recordist are sufficient to handle the equipment for three or four re-recording crews. A transmission engineer, or maintenance man, who sometimes is also the recordist, maintains all the electrical equipment. The mechanical equipment is usually maintained by men who care for the rest of the equipment in the sound department as well. A representative of the music department is often assigned permanently to the re-recording department, and is responsible for the music cutting, and acts as contact between the two departments. A film clerk receives all incoming and outgoing film and acts as general secretary to the department.

In connection with the re-recording of a picture, the recording department is called upon for a variety of duties other than those mentioned. Pre-recordings may be required for timing the photographed action on the set to a previously recorded song or dance number. Frequently the music recording for this has been made in sections. Perhaps a separate choir track of voices, an orchestra track, or even added tracks of trumpets, drum beats, or other effects may be needed. To permit the chorus and dancers to perform in proper tempo while they are being photographed without sound, a composite sound-track is played back to them on the set through loud speakers for timing. This track is made in the re-recording department by editing the various music tracks or parts of tracks and re-recording them to the playback film or disc.

Timing Discs

Timing or "tick" discs are similarly prepared for the use of the orchestra in music scoring. The ticks are made in a special machine, and so spaced that when played back to the members of the orchestra through headphones the musicians will be in tempo with each other and with the action of the picture.

The re-recording department is equipped to record acetate discs at either 33⅓ or 78 r.p.m., as in some cases songs and musical numbers are re-recorded from film to disc for talent rehearsals at home or for music-publisher auditions. Microphone pick-up facilities are available for recording sound-effects and "wild" lines of dialogue. These can be timed by watching the picture on a screen or by following the dialogue played back through headphones.



The theatre review projection room booth of a sound division at the United Artists Studios, showing the two projection machines, and the turntable for the wax records after they have been made and are ready to be heard.

Circuit Equalisers

Many kinds of circuit equalisers are used to distort the quality of speech or music purposely to simulate radio, telephone, dictaphone, or other types of sound. An "echo chamber" is available to simulate voice sounds in large halls, caves, etc., and to add reverberations and life to some kinds of music. Sound-tracks are often run at variable speeds to achieve special effects, particularly in cartoons.

Gas Turbine Motor Cars

Particulars of a New British Unit

By J. DENNIS

THE account of a projected gas turbine motor car, given in the December, 1942, issue of PRACTICAL MECHANICS, is of Swiss origin and gives some interesting particulars of the way a new power unit might be made for motor cars. It is fairly obvious to an engineer that cars built round such units would be big, and so expensive that they could only be sold if they were made very heavy and luxurious indeed. If such are made, they will seem unduly large and needlessly expensive to British "light car" owners of to-day. To power a car similar to those we

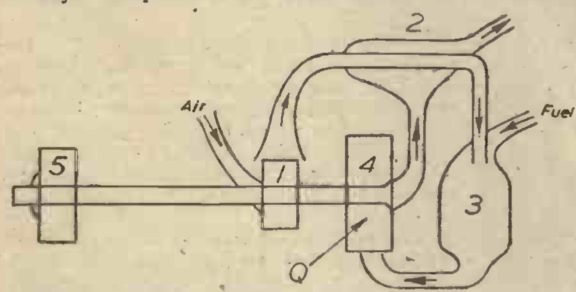


Fig. 1.—General diagram of an internal-combustion turbine engine.

know, with any engine but the familiar petrol engine, is a very different problem. So if a designer is not going to be satisfied until he sees a chance of making a power unit small enough, light enough, and able to give the power needed, all but the simple action or reaction turbine directly powered by gases with pressures and temperature comparable with petrol and Diesel practice can be ruled out.

Many experimenters have realised this and have come up against the stumbling block that makes the Swiss engines so big and heavy.

Air has to be compressed to at least four times the pressure of the atmosphere (60 lb. per square inch), and exploded (or burnt without pressure increase) and the heat in the gases produced used to drive the car.

Now, here you have gases as hot as are needed to make a small efficient engine possible; they will melt any complex blade system. We know that gases after cooling and doing a lot of work burn exhaust valves, so what would happen to a turbine rotor is obvious, for it is not protected by a rhythmic cycle like the exhaust valve, or cooled as efficiently. So before the gases strike the rotor they must be cooled. Every way must waste some power, and the obvious ways waste a lot. This waste, as well as pushing up fuel consumption, will reduce the power output in proportion to size and weight of the turbine and the air compressor.

This is the point at which the English engineers have dismissed this type of engine as impossible, unless a new invention, described below, alters their calculations.

A New Unit

This new invention was made by a certain Mr. Williams, who was a sea-going engineer till he retired in 1918, and was developed with his grandson's help at Smethwick. The engines he made follow the general diagram given in the December issue of PRACTICAL MECHANICS.

The gases for propulsion originate from air and fuel burnt in the combustion chamber (3) (Fig. 1), and these actuate the gas turbine (4); in its turn the turbine drives the air compressor (1), which supplies the air to the combustion chamber; the turbine also drives the car (or boat) by some sort of hydraulic coupling (5).

The main difficulty lies at the point Q where the gas meets the turbine blades.

In the Brown-Boveri engines, cooler compressed air is mixed with the flame-hot gas; the temperature has to be low enough for the first ring of the complex blades of a Parsons type turbine not to be weakened excessively by the heat. In such turbines temperatures and pressures fall as the gases pass from one ring of blades, to the next, and so on.

Mr. Williams uses the principle that an English light engine maker would use, expanding his gas down to atmospheric pressure in one stage. The power appears as velocity in the gas stream.

This use of De Laval turbine practice is a big advantage, as the gas is cooled enormously by this expansion. It would still be too hot for the complex blades of a Curtis turbine, which was the only one that could be considered in 1918 with velocities of the order of two or three thousand feet

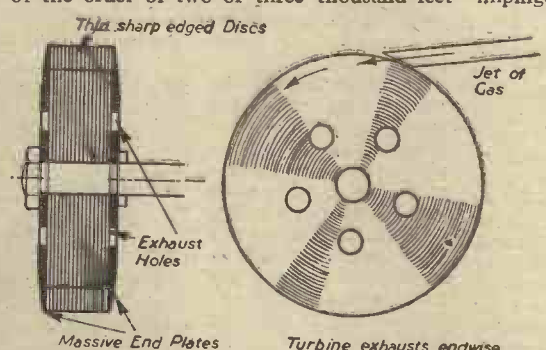


Fig. 2.—Section and end view of Tesla's patent steam turbine used in the U.S.A. for generating electricity.

per second, which are produced by the first jet of a Williams unit.

In this unit this high velocity, atmospheric pressure gas draws in air, so reducing its temperature and velocity without altering its usable momentum very much. The result is a stream at about 200 deg. centigrade and 1,000 feet per second.

This drove a Curtis turbine in his earlier engines. The later ones, including the one that powered a car I drove in June, 1939, have blades of the type patented in 1922 by Nichola Tesla.

This peculiar type of blade system enabled the rotors to be models of robust simplicity.

Without serious overloading we obtained over 30 h.p. from a rotor 18in. in diameter and 2½in. thick, built up of 22 thin steel discs, and two heavier end plates, which weighed under 6 lb. complete (Fig. 2).

Injector

Gas comes out from the combustion chamber through the jet A (Fig. 3). This high speed steam draws in cold air from the atmosphere by means of the staged injectors. The gas enters the turbines in a good sized stream.

Now, as this is a Tesla centrifugal turbine, the gas enters at a tangent, and goes round and round in the casing till its velocity is given up to the blades. It is probable that the gases entering the turbine are a streaky mixture of flame and cold air; presumably they mix in the turbine, and come out at the exhaust as the odourless steam of fully burnt gas at a temperature that varies from 140 deg. to 170 deg. centigrade.

Of course, it is obvious that this use of De Laval practice and a gas air injector will be wasteful, but an engine that is theoretically capable of the efficiencies made possible by a working temperature of the order of 1,500 deg. centigrade can waste a considerable percentage, and still score over the petrol engine.

Mr. Williams stated that in the case of 40 h.p. jets, 83 per cent. of the power impinged on the rotor is usable momentum.

This would be the size jets in the little marine engine he demonstrated. That gave 108 h.p. for an hour on 35lb. of industrial fuel oil. A very good example of what internal-combustion turbines can do.

Readers will realise that if gases at flame temperature were continuously in a jet-injector system like the one shown it would soon burn out.

Operation

This is prevented by the use of a rhythmic cycle in the combustion chamber jet-injector system.

In the Williams unit a valve in the chest is opened by a cam. This lets air at about 300lb. per square inch into the thin pipe leading to the combustion chamber. The rush of air enmeshes the drops of fuel from a space near the valve and throws it at the wall of the combustion chamber. The rush of air then slams the valve open wide; the pressure

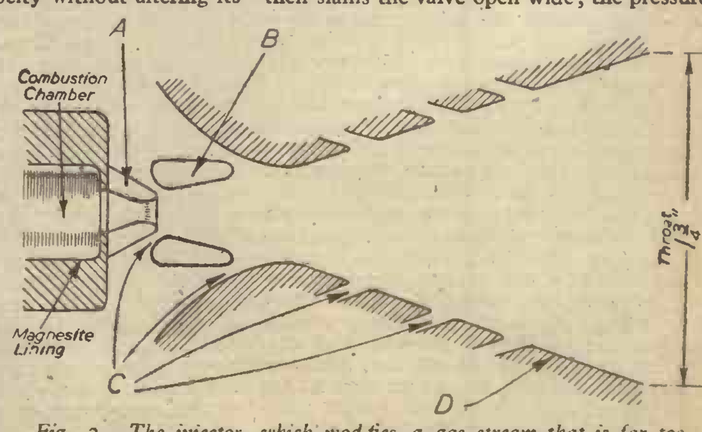


Fig. 3.—The injector, which modifies a gas stream that is far too hot, and has too high a velocity, to be used efficiently by any turbine. The injector was invented by Mr. Williams about 1919.

in the large and the small tube rises towards 300lb. The fuel catches fire, for the combustion chamber is hot, and for about a second the fuel burns, mainly catalytically on the surface of the rough magnesia lining. Then the mixture weakens, and the gas in the pipes explode. This slams the valve shut and as the cam has moved away the valve stops shut. The pressure changes make the little fuel diaphragm feed its measured quantity of fuel into the space to be picked up when the valve opens again, in about two seconds time. This is about a cubic centimetre in the case of the 16 h.p. jet.

This two-second gap allows the parts to cool ready for the next impulse.

The reader may wonder how a turbine which can run at only one speed, and will be hopelessly inefficient 20 per cent. faster or 20 per cent. slower, can drive a car.

Hydraulic Drive

Electric drive is the obvious way, but Mr. Williams used a hydraulic drive because it is cheaper to make, and produces the same sort of result.

The use of hydraulic drive is used in this particular engine, linked with the inventor's method of getting over the size of the air compressor. In the power unit there are two inverted cones which are banks of water-air injectors. The one that supplies the No. 2 rotor we have been considering so far has inside it over 200 tubes, each of which acts like the water pump nearly everyone has seen in chemical laboratories, spacing streams of water out with air. The result is that the water entering through the 2in. pipe at the top is mixed with air drawn up from the atmosphere, and each volume of water has about four volumes of air with it when it enters the centrifugal pump below the cone.

Tesla Pump

This mixture is pumped almost as if it were only water by a Tesla bladed water pump, the water giving the pump a chance to grip the air, and because of its coldness it absorbs all the heat produced by compression.

This is a very efficient air pump indeed, but its disadvantage is that so much power is used in pumping water against the same pressure. This is used in this case so that *all* the power generated by the turbine pumps water or air. The air and water are separated in the tank behind. The air feeds the turbine and the water drives the car. This is not a particularly nice arrangement but it is simple and cheap to make. It neatly eliminates the practical problems of making a mechanical transmission.

What is more, the water motors are small and easily housed in the back axle casing. The resulting car, though a hopeless commercial proposition, did prove that the internal-combustion turbine engine is very reliable, quite reasonably efficient, and worthy of further development.

One competent engineer who examined the car said the success of hydraulic transmission was too striking to go unobserved for long. The system is smaller, lighter, more efficient, more controllable, and vastly cheaper than electrical transmission.

I believe that this type of power unit has a great future for small ships, and maybe it will later be developed for motor cars.

If that is to come, the hydraulic drive system that is the joy of this unusual car will have to be vastly improved. It may be developed by motor engineers, for I believe a simple variation of it would be cheaper and more foolproof than the complex gear boxes and differential systems in use to-day.

Masters of Mechanics

Henry Winstanley—Lighthouse Builder

The Story of the Eddystone Lighthouse

HENRY WINSTANLEY constitutes one of the strangest characters which are to be found in the records of engineering and constructional activities. As the world's pioneer lighthouse builder, and as the first designer and erector of a lighthouse on the treacherous Eddystone rock, off Plymouth, his activities have provided much imaginative material for a dozen or more book-writers on the history of inventions.

Without a doubt, Winstanley possessed his own peculiar eccentricities, but, in spite of such inborn traits, he seems, more than anything else, to have been a man of great originality, an individual of considerable inventive and constructive ability, to say nothing of his being the possessor of many decided business instincts.

Our present knowledge of Winstanley's life is not very satisfactory. The "popular" histories state Winstanley to have been a retired London mercer, but he was nothing of the sort. The available evidence shows that he was born in Saffron Walden early in 1644. His father was a Saffron Walden man, and was probably a yeoman farmer in the district.

Civil war was rampant in England at the time of Winstanley's birth, and, for that reason alone, his early upbringing and education may have been a very chequered one. All we know about him at this period is that in 1665, at the age of 20 or 21, he was employed as a "porter" by James Howard, third Earl of Suffolk, at his mansion at Audley End, Essex, about a mile away from Saffron Walden. The Earl's palace or mansion had been built out of the ruins of the old Walden Abbey, and it had been intended as a residence for James I. In 1666, however, the Earl of Suffolk sold the property to Charles II, and apparently Henry Winstanley, the "porter," was transferred as one of the "appurtenances" of the palace, for he seems automatically to have entered the King's service and to have become a sort of clerk of the works at Audley End, and its estate.

The Engraver

Undoubtedly, Henry Winstanley seems to have become a person of some consequence and no inconsiderable leisure, for, in 1672, he found time to draw up and to engrave a set of 24 plans and views of the Audley End estate, which set, being published in 1688, was dedicated by Winstanley to James I, the Earl of Suffolk (the former owner of Audley End), and the renowned Sir Christopher Wren, builder of the then new London.

At this time Winstanley married and moved to a house of his own at Littlebury, Essex, near Audley End. It was in this house that he is supposed to have set up the many curious mechanical contrivances which persistent legend has attributed to him.

Winstanley's ill-fated Eddystone Lighthouse. (From an old print.)

If the stories which are related about the Henry Winstanley of this period are true he must have been a practical joker of the first water, quite apart from giving practical evidence of a very considerable mechanical ability.

There are stories of Winstanley's contriving to arrange a certain seat in his garden so that when any visitor chose to sit upon it the unfortunate and unsuspecting individual was at once shot into a nearby pond, much, presumably, to Winstanley's enjoyment.

The "Water Theatre"

He seems to have commercialised many of his mechanical gadgets and notions, for contemporary records tell us that he became the inventor and owner of an amusement park (which he called the "Water Theatre") and which was situated in London, "at the lower end of Piccadilly."

Here we have authentic evidence of one of the earliest of Britain's "amusement palaces." Exactly what the "Water Theatre" embodied nobody knows, but one may surmise that it comprised a commercialised collection of Winstanley's ingenious mechanisms, which, like the modern counterparts of our own days, were designed and constructed for the purpose of giving a pleasurable if only a passing thrill to the holiday populace.

Winstanley's "Water Theatre" appears to have been a very successful venture. Even after the tragic death of its perpetrator, this pioneer amusement park was carried on by Winstanley's widow up to the year 1712, the price for admission at that time being one shilling per person.

It would seem that a fairly successful career as an amusement caterer did not altogether satisfy the energetic and almost entirely indefatigable Henry Winstanley. His mind seems to have hankered after more spectacular and lasting achievements. No doubt, in this respect, he was encouraged in his ambitions by witnessing the magnificent feats of his contemporary, Sir Christopher Wren, in his bringing a new London into being after the

Great Fire. Probably, Winstanley was friendly with Wren, although we have no positive evidence on this point. At any rate, Winstanley's aspirations in the direction of practical constructional work turned to harbours and lighthouses. He drew up plans for harbour works, which although they did not materialise in practical form, apparently served the purpose of gaining for their author some considerable constructional reputation, because, early in 1696, Winstanley got the authorities of Trinity House to agree to his project for erecting a serviceable lighthouse on the Eddystone reef, off Plymouth.

The Eddystone

For years without number, those Eddystone rocks, the majority of them hidden and submerged, had given the Trinity House people a headache. Many a ship sailing into Plymouth from the Atlantic and striking sudden bad weather had been dashed to pieces on the Eddystone rocks. Consequently, homeward-bound navigators, making sure that they gave the Eddystone reef a wide berth, sometimes crept so much southwards that, in treacherous weather, their vessels were known to come to grief on the dangerous rocks surrounding the Channel Islands. It was, indeed, in those days a tricky and a dangerous business to bring into port at Plymouth a frail vessel from the Atlantic in any but perfectly calm and tranquil weather.

Armed with the Trinity House sanction, Winstanley at once plunged with the greatest enthusiasm into his self-appointed task of putting a lighthouse on the Eddystone rock. Perhaps, indeed, his enthusiasm got the better of his clearer reasoning powers and impelled him to place his trust in a design which was, on the face of it, altogether impracticable.

A Wooden Lighthouse

Winstanley's design was for a *wooden* lighthouse of curious and fantastic shape. He was only able to work at his task, along with a few chosen men, in the summer-time, on account of the absolute impossibility of mooring any vessel near the Eddystone rock in the high seas of the winter. Consequently, during the summer of 1686, the year in which he started out on his task, Winstanley was just able to drill a dozen deep holes in the black Eddystone rock and to cement a dozen iron uprights into them before the rough seas of the autumn made any further progress that year impossible.

During the second summer (1697) Winstanley succeeded in constructing a solid stonework pillar around his iron uprights, the pillar being 12ft. high and 14ft. in diameter. Upon this the whole superstructure of the lighthouse was to rest.

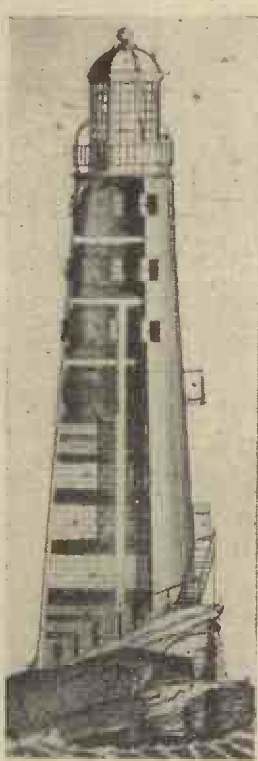
Whilst working industriously at this task an unexpected adventure befell him. He was suddenly pounced upon by a French vessel and carried off a prisoner to France, with which country we were then at war. But warfare was anything but "total" in those days, and it did not take the British Admiralty more than a week or two to negotiate for and obtain Winstanley's release and return to England.

In the third summer (1698), Winstanley's lighthouse on the Eddystone was completed to the upper vane, some 80ft. above the rock. Winstanley took up residence in the lighthouse during that year, but owing to summer storms it became apparent that the edifice would have to be highered if the lantern were to be out of range of the boisterous waters. Consequently, the constructor's final move was to plan an upwards extension of his structure, although the light in the original building was exhibited for the first time on November 14th, 1698.

Winstanley's fourth—and final year—on the Eddystone was occupied in strengthening the foundations of his lighthouse, making the whole structure almost completely solid up to a height of 20ft. above the rock, and afterwards in putting on another "storey" to the edifice, which latter augmented the total height of the lighthouse by some 40ft.

Fantastic Structure

What a curious feat of construction Winstanley's Eddystone lighthouse must surely have been! Except for the first 20ft. above the rock, it was purely of timber construction. At the upper end, below the lantern, it had a large open gallery, immediately above which extended numerous projecting arms, cranes and flag-poles. The lighthouse, too, was surmounted by a weather-vane, designed in the ornamental fashion of the period. More than anything else, judging from the original sketch which has come down to us, it resembled a Chinese pagoda-like structure. Having a decidedly top-heavy



The successor to Winstanley's lighthouse. It was built on the Eddystone rock by John Rudyerd in 1709—six years after the destruction of Winstanley's lighthouse.

The lighthouse built on the Eddystone rock by John Smeaton, the engineer, in 1759. It lasted until 1881.

appearance, it must have been deficient in almost every element and factor of structural stability. Around its upper sides were painted in gaudy colours various representations of the sun, together with various Latin mottoes, as, for example, *Post Tenebras Lux* (light after darkness), and *Pax in Bello* (peace in war), the latter epithet, presumably being a fanciful allusion to the structure's presumed security amid the war of the waves.

The lighthouse contained a well-furnished and provisioned kitchen, a state room, a richly gilded and painted bed-chamber, a store room, in addition to providing accommodation for the keepers. It was, according to its constructor's own description, a veritable palace of bodily comfort.

Despite many doubts which were expressed as to the stability of the lighthouse, Winstanley's confidence in the structure grew in intensity. He is said actually to have expressed the wish that he might be privileged to be in the lighthouse during the fiercest storm which could ever blow around Britain.

If Winstanley did, in reality, declare such a desire, his aspiration was granted. In the November of the year 1703, he set off in a boat to join the lighthouse crew for the purpose of superintending some repairs which had become necessary. The structure had been functioning for some four years and, despite its grossly impracticable design, it had successfully weathered a number of storms which had raged in the Channel.

Winstanley had only been a few days in his lighthouse when, on the night of November 26th, 1703, one of the most terrible storms which have ever raged around the coasts of our country arose. The "Great Storm," as it afterwards came to be called, expended itself not only in the Channel, but over the southern counties of England as well.

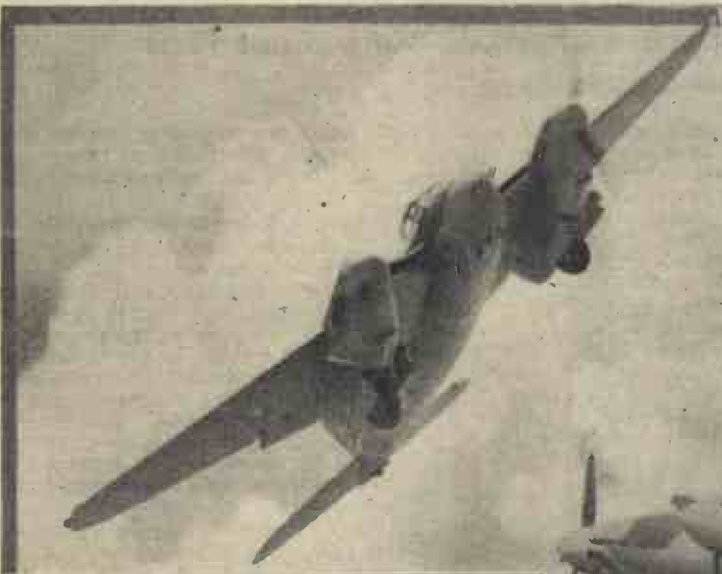
The Last of the Lighthouse

A few of the watchers on Plymouth Hoe strained their eyes over the dark, boiling waters on that memorable night, but they could discern nothing owing to the momentous height and fury of the waves. But, when the first streaks of dawn ensued, it at once became apparent that Winstanley's lighthouse was no longer to be seen. It was, indeed, no longer there! And, a few days afterwards, when a boat was able to get over to the Eddystone reef, not a single trace of the former luxurious structure was to be found, except a short length of iron chain which had become immovably wedged in a narrow crevice in the rock. The proud structure had perished during that woeful night, and, with it, Henry Winstanley, its originator, designer and constructor, and his three or four workmen.

"Winstanley's wonder," as the first of the Eddystone lighthouses may well be called, was, in every sense of the word, a truly pioneering effort of constructional skill. Although obviously doomed to failure from the very start, the lighthouse at least succeeded in proving that it was within the bounds of possibility to base a vertical, self-supporting, tower-like structure on a small area of flat rock. Where Winstanley went wrong was in using wood as a constructional material and (according to John Smeaton, a later and more successful Eddystone lighthouse builder) in his lack of knowledge of the properties of mortars and cements.

As an architect, perhaps, Winstanley was incompetent, and he paid with his life for his failure in this respect. But as an amateur engineer, a mechanic, and, most particularly, as the one British pioneer of lighthouses, Henry Winstanley deserves lasting fame not only in the histories of mechanics, engineering and constructional activities, but, also, in the better-known narratives of the social progress which has brought so much lasting renown to this nation of ours.

The Mosquito and Typhoon



The Mosquito is one of the fastest aircraft in operation. It is now revealed that the machine is in service in several versions as a day and night bomber, a long range day and night fighter intruder, etc. The basic fighter has four 20 mm. cannon and four ·303 machine guns, all mounted in nose of the fuselage, giving highly concentrated fire. The basic bomber carries 2,000 lb. of bombs, with a fuel range which brings practically the whole of Germany within its reach. It is one of the most versatile aircraft in the world to-day.

In the above illustration the streamline effect is clearly shown. In the nose and just underneath is the cannon and machine armament. The illustration on the right shows the new bomber-fighter on the ground. Its general appearance and graceful lines are clearly seen.

This view (left), looking down on a Mosquito, gives a good idea of the wing span and general design. The chief feature of this remarkable 'plane is the fact that it is constructed of wood and the hull is designed in two separate halves. This facilitates ease of assembly in interior fitments before the final assembly.

In several months of operations against the Luftwaffe the Hawker Typhoon has proved one of the most formidable aircraft in use in Fighter Command. It is fitted with the Napier Sabre engine, developing something like 2,400 h.p. The speed of the Typhoon is over 400 m.p.h.

(Above) Front view of the Typhoon IB, showing the four 20 mm. Hispano guns. (Left) Side view of the machine, showing two of the guns in the near-side wing.

Seascape Photography

Notes on the Selection of Subjects, Backgrounds, and Exposure Times

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

MOST amateurs at some time have longed for the opportunity of making some really good pictures of rough seas, with "towering" waves and "mountains" of spray; then, when the opportunity has occurred, they have been surprised to find that it is not so easy as it seemed. The waves and spray have been quite up to expectations, but, unfortunately, quite outside the region of safety. The lighting, also, has been rather dull, due to heavy overhead clouds obscuring the sun and if exposures have been made the results have not come up to expectations.

Those who have had a chance to visit some of the principal London photographic exhibitions have no doubt wondered how some of the exhibits of rough seas have been obtained. We have asked ourselves whether the maker of the picture was standing up to his neck in the water? Whether the camera was protected by means of a waterproof jacket? And whether the exposure was made from a boat or very high rock? I do not pretend to be able to supply the answers because, quite frankly, I cannot; I am inclined to think that the only persons who could give satisfactory answers are those who made the studies, and are constantly doing the work; but I believe that even they will tell you that nerve and good judgment are essential factors, and some might also inform you that you must not mind getting a camera spoiled through being soaked with sea water, or even dashed to pieces against the rocks.

The subject is undoubtedly a thrilling one and I have no hesitation in saying that I am still hoping to capture some results good enough for the walls of the Royal or the Salon; but not if it means taking undue risks either with myself or camera—I value both too much; but I feel that the subject can be tackled in a reasonable manner if one has the time and patience, and with these two invaluable qualities combined with good judgment in exposure, success should result.

When you and I have been on our usual holiday to the sea coast our time has naturally been limited, and we have skipped about from place to place seeing all we can. The sea has been very quiet—in fact, so much so that hardly a wave could be seen, certainly not anything big enough to photograph and call "A Rough Sea at Smoothbourne." Then, unexpectedly, a day arrives when the whole aspect has changed; the wind has "got up," likewise the sea, and it is not too safe to go on the rocks. Cameras are taken out and we stand in a spot hoping for a "big one" to come along, and click goes the shutter; but the results are more often than not commonplace and disappointing; they are just "snapshots," lacking in pictorial merit.

A seascape study, taken from a moving launch.

Selecting Suitable Backgrounds

The reason for this is, in my opinion, due to insufficient thought in the selection of a suitable spot from which to make the exposure, and the suggestion I want to make is that in your rambles in the immediate neighbourhood it might be possible for you to see, and note in your mind, a point where you would be certain of getting a firm footing, and a picturesque background. This latter should not be simply a collection of heavy, dark rocks, but should include perhaps a portion of the beach or cliffs, so as to avoid too much contrast.

There are many spots around our coast where it is possible to get very fine effects of waves dashing on the rocks or cliffs with abundance of spray, and glorious shapes in the actual waves, but the surroundings are such that, no matter how carefully you have calculated the exposure and development, you cannot produce a picture from the negative, because it will only yield a "soot-and-whitewash" print, owing to the absence of half-tones.

Another point which should be watched is the sky. If you feel that by waiting a few minutes you will be rewarded by a break in the clouds, then by all means wait: you will be surprised what a difference this will make to the result.

Use a Large Stop

Now for a hint or two regarding the exposure. Obviously this must be as short as is possible, and if a gale is blowing you must be in a sheltered corner, or standing where you can be certain of a firm foothold if you are to avoid "camera shake." When the sea is particularly rough, and waves high, there is much more movement than one is apt to imagine. If the light is strong enough

A pleasing composition of sea, rocks, and foreshore.

give an exposure of 1/250th with a stop such as F8. If the light is dull, owing to heavy clouds or dark surroundings, make use of F6.5 or larger one if you have it. Generally with the better type of camera, where stops vary from F5.6 upwards, the shutter works to a 1/500th, so that it is possible to easily overcome both the fast movement and any camera shake due to the high wind.

Choosing the right split second for taking is not an easy matter. Keep your eye fixed on the subject after you have set the shutter and got the image in the viewfinder to your satisfaction is the best advice, and then "shoot" when you like. If you feel that you really are on the spot for something good, I would strongly advise you to make more than one exposure, as you may not get another chance during your holidays; but do not hurry, as this is where a little patience may give you a good reward.

So far we have only considered rough seas; let us now turn our minds to the more general smooth sea with its rippling waves. This is another phase of our subject. It happens when the sun is shining, tide running out leaving plenty of wet sand reflecting some very strong light, and everything indicating that the exposure meter should be carefully studied.

Most of us are influenced by the patterns made by the receding waves, and even by the white foam of the waves themselves; we have, however, to avoid that repetition of straight lines which so often prevails. One way of doing this is to take your stand so that the ripples are slightly diagonal in your viewfinder or interrupted by a boulder or fairly big stone in the foreground. Another position might give you a better effect, such as the view from a breakwater, or even a mound where the camera will be looking down rather than along the scene, but seldom can it be taken from a very high point of view, such as from a cliff.

Taking a "roller" just as it is breaking can be done when you are in a bathing costume and within a few yards of where you know it will break and spend itself up the beach, or it can be taken from a small boat such as a dinghy, but you must not wait for the wave to reach the boat. Probably the best place for this type of exposure is on the breakwater where you can take your time and watch out for a really first-class wave to give you the full crest hanging over the trough made by the preceding wave.

Exposure Times and Composition

There are two points which are worth remembering when taking sea or beach scenes, and they are exposure times and composition. Those of you who take the trouble to refer to your exposure meters will find that for this class of work you are advised to give just about half the time required for open landscapes, and, as most of our work is of this latter type, we are inclined to be influenced by it, with the result that many seascapes are over-exposed. It is seldom that heavy dark objects, other than rocks, are included in sea scenes, therefore the whole picture may consist of items reflecting strong light, sky, sea, sand, surf and the usual pools, etc. If the shutter speeds are limited to say, 1/100th, the only chance of getting a satisfactory exposure is to use the smallest stop, and to take a chance.

Composition must, of course, be considered with every subject if a pictorial result is desired, but it is not my intention to give a lesson on it in this article, but rather to draw the attention to certain elementary rules which I have noticed are often neglected or forgotten by amateurs. You have set your camera to take a shot at a wave breaking, or at a boat or some other object, but are you quite sure that you are holding the camera perfectly straight? Is the little bulb of the spirit-level in the dead centre, or is it slipping about on the side of the dial? Make quite sure that it is where it should be, otherwise the chances are that you will find the horizon, and possibly the waves as well, are running uphill. This is quite a common fault, perhaps much more than you think; have a look at your own prints where river, lake or sea plays an important part. It is a mistake to attempt to take a wave breaking as a "close up," very often these will prove just a mass of water tumbling over a black rock and lacking in a foreground and suitable setting. Try going a step or two farther away from that spot; it will mean that you will not only get more space in the foreground, but you will get some width in the whole scene which will help to build a picture.

Beach Subjects

Children playing on the beach is a subject responsible for many a spool of film, and from time to time we see some very charming studies, but what a pity there are not more "studies." So many are just snaps, and while it is not my wish to stop anyone making these happy snaps, yet I am convinced that a little thought will produce results infinitely better and more pleasing. Choose the background, and by this I mean move a few yards to the right or left; build up the sand castle still higher if needs be, and try the effect of placing the camera on the sand and taking a low angle view. But, above everything else, do not let the child know you are taking a portrait.

In concluding this article, I give a note of warning with regard to the camera; when it is not being used keep it in its bag, and be sure that the hood or cap is on the lens. Sand can play some nasty tricks with the shutter; it can find its way even into the interior and deposit some of its grains on the film, and cause scratchings. Also, there is generally some spray or heavy moisture ready to settle on the lens and other fittings, and if not removed will eventually cause rust and retard the action of those parts. It is, therefore, advisable to give the camera a gentle wipe with a soft handkerchief before putting it away; you will be well repaid for such care.

Develop these exposures by the time method to ensure correctness; you may have made a mistake in exposure, and by developing in this way you should get a fairly good print.

The "Thunderbolt"

A new U.S. fighter which is now in operation in Europe is the Thunderbolt, which is said to have a speed of over 400 m.p.h. and a ceiling of 40,000ft. It also has a ferrying range of 1,000 miles. When first brought out the armament of this machine consisted of eight machine guns of ½in. calibre. The Thunderbolt is a single-engined, single-seat, low-wing monoplane with retractable landing gear.

(Above) A Thunderbolt revving up preparatory to taking off. (Right) A side view of a Thunderbolt, showing the guns in one of the wings. Note the four-bladed propeller. Known as the P-47, the new aircraft is designed as a high altitude fast fighter, and is now in quantity production for the U.S. Army Air Force.

Repairing Alarm Clocks—1

Practical Hints on the Correct Procedure, and the Tools Used

By G. F. LEECHMAN

IN view of the extreme difficulty under present conditions of obtaining new alarm clocks or even, in many cases, an adequate service for the repair of those temporarily "hors de combat," many people, not unnaturally, have attempted with more or less success to undertake an overhaul, and it is therefore felt that these brief notes, written especially for the layman, may be acceptable, and may save from irrevocable damage clocks on which so many depend. The remarks which follow will be found applicable also to other than ordinary alarm clocks and may, with a little consideration, be used for guidance in the repair of other timepieces, such as the less expensive mantelpiece or office types. It should not, however, be assumed that the same methods of procedure can be applied with modifications to the repair of watches or the better varieties of clocks, such as eight-day or French movements, whether chiming or not, or car clocks or others with jewelled or very fine escapements. Wherever possible explanations will be in the simplest non-technical language, the view being constantly held that unusual terms, peculiar to the watch and clock trade, may not be understood by the general reader.

The Work Bench

In the first place, work should not be attempted except under the best possible conditions. It is unwise to commence operations in a haphazard way, sitting in front of the fire with no more tools than a pair of scissors and a penknife. Therefore it is recommended to choose a suitable time, when one has two or three hours to spare, a large, firm table to work on, and good light in a moderately warm room. Accurate work cannot be well done if your hands are cold, or if one is standing up to a job which requires a delicate touch. If possible, the light should be within 15in. of the job and shaded so as not to shine in the eyes. In case it is necessary to do any soldering, gas or other suitable heating may be needed, and it is advisable to cover the table, or at least part of it, with a piece of smooth linoleum or, if that is not available, something similar which is not too creased (as brown paper is apt to be while newspaper is not so good as it is difficult to find small screws, etc., quickly on the mass of print). A sheet of wood or glass just in front of the worker is excellent, or even a tin tray, while one or two receptacles will be required in which to keep the parts free from dust; old cups or saucers or lids of tins will do for these.

Tools Required

In actual practice it is possible to get on quite well with very few tools, but, naturally, the better one is equipped the better the job can be done. It may very truly be said that alarm clock repairing is not difficult in itself, but that without adequate tools it is well-nigh impossible to produce satisfactory results. A really small pair of pliers is practically indispensable, and these should be in good condition and have flat jaws in preference to the pointed variety, although these latter may also be useful if they are available, in which case the longer and thinner the points are the better. The same remarks apply to some extent to screwdrivers; they must be in good condition, clean and sharp and fairly small, the blade not more than 1/16in. across; but there again an assortment of sizes is preferable, and very serviceable ones may be made from thick roping needles or short lengths of good quality steel rod. These may be made and used in a pin-vice, that is a small four-jawed chuck closed by screwing it into a tubular part which forms the handle and which is threaded at one end to take the chuck or else to take a nut which screws down around the chuck. A pair of tweezers will also be required, and these must be firm and clean, with sharp points which close, as they should, at the ends first rather than part way down. This fault can easily be remedied by careful and judicious bending, and little

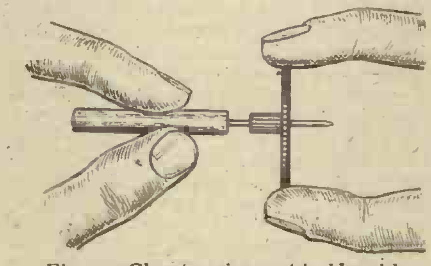


Fig. 1.—Cleaning pivots with elder pith.

points like this are well worth the time in view of the amount of trouble which may be avoided at a later, and perhaps critical, stage of the work. Two pairs of tweezers are a great advantage in case it is found necessary to correct any bad bends in the hair-spring, and one of these may have stronger and broader points.

An eye-glass, while not really necessary, will certainly be very useful to anyone who can work with it comfortably, or its place may be partly taken by a small magnifying glass when it is required to see if some of the smaller parts are absolutely clean. Some benzine will be needed for washing these small pieces, and if possible it is better to have a small glass jar with a screw top (such as chemists use for ointments or cold cream), while a much larger jar, also preferably with a screw top, is very useful for cleaning the whole movement (or "works") by immersing it completely in the cleansing fluid. For

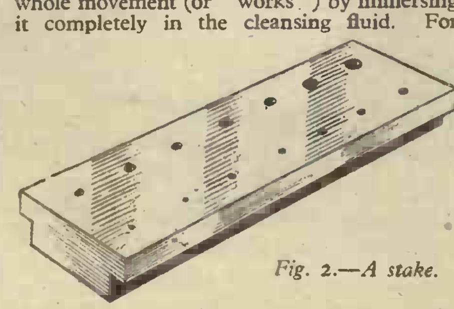


Fig. 2.—A stake.

cleaning out the pivot holes (these are the holes which form the bearings in which the wheels run) some "peg-wood" may be obtained; this is bought in bundles resembling small skewers, and is specially made from cherry wood; but for an occasional job clean matches pointed with a sharp blade may be used if care is taken that no splinters are left behind. For cleaning the pivots (these are the ends of the spindles—or, as they should be called, the staffs—of the various wheels) some elder-tree pith (Fig. 1) may be obtained for a few pence, but this may also be dispensed with by using a very soft piece of cork instead.

Lubricating Oil

A mistake is often made in trying to economise on oil; it is wrong to suppose that any kind will do. Some people use olive or salad oil, which in the course of a few months dries into a sticky mass with a plentiful supply of dust adhering to it; the dust, being formed partly of fine, sharp sand, makes an excellent abrasive for wearing away the working parts. Other ingenious folk prefer something lighter and try paraffin, which does not lubricate at all, but has well-developed covering properties, so that in a few days it will be found to have spread practically all over the "internals" of the clock. Those of us who possess motor-cycles often try a liberal supply of heavy lubricating oil, which will certainly prevent any of the bearings from running hot, and is, in fact, quite likely to "stop the works" altogether, since the braking effect which it exerts on the lighter moving components is more than they can withstand. The lawn-mower expert may try something lighter, perhaps some fine oil designed for his wife's sewing-machine, and this is really not so bad, if judiciously applied, but for serious work it certainly pays to purchase a bottle of oil which has been specially prepared for use in clocks. This is usually a blend of very good quality fish oil, with a percentage of mineral oil to increase the penetrating powers. A great deal of research work has been done on these highly specialised lubricating oils, and preparations are made with varying properties according to whether they are designed for use in watches or clocks, different products being made for watch escapements as distinct from those used for the wheel work (or "train"), for instance.

Additional Equipment

The above remarks cover tools which are absolutely necessary where it is only required to clean a clock without having to effect any repairs, but if these are required various other items may be necessary according to the job in hand. Apart from the more ordinary tools such as a vice, hammer, fine punch, small files and drills, it is a great advantage if a pair of watchmaker's turns, or the use of a good lathe, can be obtained. This will naturally be available to the well-equipped and experienced precision worker, but he may care to purchase a "stake" (that is, a small strip of wrought steel shaped to form a kind of small table when held in the jaws of the vice, and perforated with a series of holes of differing diameters) Fig. 2; this is used for removing the spindles—or staffs—from the wheels, if this should prove necessary, or when punching holes in the ends of springs, etc. For this latter purpose a very useful instrument is the main-spring punch, which somewhat resembles the weapon with which ticket inspectors clip railway tickets; it shortens very considerably the process of adapting a broken main-spring where the end has to be fitted up, without spoiling the temper of the metal. In some cases it is necessary to effect repairs by soldering, in which case it is not advisable for the work to be attempted by anyone unfamiliar with the principles involved, while those who are competent to make a small, neat job will naturally have their soldering outfit at hand; it may be mentioned, however, that the stronger fluxes, such as chloride of zinc, are not so easy to keep from spreading to adjacent parts where they may set up a tendency to rust. The hollow flux-cored type is very satisfactory for most work, but in some cases it may be necessary to resort to brazing or even to hard—silver—soldering, particularly where parts of the alarm control system are damaged.

A point which should be mentioned, although it does not concern the experienced workman, is the pernicious habit of using the wrong tools for the particular operation in hand. Not only do they thus spoil their equipment, but they also, very often, seriously damage the work, perhaps producing a nasty scratch on the case or dial, or possibly messing up the head of a stiff screw so that it is almost impossible to use it satisfactorily again. Nuts are found to be a little tight, but instead of using a small, good-quality spanner, a larger and more damaging pair of pliers is taken in hand, with results which do no credit at all. At the colleges in Switzerland where watch-work is taught the students have first of all to make all their own tools. Some of us have had to do the same thing, thus learning to appreciate them so that great care is taken of them, and a certain pride felt in their proper use. Let all the work be steady and systematic; let the tools be kept all together on the work-bench, spread out a little near the right hand so that they come naturally to the fingers when required. As the various pieces from the clock are removed they should be placed on the table in their proper order so that it is possible to identify them without hesitation, or, as one old instructor used to say, "so that if you never came back to finish the job, the next man could carry on just where you left off." This orderly way of working is, coupled with a certain amount of common sense, the secret of success; those who are experienced practise it naturally, but we were all inexperienced once.

Dismantling

Having covered the details regarding the requisites for work-table and tools, we may how commence operations by dis-assembling the case and outer fittings of the clock. In most of the older types this resolves itself into unscrewing the legs, which may be so tight as to need starting with the pliers, but care must be taken not to mark them or, indeed, any part of the clock, whether outside or in. In many cases the legs are provided with washers which should not be omitted when re-assembling. If there are no legs the base may be secured by means of screws or nuts and bolts, and sometimes it is not necessary to remove these, so that it is better not to loosen them until later on, if at all. The top of the clock may have the old-fashioned bell and hammer, which are unscrewed next; the bell is mounted on top of a pillar which is threaded at both ends so that either the upper or lower end may unscrew first. Should the bell come away from the pillar, start the pillar with the pliers and then screw the bell on again so that they now unscrew together. Beneath the pillar will be found, usually, an assembly of two washers, a spring and the control arm, and the correct order in which these have to be placed should be noticed. Where possible, right through the work, as pointed out above, it is always essential to lay out the pieces in the order in which they are taken down, so that no mistakes are made when putting them back. In more modern clocks the bell, or gong and hammer, are enclosed inside the case and cannot be taken off until the case is removed, so that nothing remains now except to remove the back. Unscrew the key which winds the time; this will be indicated by a symbol or label and an arrow indicating the direction in which it should be turned to wind up. To unscrew it turn it in the opposite direction, and do the same with the key for the alarm side. These two keys are frequently very similar, and one may be right-handed and the other left, therefore lay them on the table or work-board in such a position that one can readily be distinguished from the other, noting at the same time which way each one turns. Occasionally it is impossible to unscrew these keys owing to some damage inside, and if it is not possible to grip the lower part on to which the key screws, which is called the "arbor," then this will have to be left until later when the rest of the fittings

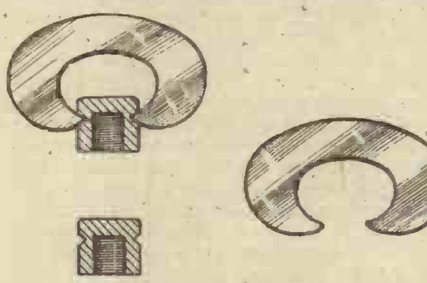


Fig. 3.—Removing a difficult winding key.

have been removed and it is possible to reach the wheel or arbor and hold it below the back while unscrewing the key. If this is also impossible one may be able to dismantle part of the key (Fig. 3) so that the finger-piece comes off and the remaining centre-piece may then go through the hole in the back; if not, this hole will have to be enlarged until it does pass the key through. The hands are controlled by a "set-hands stud," which usually pulls straight off, but may unscrew right-handed (against the arrow). The alarm hand or indicator is controlled by the "set alarm stud," which nearly always unscrews, but in some cases the alarm hand is of a different type, working from the centre of the face (or dial, as it should be called). In this case the set alarm stud will be found in a different position from the usual, but it will still unscrew; alternatively, the set hand stud and the set alarm stud may be smaller and the holes in the back of the case larger, so that they will pass through and it will not be necessary to remove them. In cases where the back of the case is made of much heavier metal, forming the bell or gong, it will frequently be found that there are three screws near the centre which will need to be removed before the back will come off, and sometimes there is an additional supporting foot to remove, or a small lug at the very bottom which hinges backwards, forming a lever for springing the back out of the case. If this is not present the back must be eased out with the fingers or with a screwdriver placed between the two parts and turned gently, care being taken that it does not slip or it may cause a nasty scratch which will be visible after the job is done. This also applies to more modern clocks, particularly an American pattern, which opens from the front or dial side, it being unnecessary, in some cases, to remove any more than the winding keys beforehand. The movement is now freed from the case by grasping it firmly with the fingers by the corners and gently easing it out, great care being taken that the dial or hands are not damaged by the former catching on any projections which cause it to bend and perhaps disturb the hands. If the main spring is broken it may be pressing heavily against the case, while if any parts are out of place they also may be damaged if the movement is drawn out carelessly. A point which requires constant attention at this stage is that the fingers should not be allowed to press accidentally on the balance wheel or on the lever. These delicate pieces are usually protruding to some extent and the movement should, as far as possible, be held by the parts farther away from them. As each piece is laid aside it should have been examined for any obvious defects, and these may with advantage be corrected as they are encountered, so that when assembling is commenced it will not be necessary to stop to rectify anything which could have been put right before; on the other hand, pieces which are dirty will have to be cleaned at a later stage and it may be more convenient to put them in good order then.

Removing Dial and Hands

The "works," or, more correctly, movement, being now clear of the case, is seen to consist of dial and hands, connected to a pair of brass plates, which have between them an assembly of springs, wheels and escapement; in order to avoid damage the hands and face should be removed next. The minute hand should be grasped firmly with the pliers and lifted away from its centre boss, which is the end of the staff running from the set hands stud to the centre wheel. It should be lifted straight off without any twisting or "waggling," which would make the hole in it too large, causing a loose fit in future, but if it will not move try replacing the set hand stud and turning the staff from the back while the hand is held in front. Do not exert too much force, and if it will not come away try placing the round-nosed pliers or a screwdriver between the minute hand and the hour hand and gently lever it up until it does come clear. With rough treatment the hands, which are made of hardened steel, are very likely to get badly buckled or break off short, ruining the future appearance of the clock. The hour hand will be lifted off in the same way, and will probably come away more easily, but the alarm hand is frequently a very tight fit. This may sometimes be easily removed by the method shown in the illustration (Fig. 4).

a—Minute hand.
b—Hour hand.
c—Motion work.
d—Alarm hand.
e—Pliers.
f—Fulcrum.
g—Flat plate.
h—Dial.

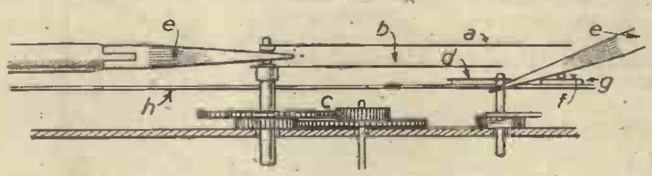


Fig. 4.—Removing difficult hands.

A thick piece of cardboard or similar material is laid on the face, and a small bar to serve as a fulcrum placed upon it; the points of the round-nosed pliers are then worked under the alarm hand, preferably parallel to its length (to avoid curling it up if a slip occurs), and used as a lever to raise the hand off its centre. It is advisable to keep a finger in position over the hand, otherwise it may come off suddenly and fly across the room where it may be quite difficult to find. It is usually a simple matter to remove the dial, this being frequently secured with bent tacks or soft metal lugs, which have been passed through holes in the main body of the movement, and given a twist to prevent them coming out. Care should be taken in removing the face, as dirt or unsightly marks invariably show a poor workman, so that it should be laid aside with the hands in a safe place. If the hands or dial are luminous this paint should be treated very carefully, as it is very brittle; should they need repainting, tubes of luminous compound can be obtained for the purpose.

Repair of Fittings

It may be that some of the outer fittings are in need of repair or replacement; legs are sometimes missing, and if new ones cannot be obtained substitutes will have to be improvised, such as a short bolt secured with a nut, or else a new piece turned up on the lathe. Winding keys are a little more tricky to make up, particularly when the thread is left-handed; it is useless to make any arrangement with a right-handed thread, however, as it will constantly unscrew. Sometimes it is best to drill a hole through the arbor on which the key should fit and provide a short length of brass tubing which can be riveted in place through hole; the tubing should be small enough to pass through the hole in the back of the clock case, and can have a threaded outer end to take a knob, but this will have to be keyed on or otherwise secured against unscrewing when winding the clock. Set hands studs can generally be arranged more easily from a piece of smaller tubing slit at one end with a fine saw—it may be drilled at the other end, and a strong steel ring inserted to assist in turning. Set alarm studs are usually right-handed thread, and the tubing can then be tapped to fit without much difficulty. Should the arm or lever which silences the alarm be broken a new one can usually be made from a piece of sheet metal, and in fact all these exterior repairs are more or less a matter of improvisation according to circumstances, but this is not the case when dealing with the other parts, such as the hands, with which we will now deal. Usually they are made of steel tempered to a strong blue, so that they are not at all soft and frequently break close into the centre; it is not possible to solder them without spoiling the colour, although this can be corrected with black enamel, but if a join is effected by means of a small piece fitted under the hand this can be secured with any strong adhesive, since the hands do not actually carry any more than their own weight, so that strong glue will be quite satisfactory. Sometimes the steel part of the hand has a centre piece of brass which fits over the spindle, and the two components may not be a tight fit to each other; this can be remedied by hammering lightly the brass centre so as to spread it, or one or two punch marks made on the under side :- this may have the effect of closing the hole in the centre to some extent, in which case it will be necessary to reamer it out slightly so as to obtain a tight fit again. This also applies if the hands were originally loose. Repairs to the dial generally consist only of smoothing out any places where the surface is rubbed, and in most cases little can be done to improve the appearance. Naturally the paper variety must never be washed, but rubbing over with fine white powder may cover oil stains to some extent. If the dial is secured by means of soft metal lugs these must be handled as little as possible as they soon break, but generally the face is kept in place temporarily by two not very satisfactory bent tacks, and these may well be replaced by a short length of thin copper wire passed through the holes and doubled back so that the ends can be twisted together behind the dial. Metal dials call for little attention as long as they are flat.

(To be continued)

THE MONTH IN THE WORLD OF

Science and Invention

U.S. Army's Tank Destroyer

DETAILS of the U.S. Army's new tank destroyer show that this caterpillar juggernaut, the M-12, carries a 155-millimetre gun capable of knocking out a tank with its 95lb. projectile at a range of over 10 miles.

Pulling Her Weight

BRITAIN'S oldest locomotive on regular service, L.M.S. engine 20002, is "pulling her weight" in the war effort, despite 77 years of hard work. Fifty years ago, 20002 was one of Britain's fastest expresses. She has also played a big part in three wars.

She sped British troops on their way to South Africa, and helped to whisk "Tommies" to and from their homes in the Great War. Now she is hauling guns and tanks.

Radio-controlled Ships

RADIO-CONTROLLED concrete ships of 2,000 tons, without crews or superstructure, have been proposed as a solution to the U-boat problem by two American engineers.

The ships, which would be powered by Diesel engines and controlled from a single armed mother ship—a corvette or destroyer—would be tricky targets as they would be almost invisible at a distance.

The radio system would control the ships either singly or as a convoy, even to the extent of the scattering of an entire formation in the event of attack.

Special Lights for Night Vision

A REMARKABLE instrument for calculating men's ability to see at night is being used by the Canadian Navy to increase the fighting efficiency of their ships.

Look-outs with the keenest sight are being selected for dark watches, and a way has been found to permit the captain or navigator to consult the chart with the right light without being temporarily "blind" when returning to the bridge.

Automatic Bombsight

DETAILS of the famous Norden bombsight were recently revealed by the United States Army.

Before beginning the bombing run, the bomb aimer sets the sight for the chosen altitude.

He adjusts the gyroscope to spin with its axis perpendicular, lines up the sight with the 'plane's true direction, and prepares the bombs for dropping.

Within 25 seconds he must line two cross hairs inside the telescope of the sight so that they intercept the line across the target.

Land girls driving a tractor and working a huge circular saw used for hedge cutting.

Then he adjusts the sight so that the cross hairs automatically stay on the target, even when the 'plane is flying at 300 m.p.h.

Once adjusted the Norden sight is almost as accurate at 25,000ft. as at 5,000ft.

Blind Precision Testers

IT is reported that when a new instrument developed by an American manufacturer comes into general use, blind persons will be able to work as inspectors in war factories engaged on precision work.

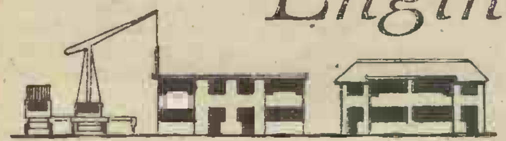
The instrument is mainly a comparing device. Tolerance limits are set on the dial, and a gauge shows automatically whether the product being inspected falls within the permitted tolerance.

By raising the fixed "tolerance markings" above the dial and attaching a vertical pointer to replace the gauge, the instrument can be "read" by the fingers of a blind person.

For Shipwrecked Sailors

AN ingenious device for distilling drinking water in lifeboats was tested at sea recently by Chief Engineer Edmund D. Leahy, of the Shaw Savill Line, who believes it can wipe out the shipwrecked sailor's nightmare—thirst.

The device looks like a five-gallon drum, weighs about 28lb., and boils 12 pints of sea water at a time. Mr. Leahy made it at sea from drawings supplied by the inventor, Mr. Keenan, of Liverpool. One pint of drinking water can be obtained every 15 minutes by burning a 3in. length of 3½in. by 3½in. timber, and a small amount of kindling wood. Salt content was found to be only 1 1-50th oz. per gallon.



Engineer-built Houses of the Future—5

Collateral Security : Various Types of Solid Ground Floors : Vested Interests Explained

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

(*Continued from page 263, May issue.*)

NOW it may be asked, "When does the builder receive back from the building society his money which he has deposited as collateral security under the pool system?" As a general rule he receives it back, less any part of it which has been forfeited to the building society to cover any loss which it has incurred, at a period when the capital amount of the mortgage is reduced by an amount equal to twice the amount of the *excess-advance.* Taking our example again, the *total advance* is £540, of which £60 is *excess-advance,* so the builder does not receive his £20 pool deposit back until the amount owing to the building society equals £540, less twice £60, which is £540 minus £120, equals £420. On an ordinary long-term mortgage it is many years before the reduction to £420 is reached. As may be well known, repayments made by a house purchaser during the first few years of an ordinary long-term mortgage, such as 20 years, is absorbed in interest, and consequently the capital is not reduced to a great extent during the early years. This is very important to a house purchaser because the builder, in depositing money as collateral security, although he may receive a little interest on the money, is faced with two problems: (1) The sinking for a considerable period of money which may or may not come back; it will not if the building society uses it to cover losses, and (2) as such sunk money may represent a good proportion of the profit on houses, how can such proportion be recovered or considered as immediate profit? I am afraid, knowing commercial nature as I do, and what goes under the guise of "good" business, there is a strong tendency to add the amount, or part, deposited under the pool system, to the cost of the house. This means that the "baby is handed to the purchaser," who has to nourish it in a house which is a little worse jerry built due to competition to cover the amount of collateral security.

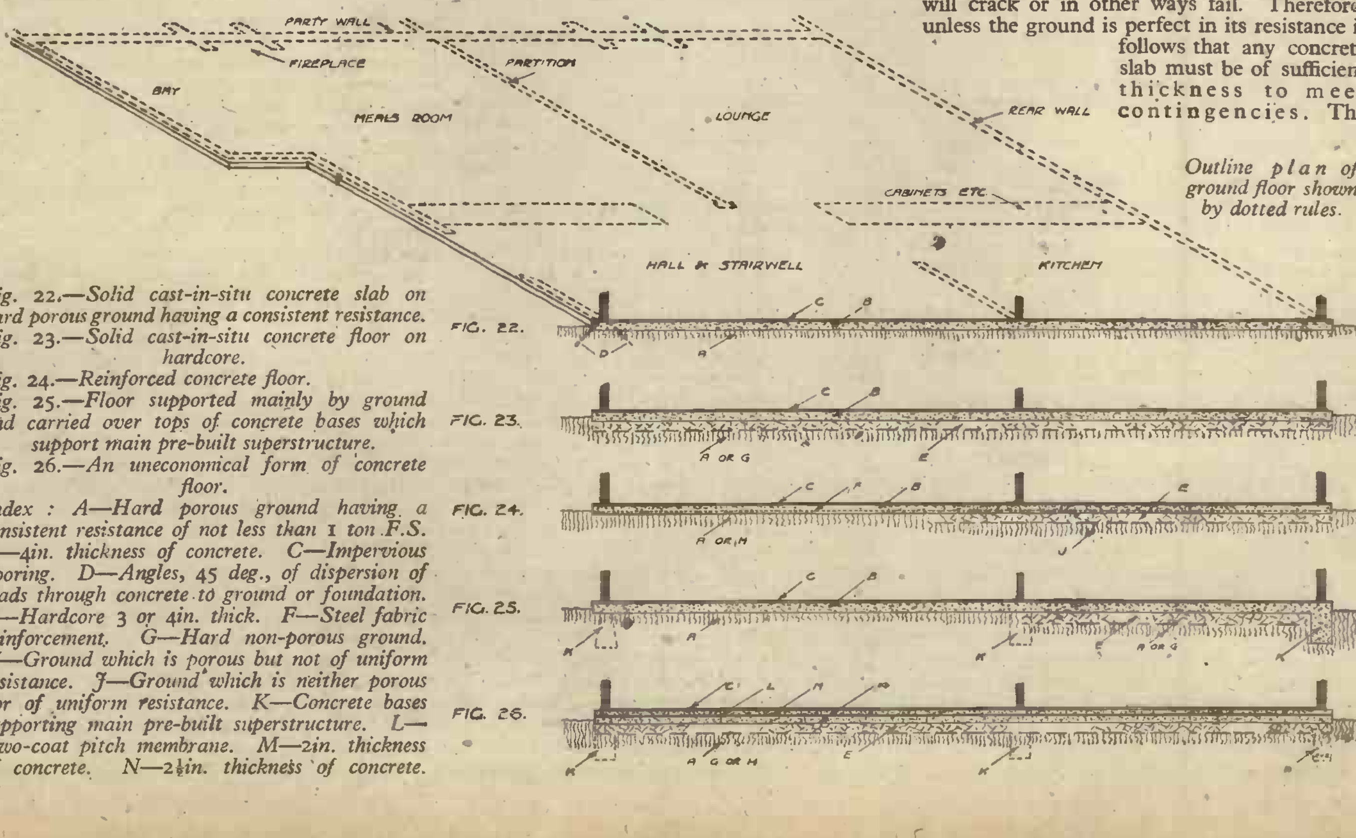
From the foregoing may be gathered very important and interesting conclusions as to another great advantage of engineer-built houses over the ordinary pre-war type of houses. An engineer-built house, by reason of it being practically foolproof against bad workmanship and materials, and being cheaper than the ordinary house, provides but little risk of an owner "throwing it back" at the building society because of its quality and thereby causing any collateral security to be sounder, and, as the house is cheaper, it is fair to suppose that a purchaser would be able to "pay down" a greater percentage of the cost, which would, of course, reduce the amount of any collateral security to be found by the builder.

Ground Floors

Ground floors of pre-built houses will present problems to those designers who are aware of certain fundamental principles of traditional construction which should be followed to ensure a sufficiently strong, dry and hygienic floor. It is because of these three essential conditions that the construction work in a ground floor often necessitates the use of materials of the heavy kind, such as concrete, to obtain the best results. Consequently, this is one reason why I am disinclined to believe that a pre-built house of ordinary accommodation can be of such light weight as some designers think possible; it is wiser to consider the 40 tons weight (comparable with about 125 tons of the traditional house) as more reasonable than any fantastic claims to light weight.

Floor of Sufficient Strength

The provision of sufficient strength may be analysed first. A ground floor may be constructed in several ways, as explained in detail later in this article, and generally may be grouped under two main headings, viz.: (1) a floor slab which rests directly on the ground, or on ground prepared with a bed of hardcore or other similar material on which the slab rests. In addition to the slab deriving support from the ground, it may also bear on the bases described in the last article. To meet the sufficient strength requirement only it is a structural fact that *if* the ground has *sufficient and uniform resistance* to the loads to be imposed on it, a concrete or similar floor slab laid over the entire area of a house may be comparatively thin. Unfortunately, grounds or foundations are apt to be very fickle and variable in their sufficiency and uniformity of resistance; they may have soft pockets, there may be areas under the floor slab which will resist safely any ordinary load, and yet other areas which will not do so. This means that some part of the ground may subside more easily than another, with the inevitable result that if the floor slab is not strong enough it will crack or in other ways fail. Therefore, unless the ground is perfect in its resistance it follows that any concrete slab must be of sufficient thickness to meet contingencies. The



Outline plan of ground floor shown by dotted rules.

Fig. 22.—Solid cast-in-situ concrete slab on hard porous ground having a consistent resistance.
Fig. 23.—Solid cast-in-situ concrete floor on hardcore.
Fig. 24.—Reinforced concrete floor.
Fig. 25.—Floor supported mainly by ground and carried over tops of concrete bases which support main pre-built superstructure.
Fig. 26.—An uneconomical form of concrete floor.

Index: A—Hard porous ground having a consistent resistance of not less than 1 ton F.S. B—4in. thickness of concrete. C—Impervious flooring. D—Angles, 45 deg., of dispersion of loads through concrete to ground or foundation. E—Hardcore 3 or 4in. thick. F—Steel fabric reinforcement. G—Hard non-porous ground. H—Ground which is porous but not of uniform resistance. J—Ground which is neither porous nor of uniform resistance. K—Concrete bases supporting main pre-built superstructure. L—Two-coat pitch membrane. M—2in. thickness of concrete. N—2½in. thickness of concrete.

building by-laws require a thickness of 4in. if the upper surface is grouted with cement, and 6in. if not grouted. It may be stated that by-laws may be amended to suit modern conditions. It is important to realise that this group (1) allows for the flooring material to be laid directly on the slab, thereby forming a solid floor, which is quite different from group (2), which may now be explained. Additionally, to any slab over site required for purposes which are explained later, a ground floor in accordance with pre-built systems may be of a comparatively light-weight framework of panel construction complete with flooring, which may be delivered to site in units ready for placing in position and supported by beams or other means. In my opinion, which is shared by others who have studied the matter with impartial minds and without any regard to vested interests, this method of ground floor construction for pre-built housing may be the most favoured, and probably the best, provided only the following important conditions (a) and (b) are met, and they are rather stringent: (a) That unless there is a layer of surface concrete or other reasonable impervious material under the pre-built panel floor units it is essential to make the units and the joints between them resistant to any rising dampness or ground smells. This is absolutely necessary in the interests of national health. (b) That compliance with the conditions imposed by (a) that such pre-built panel construction will be as economical, directly and indirectly, as the traditional method, perhaps with a few modern modifications, of a monolithic cast-in-situ concrete slab to which may be applied the flooring material.

A Dry and Hygienic Ground Floor

The next matter to be considered is the provision of a dry ground floor. There are very few grounds or foundations which are, or may be relied upon to be, permanently dry; they may be subject to rising dampness from subsoil water and to water gravitating over their surface. It is vitally important to prevent any dampness rising through a ground floor, or attacking any materials which may be sooner or later rotted by dampness. This makes it essential that a ground floor be so designed and constructed as to combat dampness and rotting influences.

The last matter relates to hygiene.

If a floor is of sufficient strength, and is dry, the battle for the hygienic floor is almost won, but not quite. Strength will ensure that it will not fail or crack and let in dampness; dryness will prevent those faults described previously. But there are other matters to be considered. The floor should have a surface which is reasonably impervious and will not allow water used for cleaning it to penetrate into any structural parts and cause rotting, and it should not have too many crevices and corners for accumulating dust and dirt. Another subject of hygiene is related to hollow spaces under ground floors. The mind should cast out thoughts of any system of construction which includes building up on stools and leaving a shallow depth space into which leaves, paper and other litter may be blown, or cats and dogs may wander.

We now have a good perspective of the problems of ground floor construction, which will enable the best methods to be explained.

Solid Cast-in-situ Ground Floors

From what has been stated previously it may be obvious that there will be a fairly well-balanced use of solid cast-in-situ and pre-built types of ground floors, as both have advantages which will meet site and other conditions. It may be argued that the cast-in-situ floor makes it necessary to use loose materials, mix and lay them, and employ more site labour than would be needed for other methods of construction. This is only true if the other methods do not require a layer of surface concrete over the site, which in many cases they do, and if such concrete is used it may as well be economically employed as the major part of the floor.

Fig. 22 depicts the simplest of all types of solid cast-in-situ floors suitable for engineer pre-built houses. It will be noticed that it does not even require any concrete or similar bases as described in the last article. It is, however, a floor which really must only be used on *hard, reasonably porous grounds having a consistent resistance of not less than 1 ton per super foot*. There are good reasons for these statements which will be simple to understand. Firstly, the ground must be hard or made so by consolidating, so as to avoid unequal settlements. Secondly, a porous ground does not allow water to lie under the concrete, which in winter may freeze and cause damage to the floor, and otherwise may induce too much dampness in the floor. (The floor is covered with an impervious flooring material.) Thirdly, the stipulation as to resistance has been considered carefully by me, and needs a little explanation. It will be noticed that there is a heavy dotted line at one edge of the slab. This line is known as the angle of dispersion through which a force or load on the top surface of the concrete will transmit itself fanwise to the underside of the concrete and thence to the foundation or ground. The concrete is 4in. thick, and if the wall supported by the concrete is 3in. thick, the two angles of dispersion will cause a fanning out to 1ft. 3in. at underside of floor, which will be ample to ensure no greater pressure on the ground or foundation than it is capable of resisting. The concrete outside the dotted lines is theoretically useless for dispersing any pressure.

Fig. 23 is somewhat like the construction of Fig. 22, but has a layer of hardcore of broken brick, ballast, stone or other hard, porous material. This construction is used if a good hard ground having a consistent resistance of not less than 1 ton per super foot underlies a few inches of soft top soil, which so often exists. It is also suitable if such hard ground is at surface level, but is not of a porous character, making it necessary to lay a bed of porous hardcore for reasons explained previously.

Fig. 24 is a composite illustration of a concrete slab which is reinforced with one of the steel fabric types of reinforcement. This is an excellent floor to use if the ground is of a varying and doubtful character in resistance. As a general rule it can be used on grounds having a resistance varying from ¾ ton per foot super upwards. The use of hardcore depends on the conditions explained in connection with Fig. 23.

Fig. 25 depicts the use of the floors in conjunction with concrete bases and piers under the main walls of the house.

Fig. 26 shows a type of floor which has become the vogue during this war for hutments and is one of those which the Ministry of Works has recently put forward for the rural housing programme. In my opinion the type of floor is only useful if a *pervious* flooring material is used, such as cement and sand screeding, or any material which is affected adversely by dampness. Generally I do not advocate it because of the following reasons: (1) The labour cost of separately laying firstly 2½in. and secondly 2in. thickness of concrete is more costly than laying 4½in. in one operation. (2) Four inches thickness of concrete, which has a layer of impervious material, is sufficient for housing work, and therefore 4½in. is extravagant; the extra ½in. adds about 7d. super yard to cost. (3) The separation of the total thickness of the concrete by the membrane can reduce the structural strength of the concrete because any bending stresses will cause one layer to slide over the other. (4) There are excellent flooring materials, varying in cost, and all, while being more costly than the combined two-coat pitch membrane and cement and sand screeding, have advantages which must not be overlooked. These floorings will be described in detail in the next article.

It is necessary to emphasise that any of the solid floors which have been described can be constructed on or form part of the general system of concrete or other bases just as such bases are suitable for the various types of ground floor units.

Vested Interests

The subject of vested interests is receiving particular attention now, and is often mentioned in Parliament, creeps occasionally into the technical and other press, and comes into general conversations. I have often been asked to explain and give examples of vested interests as they affect building, and in exploring the knowledge of many people on this subject it has been obvious to me that many have only vague notions of what it really means.

Vested interests may be broadly defined as the subjugation of good principles which are best in the national interests and for the "man-in-the-street," in favour of baser principles which will cause a greater financial advantage to those who advocate, under the guise of "good business," those baser principles. This is, of course, blunt, and by my following remarks it may be evident that vested interests can be as much a canker to building as jerry-building.

Take brickwork as the first example. Modern research gives a pointer that there are infinitely better materials to use than bricks for houses. It has been proved that a certain machine will usually force moisture through an ordinary brick wall of a house in from *eight to 10 minutes*, and that with the same force it will take *five days* for moisture to penetrate ¼in. of a certain wall board, and that the same pressure will not allow any penetration through an asphalt lining. It is a fact that a 9in. thick brick wall of a house is anything from four to five times too strong than is necessary to support all loads and resist all stresses. Despite all the advantages of *better, lighter and much cheaper materials* than bricks, it will be found that the sponsors of the latter will do everything in their power to prevent the universal use of other materials—a quite natural action to do to try to save many millions invested in the brick industries, but an action which is contrary to the best national interests.

Cement may be the next example. A building designer would probably be assured of a very bad reception with cement manufacturers if he, for instance, suggested that the concrete bases of a 40-tons pre-built engineer house could be much smaller than necessary for an ordinary house. To attempt to criticise the heavy-weight qualities of some reinforced concrete work and prove that they could be lighter would cause astonishment; to mention, as "walking out of the door," that modern types of walls will not need cement for mortar would only add to the trouble. Despite *better, lighter and much cheaper methods* than those requiring cement in large quantities, it is more important to boost up cement sales than to effect financial economy in house building; and here is the "sting": every £25 saved in the initial cost of a house reduces the rent by about 1s. per week!

I believe that post-war building, if coupled with proper press appeals to the public, will go a long way to ensure houses being built in accordance with the best constructive and economical principles, and that a general betterment of public education in building will help to kill the most insidious kinds of vested interests.

(To be continued.)

Outdoor Painting

Useful Hints and Tips About Painting the Outside of a House

By "HANDYMAN"

BEFORE commencing to paint the outside of a house there are one or two important things to be considered. For instance, a ladder will be necessary, long enough to enable the barge boards and gutters to be easily reached. A double-extension ladder is the handiest for the amateur, and one may possibly be loaned from a neighbour. Failing that it may be necessary to hire one from the local builder's yard. To reach to the first floor windows only half of the extension ladder will be required, and for painting up to the top of the ground floor windows an ordinary folding step-ladder will be sufficient.

Tools and Materials

With regard to the necessary tools and materials, there is, of course, the paint (usually two colours), brushes, linseed oil and turpentine for thinning down, a piece of flat pumice stone, a pail, a hard sponge, a stiff brush for cleaning the gutters, and two or three sheets of glasspaper. It pays to use good paint brushes. The kind known as enamel, or flat paint brushes, are best for amateur use, and a 1in. and a 2in. brush will be sufficient for each colour.

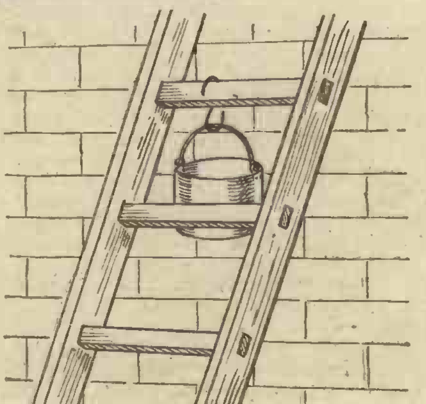


Fig. 2.—It is a good plan to hang the paint can on a meat hook placed over one of the rungs of the ladder.

Preparation

Having obtained the necessary materials, the first thing to do is to start at the eaves of the house and remove all dirt and other litter which may have collected in the gutters.

Having done this, the old paintwork must be washed down before a new coat is applied. This can be done by dissolving a packet of soap extract in a pail of hot water, and scrubbing down the surfaces, at the same time rubbing over the paint with a piece of pumice stone, which will help to smooth and level the surface. Then sponge down with clean water and leave until thoroughly dry.

Filling Cracks

In many small houses the window sills are of wood, and these often show signs of deterioration owing to weather conditions. Cracks may have developed, and when preparing for painting these should be filled with putty or plastic wood (Fig. 1). When properly hardened this can be rubbed down level, and smoothed with glasspaper before the undercoating is applied.

If the old paint is in good condition two new coats will be ample to provide a good finish, the first coat being a "flat" paint, or undercoating, and this should not be applied too thickly. If too thick the paint can be thinned by adding a little turpentine and linseed oil in equal amounts.

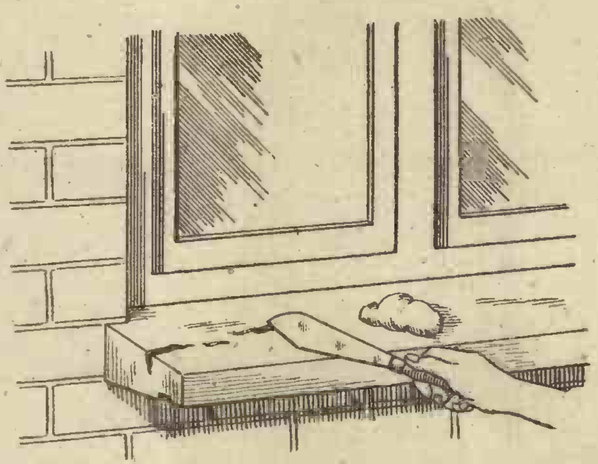


Fig. 1.—Cracks in wooden window sills and window frames can be filled in with putty.

Order of Painting

Some houses have a gabled front, in which case the barge board and the rest of the gable woodwork should be painted first, then the guttering and drain pipes, following with the first floor window frames and sills. When these parts have been painted, next in order come the ground floor window frames, porch and front door.

Before painting the window frames make sure that the putty which holds the window glass in place is in good condition. If parts of this have broken away, replace them with new putty. This should be done the day before painting is commenced.

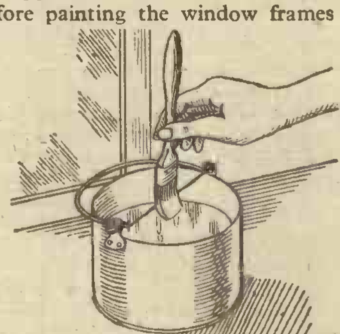


Fig. 3.—A piece of string stretched across the paint can acts as a wiper.

It is a good plan, when painting the top half of the house, to suspend the paint-can at the back of the ladder by means of a meat hook placed on one of the rungs (Fig. 2). This arrangement allows the left hand to be free, thus enabling a more secure hold to be obtained on the ladder.

A piece of string stretched across the top of the paint can will act as a wiper for the paint brush (Fig. 3).

The finishing coat should not be applied until the undercoating is dry and hard, and this usually takes at least 24 hours. In the meantime the side of the house can be proceeded with, commencing with the gutter, and working downwards, as before, finishing with the side door.

After the side of the house has had its first coating applied the back of the house can be treated in the same way. If the house is of the terraced kind, there will, of course, only be the front and back to be done.

Finishing Coat

By the time the back of the house has had its undercoating put on the front should be ready for receiving the final coat, after rubbing over with fine glasspaper, and brushing away all dust.

Use a good quality hard gloss paint for this final coat, and start at the top of the house, and work down, as before.

Best Time for Painting

The householder will naturally choose the time most convenient to him for painting, but there are differences of opinion as to which is the best time of the year for the job to be done. Some people prefer the spring, so that their houses will look smart for the following summer. It should be remembered, however, that although paint dries in two or three days, it does not become properly hardened until many weeks have elapsed. Therefore, the disadvantage of outdoor painting in the spring is that a hot summer sun acting on the not completely hardened paint is liable to cause blistering. Summer painting, too, has its disadvantages, as the work may dry too rapidly. For several reasons, therefore, it is preferable, when circumstances permit, to delay outside painting until the early autumn, so that there are several months of cool weather ahead for the paint to become thoroughly hardened off, and more able to withstand the heat of the following summer.

Finally, after each day's work, do not leave the brushes in the paint. At the end of each day, work the paint out of the brushes on a piece of board, and suspend them in a jar containing a mixture of linseed oil and turpentine, so that the bristles are immersed, but do not rest on the bottom of the jar (Fig. 4). In this way the brushes will remain soft and pliable, and are at once ready for use again when required.

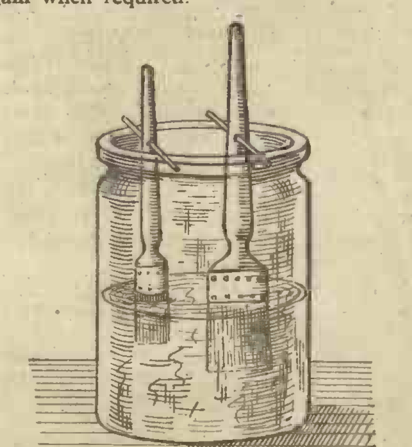


Fig. 4.—Storing brushes in a solution of turpentine and linseed oil.

The Story of Chemical Discovery

Colour in Plants and Flowers

No. 23.—A Modern Chapter in Creative Chemistry

WITHOUT the ever-changing hues of plants, flowers and trees, ours would be a drab world indeed. Nature, however, seems ever to have adopted the principle of vivid colouring for a large number of her creations, and a supremely expert and truly excellent colourist she shows herself to be.

During the early days of synthetical chemistry, more than a century ago, at which period the few ruling chemists in the world were busily engaged in endeavouring to discover the composition and the inner chemical make-up of various natural products, one or two conjectures were tentatively put forward as to the true nature of the green colouring-matter of leaves and the red and yellow colours of flowers.

Chemical science, however, at that time was far too immature to tackle such a complicated problem. Nature's vivid colours, built up atom by atom in the silent and, even nowadays, the still highly mysterious laboratories of the plant cells, were far too complex to permit of any ordinary chemical analysis. All that could be stated a century ago with regard to the colouring-matters of leaves and flowers was enunciated by that Swedish genius of chemical science, the great Baron Berzelius (1779-1848), who conjectured that the green matter of leaves was due to the presence of a special green pigment, *chlorophyll* (Greek: *chloros*, "yellow-green"; *phyllon*, "a leaf"), and that the yellow and red colours of flowers were due to two other pigments, *xanthophyll* and *erythrophyll* respectively (Greek: *erythros*, "red"; *xanthos*, "yellow").

But that is as far as Berzelius and his fellow chemists went. They did not attempt to explain the nature of their chlorophyll, their erythrophyll and their xanthophyll. Indeed, few attempts were ever made to obtain the green colouring-matter of plant leaves in its pure state, and it was not until the last century was nearing its end that Dr. Edward Schunk, of Manchester, hit upon a method of preparing fairly pure chlorophyll, from which he managed to obtain a complex compound which he named *phyllo-porphyrin*. Schunk's "phyllo-porphyrin" was in no way a very spectacular compound in itself. The fact which gave it some importance was Schunk's discovery that, in chemical composition, his chlorophyll-derived "phylloporphyrin" was related to the red colouring-matter of human and animal blood.

There the whole subject of plant colouring-matters was left until Richard Willstätter,

Baron Berzelius (1779-1848).

one of the world's greatest synthetical chemists, gave his penetrating attention to the many problems connected with plant colours. Willstätter, it may be interesting to note, was professor of chemistry in Berlin and in Munich, but on the accession of the Nazi party to power in 1933 he took refuge in Switzerland, where he died only last year (on August 3rd, 1942).

Concerning Chlorophyll

Richard Willstätter did an enormous amount of research on the biochemistry of plants, and it is to his original genius that the chemical world of the present day is indebted for much of its knowledge of the composition of plant and vegetable products.

It was about 1906 when Willstätter first took up the subject of plant pigments. To begin with, he devised methods of extracting the green colouring-matter from plant leaves. Having effected this, he discovered that there are, in actual fact, two allied green colouring-matters present in every leaf, which products he called *chlorophyll-A* and *chlorophyll-B*. In most plants containing chlorophyll, the ratio of the two types of chlorophyll is about three parts of chlorophyll-A to one part of chlorophyll-B.

Willstätter brought to light the remarkable fact that chlorophyll contains magnesium, and that the presence of this metal is essential to the development of the characteristic green colour of the leaf, just as the presence of iron in the red colouring-matter of our blood is essential to the colour thereof. Willstätter showed that chlorophyll-A has a chemical composition which can be represented by $C_{55}H_{72}O_5N_4Mg$ and that chlorophyll-B has, also, a similar composition.

This variety of chemical formula representation, however, does not give us much satisfactory information as to how all the various component atoms are linked up in the molecule of chlorophyll. Despite a good deal of research which has been put into the subject, we are still unable to synthesise chlorophyll, that is, to make it artificially, for we are not yet certain as to its precise composition. All we can say, at present, is that chlorophyll, chemically speaking, is a complex compound of a highly complicated alcohol and an acid, and that it contains magnesium linked up in some peculiar way with nitrogen atoms.

A curious feature of chlorophyll is that when it is chemically split up into simpler substances it yields products which are very similar to those resulting from the chemical splitting-up of hæmoglobin, the red colouring-matter of blood. Chlorophyll is a magnesium compound; hæmoglobin is an iron compound. The first is essential to plant life, the second to animal life. One is the green principle of plants, the other constitutes the red principle of humans and animals. Yet, in some strange way, these two apparently entirely different vital materials are interrelated.

Dr. Edward Schunk (1820-1903), *the pioneer of colour chemistry.*

Just one more natural colouring-matter contains a metal as an essential ingredient. This is *turacine*, the red colouring-matter of the wing feathers of some birds. Turacine contains copper, and its molecule is built up around that metal, just as chlorophyll has a vital nucleus of magnesium and hæmoglobin of iron.

The extraction of chlorophyll from leaves. The illustration depicts the initial maceration of the leaves in water, previous to chemical treatment.

Chlorophyll Preparation

It is not a difficult matter for any amateur to obtain as much chlorophyll as he requires, for this essential green colouring-matter of plants can be extracted merely by soaking clean, soft leaves (such as nettle leaves, spinach, grass, etc.), in warm water and then afterwards by pouring off the water and crushing the leaves to a pulp. This latter is then boiled for a short time in a half per cent. solution of caustic soda, which dissolves out the majority of the chlorophyll. The liquid is filtered and afterwards made just acid with dilute hydrochloric acid. This precipitates the chlorophyll as a dark green mass. The latter product is then filtered off, washed and finally dried. It is soluble in spirit to a fine green solution which may be used as a colouring-medium for essences, tinctures and other edible preparations.

There is no doubting the fact that chlorophyll is built up in the leaf cells of the plant by photo-chemical means, that is to say, by light influence. For if a plant is made to grow in the dark, its leaves are immature, pallid and almost white, owing to the absence of chlorophyll. Vegetables which have been "blanched" are those in which the chlorophyll content of the leaves has been suppressed. Mushrooms and other fungi are habitually whitish in appearance owing to the fact that their internal economy does not provide for the presence of chlorophyll. Apart from such instances, however, a good supply of chlorophyll is essential for the true functioning of plant life, just as an adequate supply of hæmoglobin is essential to human and animal life. In either case, the living organisms become pallid and lifeless whenever their colouring-matter mechanisms are interfered with.

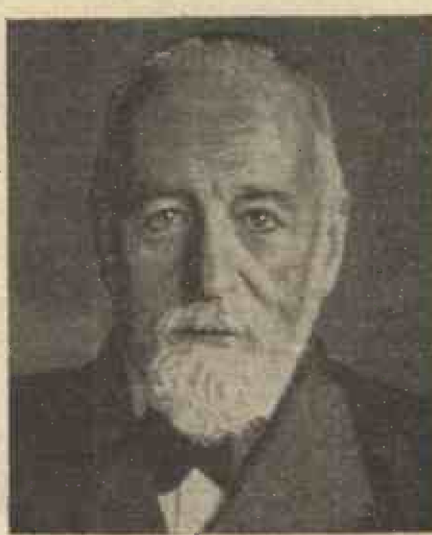
Since chlorophyll is such an all-pervading compound in the economy of the plant, it might reasonably be supposed that the vivid colouring-matters of flowers, the reds, the blues, the yellows, the violets and the rest of the myriad colours of plant petals, are all composed of chlorophyll derivatives and chlorophyll products. Such, however, is definitely not the case, and, generally speaking, the multitudinous colours of flowers have nothing whatever to do with the chlorophyll of their plant leaves.

The common cowslip is a wild flower whose orange tints have now been chemically analysed.

Sir Robert Robinson

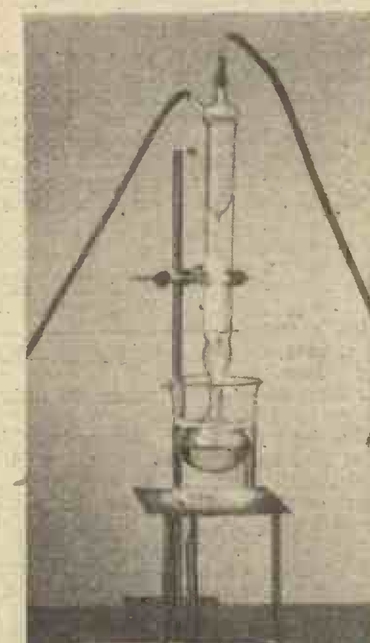
By far the greatest proportion of the work which has in recent years been performed upon the chemical composition of flower colouring-matters is due to Sir Robert Robinson, of Oxford University, a brilliant chemical scientist who, even during his early career, securely grasped the torch of chemical progress from the failing hands of Richard Willstätter.

Although it is true that Willstätter commenced the research work on the colouring-matters of flower petals, it was Robert Robinson and his able co-workers who carried out and completed the greater part of the work.



Richard Willstätter (1872-1942).

The story of the gradual elucidation of the true chemical nature and composition of the colouring-matters of flowers which has, in our own times, taken place in the Oxford University laboratories, constitutes one of the most vivid and enthralling chapters in present-day chemical discovery. It forms a veritable epic of pure chemistry for, unlike the investigations which have taken place and which are still going on into the nature of, say, the synthetic resins, the commercial motive has been entirely absent. Unfortunately, the story of the chemistry of flower colours is so highly complicated a one that it cannot be disclosed in any semblance of detail in these columns. At the best, all that can be presented here is a brief non-technical explanation of the present position of chemical science in relation to this subject, in the hope that the individual reader may be influenced to follow up the subject for himself at some later and, perhaps, more convenient date.



Small-scale chemical apparatus for the extraction of plant colouring matter, scents and flavours.

Flower colours, as we have just indicated, are not merely camouflaged chlorophylls. They are entirely different in chemical composition from the latter. Sir Robert Robinson, after devising methods of extracting the colouring-matters of flower petals, found that nearly all the red, blue and violet colours of flowers and fruits are chemical compounds which are now known as *anthocyans.*

Sugar Compounds

Now, these anthocyans are somewhat curious compounds in that they comprise what are termed, in chemical parlance, *glucosides*, that is to say, compounds containing glucose, or some other natural sugar. So that most of these flower reds and flower blues (to mention but two types of flower colours) are, in actual fact, sugar compounds, from which the sugar can be split off by chemical means.

Three or more different sugars can exist in the molecule of an anthocyan, or, alternatively, one distinct sugar can exist in a number of anthocyans in different proportions. Such a fact implies, of course, that a vast number of anthocyans are theoretically possible. That is why the flower reds, the flower blues, the pinks and heliotropes occur in so many varieties of hues and shades. Under the action of light, the cells of the flower petals conjure up numerous anthocyans, each one having a distinct colour of its own, and each one being a compound of one or more natural sugars with three or more complex "rings" of carbon and hydrogen atoms.

Carotene

The red colour of the wallflower is due to an anthocyan, but the yellow colour of wallflowers is derived from a different type of pigment which consists, to a large extent, of a substance called *carotene,* this being a hydrocarbon, or hydrogen-carbon compound of the composition $C_{40}H_{56}$. Carotene occurs

The daffodil, the rich yellow hues of which have been proved to be due to natural pigments of the Flavin class.

in most orange and yellow flowers and fruits. It is present in carrots and in the yolk of eggs.

Now, in the case of wallflowers, when carotene and a red anthocyan are produced together in the right proportions a brown colour is obtained. Such is the nature of the "brownness" of brown wallflower varieties.

Another interesting plant colour is a substance named *lycopene*. This, modern research has shown to consist of a long chain of 20 carbon atoms having rings of carbon and hydrogen atoms at opposite ends. Lycopene is related to carotene. To its brilliant vermillion-red nature is due the redness of ripe tomatoes, strawberries and the other soft fruits which were—alas!—at one time so common. There is lycopene, too, in some reddish flowers, and also in ripe rhubarb stalks which have been exposed to the sun.

Flavins

Some of the yellow colouring-matters of flowers and fruits comprise chemical substances which, as a class, are known as *flavins* (Latin: *flavus*, "yellow"). Unlike the anthocyans, which are purely compounds of carbon and hydrogen, the flavins contain nitrogen. The true nature of these flavins is still more or less as yet unknown, but it is significant that some of them appear to be closely related to Vitamin B, a fact which would seem to be of much importance in view of the essential rôle played by this vitamin in human and animal life.

None of the flower or fruit colouring-matters contain any metal as an essential ingredient in the sense, for instance, that chlorophyll embodies magnesium in its make-up. Nevertheless, it has been shown that the shades of these flower pigments can be altered appreciably by the presence of iron salts in the flower juices. Tannins and tannic acid also exert a similar effect in modifying the shades of colour manifested by the flower pigments.

The gorgeous autumnal shades of foliage of all varieties which are normal to the British countryside are due, for the most part, to the influence of various natural plant tannins which are formed in the leaves. These form still more complex compounds with the natural glucosides or sugar-containing colouring-matters, the resulting compounds being deeper and less brilliant in colour, but none the less profound and striking in beauty and purity of shade.

Cornflower and Rose

Quite a number of flower and fruit colours are extraordinarily sensitive to the acidity or the alkalinity of their surroundings. Who would imagine, for example, that the colouring-matter of the blue cornflower and that of the full-red rose are precisely the same in chemical composition, both comprising the compound which is known as cyanin?

Research has shown that the rose-red is the normal colour of cyanin, the rose sap being very slightly acid, but that the presence of alkaline matter in the sap of the cornflower is sufficient to alter not only the shade but the actual colour of cyanin to blue.

The colouring-matter of red cabbage is quite an efficient "indicator," turning bright red in contact with acids, and blue in the presence of alkalies, such as ammonia.

Modern chemical science has, indeed, performed wonders as regards its patient elucidation of the complex constitution of the multitudinous colouring-matters of flowers, to say nothing of those of fruits, leaves and other vegetable products. In very many instances it has been found readily possible to synthesise or to build up artificially in the laboratory exact imitations of such colouring-matters.

But there is one thing which chemical science has yet to do. It is to afford us information as to the actual manner in which the plant cells manage so marvellously to create their usually magnificent colours. Such is a task to which only the chemistry of the future can address itself, for, so far as present-day chemistry is concerned, the mechanism of this colour formation in flowers is more or less totally unknown, although, in certain instances, chemists are now able to put forward certain shrewd guesses as to the true position of affairs.

For all that, however, a vast sphere of academic research faces any enthusiast who would devote his investigative and creative scientific energies to this modern development of "pure" chemistry. It is a sphere of work in which the financial profit may conceivably be but small, but in which any brilliant success would, without any doubt, bring to the gifted investigator international fame among the ranks of chemical scientists, students and technicians.

Toy Manufacture: Principles and Practice

Constructional Details of Another Selection of Mechanical Toys

(*Continued from page 283, May issue*)

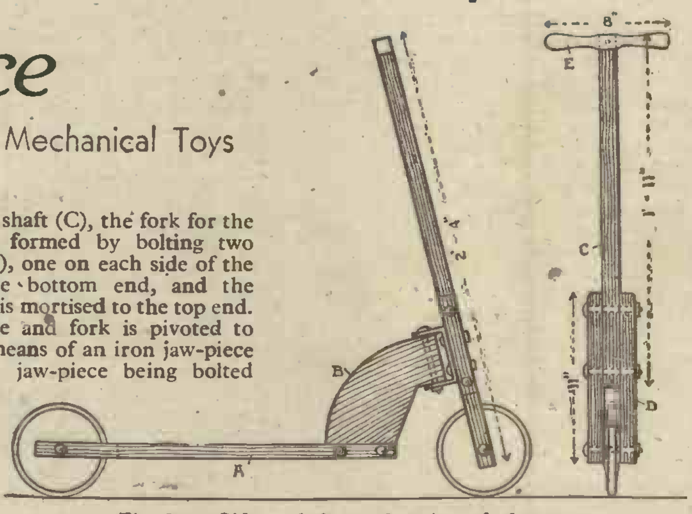


Fig. 82.—Side and front elevation of the scooter.

A Child's Scooter

THIS strong toy can be made very simply (see Fig. 82) if the scheme here indicated is carried out.

Choice of Materials.—A scooter has to stand a considerable amount of rough usage, and because of this, a hard wood, such as ash or oak, should be used. The present scooter has a running board (see Fig. 82), and on the front of this is fitted a neck-piece, both of these parts being lettered A and B respectively in the illustration.

The steering-handle and front fork is made with a centre shaft (C), the fork for the front wheel being formed by bolting two extension pieces (D), one on each side of the centre shaft at the bottom end, and the steering-handle (E) is mortised to the top end. The steering-handle and fork is pivoted to the neck-piece by means of an iron jaw-piece and long bolt, the jaw-piece being bolted to the handle and fork, and the long bolt passes through the neck-piece. The back wheel has a slot cut for it in the running board, and the front wheel fits between the forks, both being fixed with bolts.

Fig. 83.—The running board.

The Running Board.—The running-board is shown at Fig. 83. It is 1ft. 11in. long by 4in. wide, with a slot 4½in. long by 1in. wide, cut at the front end for the neck-piece, and a slot, 5in. long by 1in. wide at the back end, for the back wheel. The neck-piece will require a piece of wood, 7in. long by 8in. wide, the method of setting out being shown at Fig. 84. First mark off the bottom, 4½in. long, then mark the depth of 3in. from the front top end for the portion over which the iron jaw-piece will fit. Set the top edge of this back ¾in., and mark the width of 1½in. at the bottom. Join up these points to form the outline of the neck-piece, and mark out the shape at the back with a pair of compasses set at the point X.

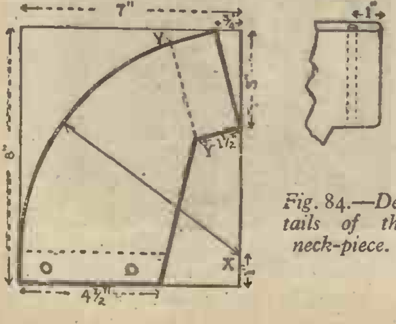


Fig. 84.—Details of the neck-piece.

The Neck-piece.—Cut out the neck-piece with a key-hole saw, and bore a ½in. hole for the long bolt at the front end. The neck-piece is now fitted in the slot at the front end of the

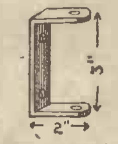


Fig. 86.—One method of fixing the steering gear.

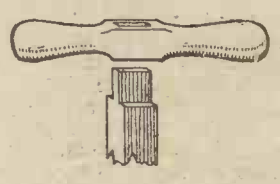


Fig. 85.—How to fit the handle.

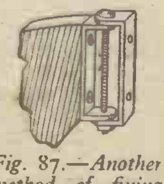


Fig. 87.—Another method of fixing the steering bracket.

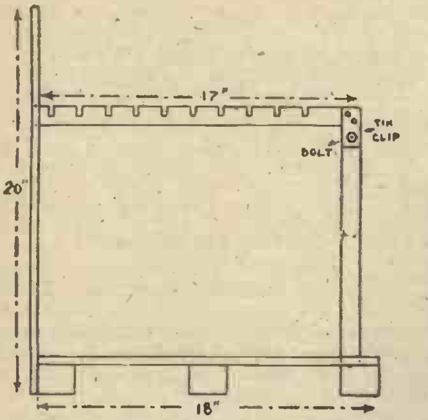


Fig. 88.—A side view of the model stage.

running-board, to which it is fixed with two ¼in. bolts.

The Handle.—The centre shaft of the handle is 1ft. 11in. long by 1in. square, and the two extension pieces, which are bolted one on each side of the centre shaft, are 11in. long by 1in. square. The steering-handle is 8in. long by 1in. square, with the ends rounded down with a spoke-shave to give a good grip to the hands. A tenon is cut at the top end of the centre shaft, and a corresponding mortise is cut in the handle for fitting the two together, as shown at Fig. 85, the joint being fixed by boring a small wood pin through it.

The Steering Gear.—The iron jaw-piece is formed from a piece of 1in. by ¼in. iron 7in. long. The ends of the iron should be rounded, ¼in. holes to receive the long bolt are bored or punched ½in. in from the ends, and two other ¼in. bolt holes are also necessary for bolting the iron to the steering-handle. When the holes have been bored, the iron should be heated and bent to the shape shown at Fig. 86. This may be easily done if the iron is held in a vice with 2in. of the end projecting above the vice jaws, the projecting end being bent over at right angles with a hammer. The iron jaw is now bolted to the steering-handle, after which the jaw is fitted over the neck-piece and the long bolt is fitted, as shown at Fig. 82.

Another method of fitting the steering-gear is to provide two iron jaw-pieces, one fitting within the other, as shown at Fig. 87, and pivoted with a long bolt. The front jaw-piece is bolted through the steering-handle, and the back jaw is screwed to the neck-piece, which, if this method is adopted, will be shaped at the front, as shown by the dotted line (Y....Y) in Fig. 84, and the grain of the wood will run perpendicularly instead of horizontally.

The Wheels.—The wheels should be 4in. diameter by 1in. thick, and they may be of the solid wood kind, or, better still, wood wheels fitted with rubber tyres. Bolts and nuts are used to fit the wheels, and both the wheels and steering gear should be well greased or lubricated to make working easy.

The scooter should be either painted or varnished on completion.

The Model Theatre Stage

The materials for making this miniature stage are cheap and easy to obtain, and most handymen have the necessary tools. If all the parts are made accurately to the measurements given, the model will be quite strong and steady.

The first part to be made will be the stage front, which may be made from a piece of thin plywood. This must be cut 24in. long and 20in. high. Rule out the stage opening 14in. long and 9in. high, the bottom being 2in. from the long edge of the wood, and the sides 5in. from the shorter edges. This opening may be cut out with a fret-saw. The next section is the stage itself, for which another piece of plywood must be cut, 24in. long and 18in. wide. We must now cut out the slots for the framework to be added later. Mark two oblongs, 1in. high and ½in. wide, on the stage front, 4in. from the top and 1in. from the sides, as shown in Fig. 88. This should be cut out with a fret-saw. Also cut two similar holes in the stage at the back corners, 1in. from each side and with their long sides parallel to the sides of the stage. The stage must now be hinged to the stage front so that it opens on a level with the bottom of the stage opening, the hinges being screwed on at the ends and recessed.

The Stage Supports.—Having carefully measured the thickness of your stage plywood, cut four blocks of wood 2in. long, 1in. thick,

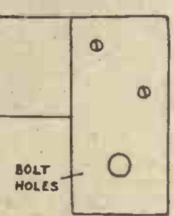


Fig. 89.—Method of fixing tin clips.

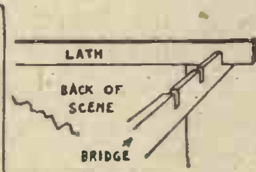


Fig. 90.—How the scenery is supported in the notches.

and in height 2in. *minus* the stage thickness. These blocks must then be fixed with glue and nails at the corners of the stage and flush with the sides, to act as supports for the stage. Next obtain some wooden laths, ½in. thick and 1in. in width. From these cut two pieces 17½in. long and two pieces 15in. long. On the longer pieces notches should be cut ¼in. wide, ½in. deep, and 1in. apart. These should first be ruled out in pencil, and they must be exactly opposite on both pieces.

Cut four pieces of thick tin, 1in. wide and 2in. long, and scratch a line across the centre of each, dividing it into two squares. In the centre of one square bore a hole large enough to take a very short bolt, about ¼in. in diameter. In each of the other squares bore two small screw holes diagonally opposite (see Fig. 89). Two pieces of tin are now screwed to the end of each of the notched strips, projecting downwards to form a slot with a hole at each side. Now fix the other end of the notched strips in the slots in the

Fig. 91.—The stage front.

stage front, and the 15in. strips in the slots in the stage (see Fig. 90). These should fit exactly into the slots and remain quite firm. The upper ends of the upright strips will not fix into the tin slots, and holes are now bored in each for a short bolt, which goes right through both tin and wood, and a nut is screwed on the other end.

Decorating the Stage Front.—The stage is now fitted up for giving a show, and may be taken to pieces again in a few seconds. But there are several things to attend to first. There is the decoration of the stage front, which may be done in any way which appeals to the individual (see Fig. 91). Plastic wood, cut-out designs, modelling plaster, transfers, enamels, and many other methods may be employed.

The next step is the construction of the scenery (see Fig. 92), which will be found quite easy and interesting to those who have some artistic ability. The best type of scenery is made with good white cardboard. This should be cut to about 28in. long and 14in. high, and the scenes painted in matt surface or poster colours, which are sold by artists' colourmen in small jars. The properties and all other scenic pieces will, for the present, be left to the reader's own judgment, and for further guidance he should consult a book on theatrical production, which may be found in any public library. The "actors" can be modelled in plaster or carved in wood, and if they are to be jointed, the parts should be connected with string and should work very loosely, as shown in Fig. 93. They may be operated by strings from above, by wires from the sides.

Lighting Effects.—For lighting the stage small pocket-lamp bulbs and batteries may be used. Four bulbs will be found suitable. Two should be fixed just above the top corners of the stage opening, inside. One may be fixed inside a tin foot-light screen fixed along the bottom of the stage opening, in front. The outside of this screen should be enamelled black. The fourth bulb may be used as a movable light, or fixed in a cylindrical gas-mantle box with a circular hole in one end for a spot light, as shown in Fig. 94.

(To be continued.)

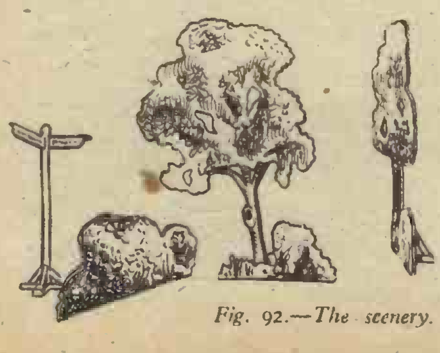


Fig. 92.—The scenery.

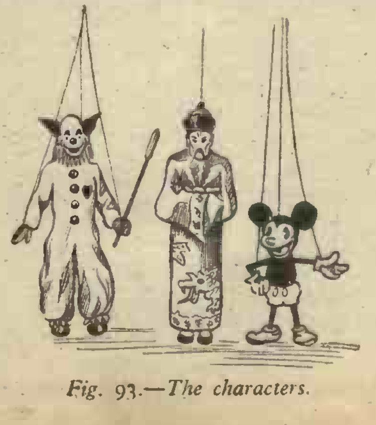


Fig. 93.—The characters.

Fig. 94.—The lighting effects.

Supercharging Aero Engines

How the System Enables Aircraft to Operate at High Altitudes

By T. E. G. BOWDEN

DUE to the fact that the power developed by an engine depends upon the weight of combustible mixture (petrol and air) admitted to the cylinders, it follows that at high altitudes the power generated falls considerably. In the case of a normally aspirated engine, i.e., not supercharged, the pressure in the induction system cannot be greater than that of the air surrounding the engine. The actual pressure is usually slightly lower than the atmospheric.

Assuming that the throttle is left in one fixed position and that the aircraft climbs up from sea level, then the horse-power developed will slowly decrease until the aircraft obtains its ceiling. Fig. 1 illustrates this reduction, which does not exactly coincide with the fall in density as might be thought. Other factors affecting the output are air temperature and the efficiency of the airscrew blades. As will be seen, at a height of 10,000ft. the horse-power has dropped to 500 from a sea level horse power of 1,000.

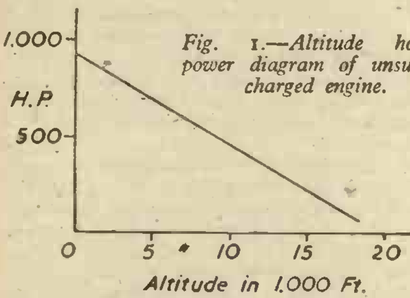


Fig. 1.—Altitude horse-power diagram of unsupercharged engine.

From the above it will be seen that normally aspirated aero engines are very inefficient at high altitudes and that good performances are not obtainable above several thousand feet.

To overcome this serious disadvantage the "supercharger" was introduced, consisting of a form of air compressor which forces the air into the induction system so that the weight of combustible mixture is increased above that normally available. By maintaining the normal weight of air admitted the horse-power developed is also maintained and, in fact, may be increased above the figure normally developed at sea level.

Fig. 2 shows the effect of fitting a supercharger and how in this case the horse-power actually increases up to a certain altitude, and then gradually falls. On comparing this diagram with Fig. 1 it will be noted that the horse-power available at 20,000ft. is considerably more, thus increasing the performance of the aircraft to which the engine is fitted.

The point at which the maximum horse-power is developed is known as the Rated Altitude. In this case it has been assumed that the r.p.m. remained constant, the increase in horse-power being due to the exhaust gases being ejected more easily at heights greater than sea level owing to the reduced atmospheric pressure.

The amount of supercharging, or boost, as it is usually termed, depends upon the strength of the engine, and full boost cannot be usually applied at ground level. If full boost were given then, the pressure on the cylinders would probably be sufficient to cause damage to the engine. In order to measure the amount of boost an instrument known as the "boost gauge" is always fitted, and is looked upon as one of the most important gauges in the pilot's cockpit. The pressure measured is that in the induction pipe leading to the cylinders and the actual pressure above or below the normal atmospheric pressure of 14.7lb. per sq. in. is usually recorded. Figures of up to 16lb. per sq. in. are obtained on modern high-power aero engines, and an increase in this high figure is probable in the near future. To control the amount of boost so that excessive pressures are not gained an automatic boost control is usually fitted so that the pilot need not worry about damaging his engine(s). The control will be described later, following descriptions of the various types of super-chargers that are utilised on aero engines.

Centrifugal Supercharger

The type most commonly used is the centrifugal supercharger, which consists of an impellor driven direct from the engine and a casing which guides the air from the carburettor air intake to the impellor and then to the distributing system. Fig. 3 illustrates diagrammatically the arrangement of this design. The impellor is usually constructed of steel and is extremely carefully machined and balanced owing to the high rate of rotation used, e.g., 20,000 r.p.m. The air on passing to the impellor is hurled outwards by the impellor at a great velocity and passed to the cylinders.

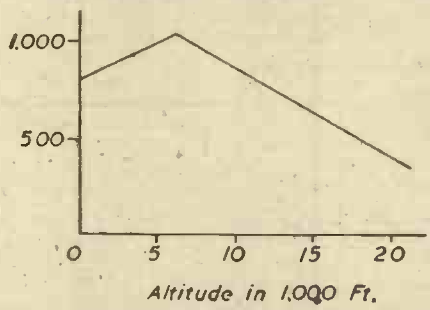


Fig. 2.—Altitude horse-power diagram of supercharged engine.

To prevent damage to the engine should the throttle be suddenly closed, the drive from the engine to the impellor incorporates friction clutches so that the momentum possessed by the rapidly rotating impellor does not cause any gear wheels, etc., to be broken.

As the air flung from the impellor possesses a high velocity but a low pressure, vanes are incorporated in the casing to increase the pressure and consequently reduce the velocity.

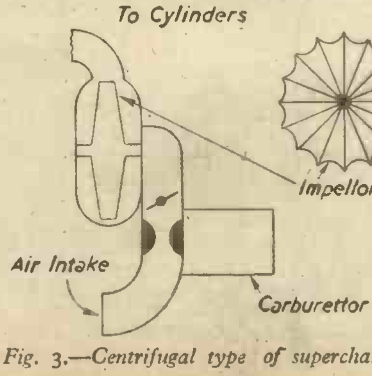


Fig. 3.—Centrifugal type of supercharger.

Eccentric Vane Supercharger

As an alternative to the centrifugal type of supercharger the eccentric vane design may be used. As shown in Fig. 4 the air is compressed by means of an eccentric rotor. Sliding vanes are mounted in the barrel portion and are free to move inwards or outwards as illustrated.

The principle on which this design functions is as follows. At the inlet position the volume between the vanes is gradually increasing, thus tending to suck air inwards. On continuing to rotate after reaching a maximum volume the vanes are forced to travel inwards in their guides. By this movement and the eccentricity of the barrel portion the air is compressed and ejected at the outlet. Several vanes are incorporated so that the supply of air is continuous owing to one space taking over from the next, to prevent undue fluctuations in delivery. This type of pump, slightly modified, is utilised in hydraulic systems for pumping the fluid to the jacks, etc. The vanes do not usually come into actual contact with the casing as this would result in overheating due to friction, and as a rule several thousandths of an inch are left for clearance.

This type has not proved itself efficient for use on modern high-powered aero engines and is mainly used for racing cars. The rotor is heavier than the centrifugal type and consequently possesses a high momentum which, combined with the unwieldy shape, makes it unpractical for aircraft.

Displacement Supercharger

This design is illustrated in Fig. 5 and is quite efficient for use on aero engines. Two rotors are fitted and rotate in opposite directions. As in the case of the eccentric vane supercharger a small clearance between the rotors and the casing is provided. The method of functioning is similar to the gear type of pump, the air being carried round with the rotors.

The rate of rotation is not so high as the centrifugal supercharger, the rotors revolving at an average of 4,000 r.p.m. The main disadvantage is the fact that the air is discharged in waves, thus causing trouble in the induction system.

For its advantages there are the facts that it is not complicated in design and that it is not too unwieldy.

To reduce the amount of power to operate this supercharger a valve may be fitted so that excessive air pressures can be released when operating at low altitudes. When this method is utilised the carburettor must be fitted between the supercharger and the

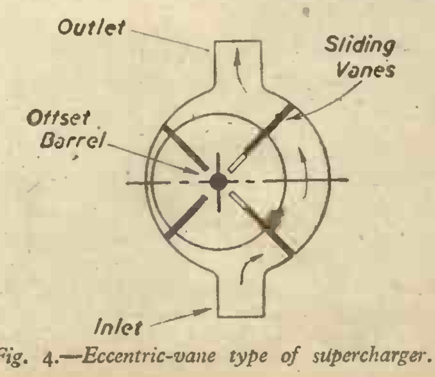


Fig. 4.—Eccentric-vane type of supercharger.

delivery pipes leading to the cylinders, otherwise when the valve is opened and the air discharged to waste, the petrol vapour will be lost as well.

Exhaust-driven Supercharger

The type of supercharger in which the impellor is driven by means of the ejected exhaust gases is rapidly becoming the probable design which will be utilised for all future high-powered aero engines fitted to aircraft liable to fly at high altitudes.

The method of operation is illustrated in Fig. 6. The exhaust gases are led from the exhaust ports in the cylinders to a rotor. This rotor is fitted with blades in a similar manner to a turbine and consequently the rotor is forced to rotate at a high speed. The gases are then discharged to the surrounding atmosphere after performing an extremely good piece of work.

A normal centrifugal type of impellor is mounted on the same shaft as the rotor and functions in a similar manner to that previously described.

The main advantage of this design is that

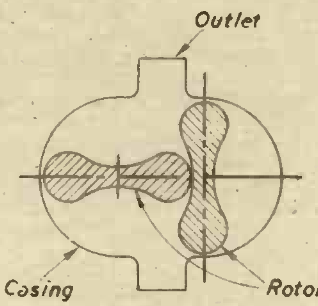


Fig. 5.—Displacement type.

the higher the aircraft flies, the higher the efficiency of the supercharger. This is due to the varying pressures on the exhaust system and the atmosphere surrounding the engines. The greater the pressure difference, the greater the speed of rotation of the rotor and the impellor.

There is also the advantage that no slipping clutches or spring drives are required to prevent damage to the engine as the supercharger is not connected mechanically to the engine crankshaft.

Due to the fact that the exhaust gases are at a high temperature the air supplied by the impellor is also heated and consequently some form of cooling is essential. A radiator is usually fitted to reduce the temperature of the air and special steels have been developed and are being improved for the construction of the detailed parts.

It will be noticed from Fig. 6 that a non-return valve is incorporated in the pipe leading from the carburettor to the cylinder inlet. The reason why this valve is necessary is that a certain amount of back pressure is created when a turbine is fitted, tending to allow the exhaust gases to flow back into the induction system. This limits the amount of valve overlapping which usually occurs when both inlet and outlet valves are open together for a small period of time. The valve also protects the turbine from any damage should a backfire occur.

The turbine may rotate at as high a speed as 30,000 r.p.m. without decreasing the power output of the engine. In the ordinary type of mechanically driven supercharger the amount of power required to drive the impellor is considerable and it is on this point that the exhaust-driven supercharger shows a considerable advantage. The approximate amount of horse-power absorbed in a centrifugal supercharger is anything up to 100 h.p.

Due to the high temperatures caused by circulating the exhaust gases, the danger from fire is increased should there be any petrol vapour present. Another disadvantage is the fact that this system is rather bulky and it is almost impossible to obtain a good streamlined cowling for the engine.

This type of supercharger is fitted to the Boeing Flying Fortress aircraft which is powered with Wright Cyclone engines and is well known for its good performance at great altitudes. The maximum ceiling of this aircraft has not been definitely determined, as the present limit is due to the human element and not lack of engine power, as is usually the case.

Boost Control

As has been mentioned in a previous paragraph, the amount of boost must be kept within certain limits to prevent damage to the engine due to excessive pressures. Fig. 7 illustrates diagrammatically a typical system by which the boost may be controlled to ensure that the best results are obtained.

From the diagram it will be seen that an airtight chamber is fitted with a stack of

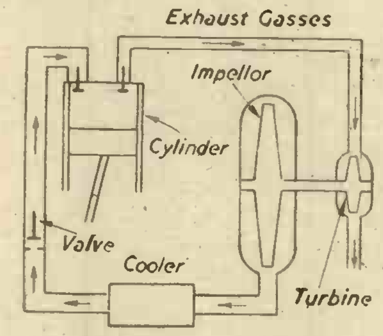


Fig. 6.—Exhaust-driven supercharger.

barometric capsules and connected to the induction system by means of a pipe. The pressure acting on the capsules is therefore the pressure in the induction pipe after the air has passed through the supercharger.

As the pressure varies, so the capsules contract or expand and this movement causes

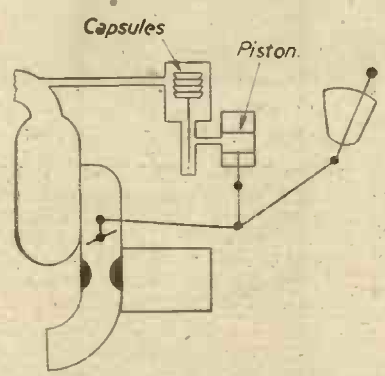


Fig. 7.—Diagram of a typical boost-control system.

a valve to open or shut. According to the position of the valve, oil under pressure is admitted to one side of a piston. This piston is connected by means of links to the throttle control and automatically varies the position of the butterfly valve controlling the amount of air flowing to the engine. The action of the boost control, as will be seen from the above, is to obtain a constant pressure in the induction system.

For various conditions of flight the pressure varies, and to obtain this variation a device is fitted which alters the position of the capsules and valve when the pilot's throttle lever is placed in different positions.

For take-off, the maximum boost is allowed to be higher than that normally used for level flight, as the period of time for which it is used is limited to several minutes.

Other alterations in the normal maximum allowable boost are: override boost (for emergency use) and maximum cruising boost. Gates are usually fitted in the throttle control to obtain these various settings.

Two-speed Superchargers

For aircraft designed to fly at high altitudes it is essential that some means of varying the rate of rotation of the impellor is incorporated. The reason for this is as follows: If only one speed is available, the supercharger is not efficient at both low levels and high levels, as if the maximum speed were used near to ground-level, the horse-power absorbed would be uneconomical and the engine would heat up. By arranging sets of gears enabling the speed to be reduced for low altitude flying, and to be increased for flying at greater altitudes, the efficiency is increased.

The effect of incorporating a two-speed drive is illustrated in Fig. 8. When the high gear is used the fall in horse-power is arrested and output is maintained to a greater altitude.

Hydraulic clutches are used to change gear, being supplied with high-pressure oil from the normal supply of the aero engine. Extra weight is naturally the result when two-speed gears are fitted, but the advantages incurred easily outweigh the disadvantages.

Two-stage Supercharger

The latest development in supercharger design is the two-stage type, in which two impellors compress the air instead of the one normally used. The air is passed on from one to the other and in consequence is extremely hot and requires cooling. A two-speed gear box is also incorporated so that the supercharger is almost as large as the basic engine itself. The Rolls-Royce Merlin 61 is equipped with a two-stage supercharger and installed in Spitfires. An extremely good performance at heights of up to 40,000 feet is the result, as well as an increased performance nearer the ground.

From the above description of the main types of supercharger it will be seen that great care is required in their design and construction. The probable future developments are multi-speed types with several impellors maintaining power output to even

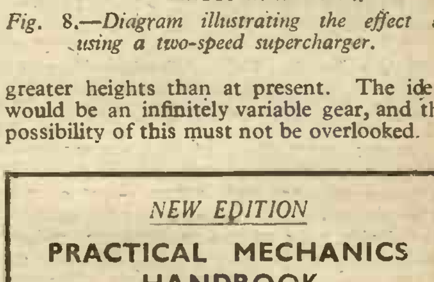


Fig. 8.—Diagram illustrating the effect of using a two-speed supercharger.

greater heights than at present. The ideal would be an infinitely variable gear, and the possibility of this must not be overlooked.

THE WORLD OF MODELS

By "MOTILUS"

The Interest Taken in Model Making by the Public Schools

Hobbies Competition

ONE of the most famous public schools in the south-east district of London is Dulwich College, and during "Wings for Victory" week in March the staff and students alike made a special effort, which resulted in the final total of over £16,000—a truly magnificent achievement.

No small part of this effort was the Hobbies Competition, initiated by M. W. Payne, with awards in the form of National Savings Certificates presented by Mr. H. M. Sankey—an "old boy" of the college—and the exhibition was enhanced by model galleons and exquisite sections of a model scenic railway he had made, as well as by some very interesting examples of Pyruma plasticraft modelling, which he had loaned for the occasion.

The entries, which in all numbered

Winners in the Utility Section—(Cup and Saucer—Thomas), (Lamp Stand—Smith), (Egg Cups—Christison).

over 100, were classified into six sections—Aeroplane Models, Ship Models, Utility, Ornamental, Art and General—but even so the judges were set plenty of problems, for the basis of comparison between models, cakes, musical compositions, cartoons and photographs is rather far to seek. However, the judges—two of whom had travelled from Northampton specially for the event—proved equal to the task, and must in addition have enjoyed the sight of the college with its gracious red-brick buildings rising amid green lawns, and its cool rooms and wide staircase lined with "Wings for Victory" posters—also odd glimpses of some of its "students" clad in the togas of Ancient Rome complete with sandals (instead of the more usual football boots), and the large and echoing hall strewn with fragments of scenery to be used in the following Saturday's production of "Julius Cæsar."

The judges were Mr. W. J.

A.T.C. Shield by Brewster—placed first in the Ornamental Section.

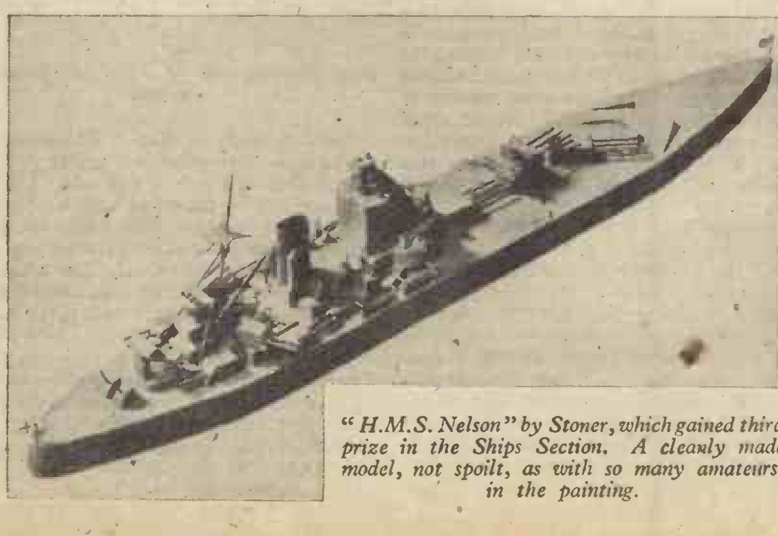
Bassett-Lowke, M.I.Loco.E., and Mr. George Sell (responsible for the Model Sections) and Mr. F. E. Courtney, A.T.D., principal of the Northampton School of Arts and Crafts (responsible for other groups). Mr. Bassett-Lowke's lecture, "The Progress of Transport by

The first award in the Ships Section—Dutch Sailing Boat by Wilmot-Dear. A clinker built model only three inches long.

Water" from the days of the Egyptians up to the present day, complete with little models to illustrate it, was delivered in the Boys' Library after the judges had considered the various exhibits, and then Mr. Courtney took the opportunity of giving his verdict on the Utility, Ornamental, Art and General sections. He illustrated his clear and helpful talk by rapid sketches drawn on scraps of paper, and explained the faults and virtues of the various exhibits, giving the entrants hints that would be valuable to them in the future.

Wood Turning

The Utility section gave plenty of scope for woodworkers. The first award went to a cup and saucer by Thomas, which showed good turning, the wood being taken to the right thickness, but, for ease in holding, the handle should have been hollowed for thumb and finger. Smith was given the second award for his lampstand, well proportioned and graceful, and a difficult achievement in wood, while a set of three wooden egg-cups



"H.M.S. Nelson" by Stoner, which gained third prize in the Ships Section. A cleanly made model, not spoilt, as with so many amateurs, in the painting.

Model Aircraft by Simes—who gained first and second awards in the Aircraft Section.

by Christison gained third prize. The turning here was competent but less subtle than the two previous items, and leaving the feet rectangular in profile made them a little clumsy.

In the Ornamental section the carving of the A.T.C. shield by Brewster was placed first. This was well executed, though rather small in scale, and the lettering would have been better square in section. The work on the wings was particularly good. Side took the second prize with his carving of the school shield.

The Art section being next considered, Mr. Courtney said that the first thing that attracted him when he entered the exhibit hall had been Burne-Jones's drawing in bright blue ink, "Country Cottages, 1942." The photograph "Rievlieux" entered by Ellis gained second award. This was a well-arranged composition of slender composite piers and pointed arches, and the spaces between the piers had been carefully watched to obviate any awkwardness. Hopwood, who had entered a set of cartoons and a photograph entitled "Llyn Vdinas," was awarded third prize for the photograph—skilful handling of a not too easy subject.

Model Ships

Messrs. Bassett-Lowke and Sell, judging the Ships section, awarded the first prize here to Wilmot-Dear for his model of a "Dutch Sailing Boat," and the same entrant gained the second award also, with his set of five small ships in matchboxes. These miniatures were excellent examples of craftsmanship and attention to detail. The Dutch Sailing Boat called for infinite patience in its making, for, although only about 3in. long, the hull was clinker-built of separate planking and ribs. The matchbox models had the addition of suitable scenic backgrounds, which set off the small ships to advantage.

Award No. 3 in this section went to Stoner for his waterline model of H.M.S. *Nelson.* This model, approximately 50ft. to 1in. scale, was reasonably accurate in its details. Guns could be trained on the beam, and there was a sharpness and cleanness about the model, which was not spoiled in the painting. Ford's waterline model of H.M.S. *King George V*, gaining the fourth prize, was an excellent model but suffered from "over painting."

Model Aircraft

Reaching the Aircraft section, first prize and second prize went again, oddly enough, to the same person—Simes. Award No. 1 was his exhibit of three aircraft and No. 2 his model of a Fairey battleplane. The skill shown in the construction of these models, said the judges, was worthy of great praise. The finish—clear and sharp—closely approached the product of professional model makers. Third prize went to Tiffin's model aeroplane, which, although not on the official list the judges felt they must include, as it contained most promising work.

A model "Short Sunderland" by Simmons took fourth prize. The general finish of the model could be improved, but the operation of the rotating gun turrets had been cleverly reproduced. Fifth award went to Preston for his "Hawker Hart," an attempt worthy of encouragement, and the final award in this section was gained by Weller with a model "Bristol Blenheim."

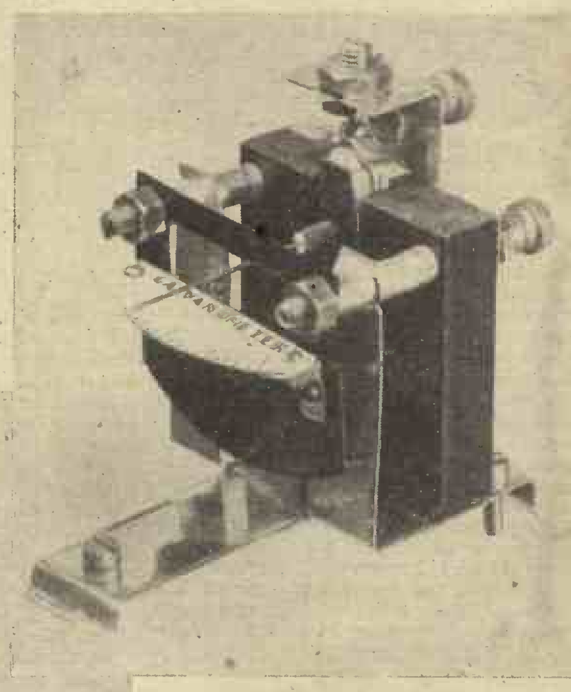
Anti-aircraft Gun by Burne-Jones, which with his Fishing Reel gained the other special award from Mr. Sankey.

All the judges were impressed by the playing of three piano compositions by Thomas and he "ran away with the General Section group, and would have done with a bigger and better group." The second prize in this section went for an attractive iced cake with the words on it, "Wings for Victory." It looked good, but owing to the imminence of lunch, the judges regret they did not sample it!

All organisers of Arts and Crafts Exhibitions welcome the kind of article which, although not every time in the prize-winning class, is yet an "eye catcher." There was a folding blotter carved in wood, a two-tiered occasional table and the carved shields, which were of this type, as also were Burne-Jones's model "Anti-aircraft Gun" and "Fishing Reel" and Sharpley's "Galvanometer," which gained special awards from Mr. H. M. Sankey for their careful workmanship.

Seascapes in Matchboxes

One most attractive exhibit was the set of six seascapes in matchboxes. Each had a different painted background in keeping with the model ship inserted, and these ranged from a Greek trireme, a convoy destroyer, a ship engaged on polar exploration, a China clipper, to a South Sea schooner. The scene for this last vessel (which was only about half an inch long) was a sandy beach fringed by model palm trees and complete with footprints in the sand!



Galvanometer by Sharpley, which gained a special award from Mr. H. M. Sankey, an old boy of Dulwich College.

One cannot do better than quote Mr. Sankey's words, to sum up this College Model Exhibition, "The more I think about it, the more I can see the wonderful future there is for modelling. It does appear that in the years to come this hobby will be one of the important features in the lives of the younger generation. That is why I am so keen on the whole thing."

The judges, too, were impressed by the high standard of the work exhibited, and all concerned with this venture—initiator, organisers and entrants—are to be congratulated on its success. A Hobbies Exhibition like this promises to be a most interesting feature of the Dulwich College year in future, and is, it is understood, likely to be arranged next time to coincide with Founder's Day.

The Distribution of Electricity

Second Cantor Lecture Given Before the Royal Society of Arts

By E. AMBROSE, M.I.E.E.

(*Continued from page 229, April issue*)

The Battle of the Systems

BY the time electricity was being used for distribution to the public both the direct-current and the alternating-current systems had been demonstrated, at least so far as the single-phase current was concerned, and naturally there were strong advocates for each system. Pioneers like Ferranti, Gordon and Mordey ranged themselves on the side of the alternating-current system, while men of equal importance, such as Crompton, Hopkinson and Kennedy, supported the claims of the direct-current system. And so for many years this difference of opinion existed as to the merits of the rival forms of current. Alternating and direct currents gave equally good results for incandescent lighting; for arc lighting the direct current formed a crater in a positive carbon which had the effect of directing most of the light downwards, but where arc lamps were used for lighting railway goods yards or docksides, the alternating current was no doubt better suited, because with both carbons pointed most of the light was directed out horizontally, and so gave general illumination over a wider area.

Direct current was more suitable for driving motors as at that time no satisfactory single-phase motor was available. The possibility of using storage batteries to supply the night load and so save running the generators throughout the 24 hours of the day, was a point in favour of the direct current.

The transmission pressures adopted for the Oxford system in 1896-7, when direct current at 2,000 volts was transmitted to substations, where it was reduced by motor-dynamo sets to a lower voltage for the consumers, showed the possibility of developing high voltage direct current. Another drawback to the alternating current was the difficulty of running alternators in parallel; a difficulty which, however, was soon to be overcome. By 1903, there were large generating stations situated outside the centre of cities, from which three-phase current at high voltages was being transmitted to substations for transformation and distribution at lower voltage. The advantages of static transformers as compared with the rotating machines necessary for giving a direct-current supply were being recognised. To meet the objection to rotating machinery in substations, the mercury arc rectifier was developed and quite a number of direct-current networks were kept in service by the installation of rectifiers fed by high-voltage alternating-current feeders from remote generating stations. Although it cannot be said definitely that the battle of the systems has been won, there is every evidence of an increasing use of alternating current for distributing networks.

Conductors

In selecting a material for an electric conductor, consideration should be given to its resistance to the flow of current in order that as little energy as possible would be lost in transmitting from the source to the point of utilisation. Of the metals, silver and copper offer the lower resistances, there being about 7 per cent. difference between them, which is in favour of silver. Copper, being the more commercial metal, was adopted as the most satisfactory material for the purpose.

For the insulation of the conductors, the electric lighting engineers were able to make use of the experience of the telegraph engineers, who, for many years before, had put cables both underground and undersea. Materials such as cotton, jute, rubber and gutta-percha were available. Rubber and gutta-percha seemed the most promising, but both are to some extent unstable, particularly gutta-percha, which is readily oxidised and had to be protected from the air. For under-water telegraph cables it proved satisfactory, but it was not considered to any extent for electric light conductors. The early overhead cables used by the Grosvenor Gallery Co. consisted of 19/15 stranded copper cable insulated with rubber and braid suspended by leather thongs from 7/16 steel cables which were supported by iron poles mounted on the house tops. A similar arrangement was adopted by the Hampstead Electric Supply Co., the largest cable supported in this way being a 37/12 rubber-covered and braided. Later, when supply undertakings were empowered to break open streets for the purpose of laying mains, the practice of supporting cables over the house tops was discontinued.

Fig. 8.—Cross-section of Edison cable.

In recent years, aluminium wires, in combination with steel wires to form a compound conductor, have been used extensively for overhead lines erected on poles of wood, concrete or steel, to give a supply of electricity in rural areas. The steel wires which form the core of the conductor add materially to the strength and permit the use of longer spans between supports.

Underground Cables

Aluminium has also been used to a small extent for underground cables, but its resistance is so much greater than that of copper that, for equal conductivity an aluminium conductor would be approximately one quarter greater in diameter than a copper conductor. There is also the problem of jointing which is made difficult by the material being so readily oxidised.

The forms taken by the cable, its insulation and the methods of laying underground are so varied and numerous that it may be of interest to refer to some of them. In the early days of distribution Edison worked out a very complete scheme in which the conductors were copper rods of segmental cross section. These rods were placed in wrought-iron tubes filled with insulating material, and having on the outside tarred ribbons wrapped round them to prevent the oxidation of the iron. To hold the copper rods in position perforated paste-boards were arranged at intervals. These conducting tubes were manufactured in lengths of 20ft. The copper rods protruded about 2in. from the ends of the tube, and were connected by means of a U-shaped piece, so as to allow for expansion and contraction of the metals; the whole joint was then covered by a cast-iron split box filled with insulating material. The tubes were made in seven sizes from 1in. to 3½in. diameter, and the cross section of the copper ranged from .0248 to 1.287 sq. in. (See Fig. 8.)

Edison made use of the tapered main in distribution; he arranged for the cross section of the conductor to diminish with the distance from the generator.

To make a T-joint or service connection, a few inches of the tube and conductors would be cut out and specially T-shaped connectors would be inserted to make the connection to the conductors of a similar tube. The completed joint would then be protected by a split T-cover and afterwards filled with insulating matter.

For a three-wire system, the D-shaped conductor was replaced by copper rods of circular cross section. Three rods were both kept apart and also bound into a bundle by long spirals of jute rope. The bundle of rods was placed in an iron tube, and insulating material run in, which was liquid while hot, but solidified in cooling. The tubes were made in convenient lengths, and the conductors in successive lengths were joined together by short pieces of flexible copper cable inside special junction boxes.

For feeding points Edison devised a large cast-iron junction box which permitted the interconnection of different cables through the medium of three substantial circular rings of metal placed vertically over, but separated from one another. Each conductor was connected to one of the three rings by means of a bolted lug.

For low-pressure distribution various methods were devised in which the conductors were of bare copper supported on insulators laid in specially constructed culverts. These methods avoided the cost of covering the conductor with insulating material. This expense was offset, however, by the cost incurred in constructing the conduit.

A culvert specially constructed by the Compagnie Edison, of Paris, in connection with the lighting of the boulevards, was built of concrete and covered with slabs of the same material; it was 30in. wide, 14½in. high and placed under the pavement at a depth which gave 6in. from the top of the cover to the surface of the footwalk. Stranded conductors, which were of silicium bronze, rested on porcelain insulators secured to the floor of the culvert and placed about 6ft. apart.

Crompton devised a culvert system, but in place of stranded conductors, he used flat strips of copper laid on top of one another until the required cross section was obtained. These strips were pulled up taut and supported on glass insulators. This system was used in Kensington and Notting Hill, London, and at many places in the provinces, on direct current systems. Until quite recently, the installation at Notting Hill was in service.

The St. James's and Pall Mall Electric Light Co. used cast-iron culverts in place of concrete. Each length of culvert, 3ft. 6in. long, consisted of two parts, a lower part or trough, and a cover which is bolted to the former, the joint being packed with yarn and red lead. The trough was 10in. wide and 6in. deep, and the separate lengths were connected by binding pieces 5in. wide, the joint being run with lead for the trough, but packed with red lead and yarn for the covers. The joint boxes were built of brick with cast-iron frames and covers. The conductors, which consisted of copper strip on edge, were supported on glazed earthenware insulators. Services consisted of vulcanised rubber cable drawn into gas piping.

About the same time that the Crompton strip method was invented, Callenders introduced a method of laying underground insulated cables in troughing, and then filling up with bitumen. The nature of the troughing varied from time to time. At first, it was of cast iron, and later installations using wood and, in some instances, sheet iron were put down. The cables rested on bridges so that the compound could flow completely round them.

Ferranti Cable

An event of historic importance was the production of a paper-insulated cable for 10,000 volts working made by Ferranti, at Deptford, in 1890. It was made in lengths of 10 to 16ft. The insulation was of brown paper rolled on (not taped) and impregnated. The inner conductor consisted of a copper tube on which was rolled the paper. This was then inserted in another copper tube as an easy fit and the tube drawn down until it was tight on the paper and all air excluded. This also was insulated, and inserted in an iron tube which was drawn down in similar manner.

The joints were made by cutting back the outer iron pipe and the outer copper tube and tapering the insulation with a special tool. The inside of the inner conductor tube was reamed out to correct size for a solid copper rod or plug that was forced into the two ends to be joined by a hydraulic press which drew the two together. Insulation was then applied and a short length of copper tube previously slipped along the outer conductor from which a portion of the insulation had been removed, was slid into position bridging the gap between the two ends to be joined. This tube was then squeezed down at several points on to the conductor by means of a rotary wheel press similar to a pipe cutter but with rollers in place of cutters.

The outer insulaton was then added and the joint in the iron pipe made in a manner similar to that for the outer copper tube. The joint was completed by filling up any space there may have been under the iron by pouring in melted compound through a small hole and sealing up.

A cable made in this way was very rigid, and until some other way of putting on the paper and the outer protective coating was devised, a flexible paper-insulated cable could not be made.

Shortly after Ferranti's experiment at Deptford, cables insulated with narrow strips of paper, saturated in a resin compound and covered with a lead sheath, were being made in America. These were probably the first flexible paper-insulated cables. The system was adopted and further developed in this country. In 1890-91 lead-covered cables insulated with jute, rubber, bitumen or paper were being used.

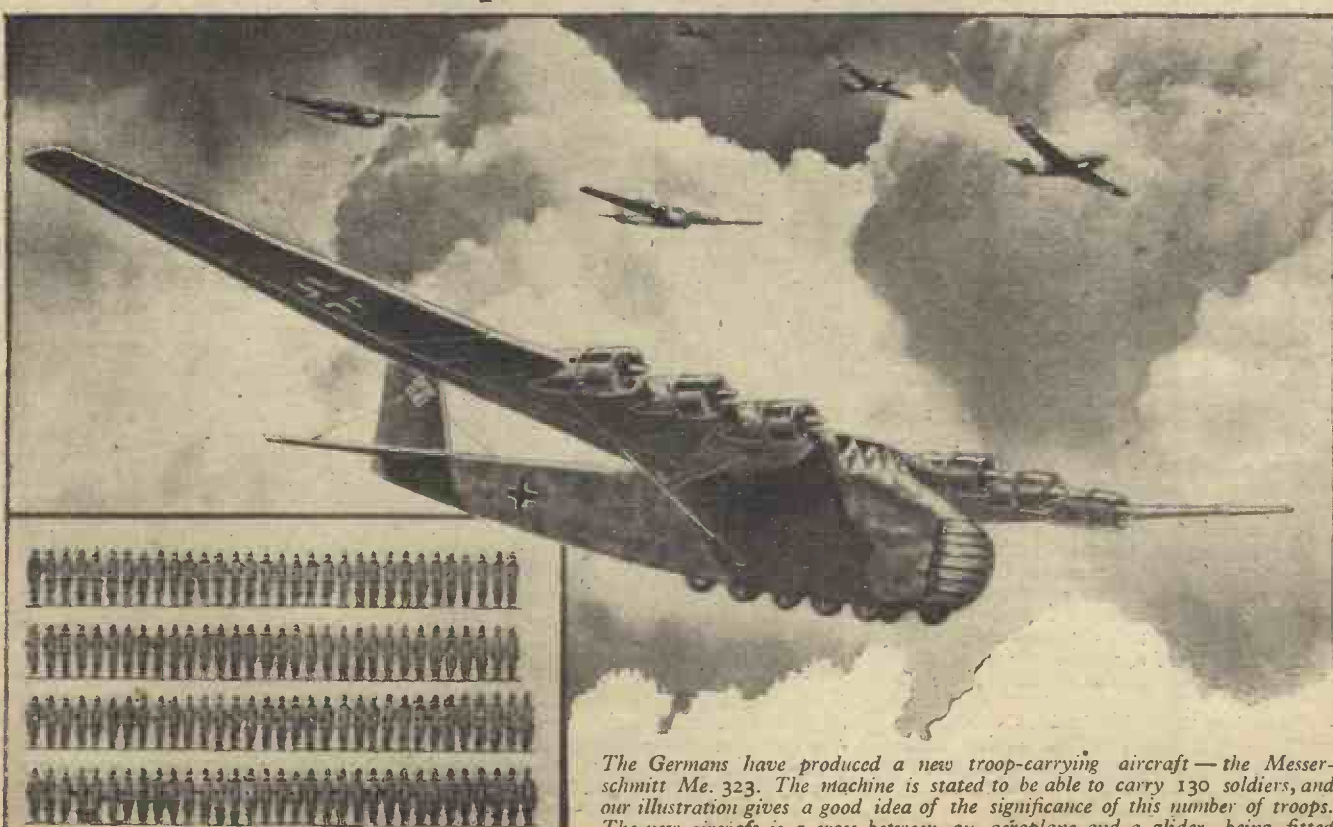
In his Cantor lectures given to the Society of Arts in 1892, Professor George Forbes, F.B.S., referred to a system of mains, which he had described at the meeting of the British Association in Manchester in 1877: "It consisted of cast-iron pipes through which are run bare copper tubes. The copper tubes, which are supported on porcelain insulators, may be first used as the conductors alone, and when the demand increases, bare wires can be drawn through the tubes. In the figure, which is more or less diagrammatic, the method of making a house connection is shown, iron tubes being tapped into the side of the pipe, through which the house mains are led and soldered to the outside of the copper tubes only, the inner wire conductors being left untouched."

In 1898 Mr. J. S. Highfield invented a cable which was intended to enable service connections to be made whilst the cable was alive, in anticipation of electric cooking.

For use on a three-wire system, the cable would consist of two conductors of segmental cross-section having a dovetail groove running along the crown of the segment, and a third conductor in the form of a deep double-headed rail with a dovetail groove running along one of the heads. The conductors are bedded in prepared wood, within a steel pipe. Each length of pipe has three holes drilled opposite the grooves in the conductors; these holes are plugged. In making a connection, two plugs are removed for a two-wire service, and in the holes is screwed a short tube containing within it a connecting piece which is split at its end and has a wedge inserted in the split. This end is driven into the dovetail groove of the conductor, the wedge expanding it so that it takes firm hold in the dovetail. The service connections may be made to the piece in any suitable way.

About the year 1894 lead-covered cables were being made with the steel armouring put on over the lead. This permitted the cables to be laid direct in the ground and so dispense with the use of pipes or conduits.

Germany's "Powered Glider"



The Germans have produced a new troop-carrying aircraft — the Messerschmitt Me. 323. The machine is stated to be able to carry 130 soldiers, and our illustration gives a good idea of the significance of this number of troops. The new aircraft is a cross between an aeroplane and a glider, being fitted with six engines—Gnome-Rhone 700/800-h.p. radials.

Our Busy Inventors

By "Dynamo"

Hand Grenade for Drill

AN inventor has been devoting his attention to the construction of a hand grenade which will be helpful in drilling soldiers in the use of this weapon. He affirms that the grenade at present employed for training has disadvantages. While a service grenade, he states, containing a full explosive charge is dangerous, a dummy is insufficiently realistic because, when thrown, there is neither smoke nor noise.

The object of his device is a grenade which is free from both of the defects of the dummy but can at the same time be used without risk of injury from disintegrated fragments. An additional object is to provide means whereby the existing service-type grenade may be utilised for practice.

The new device comprises a replaceable cartridge containing an explosive charge, means for igniting the charge and also means for admitting an ample supply of air to the interior of the cartridge, after ignition, for free combustion of its contents. The grenade casing is adapted to enable a fresh cartridge to be inserted after each one is used.

The charge is of sufficient power to cause a realistic explosion. And holes in the end of the cartridge and the chamber which it occupies allow the gases to issue through the customary filler plug orifice—left open for this purpose—in the form of smoke. This affords visual evidence that the grenade has been fired.

As the charge is not powerful enough to damage the casing or movable parts, these may subsequently be collected and used again when a fresh cartridge has been inserted.

Useful Spectacle Hinge

AT the present time it is almost a tragedy to break one's spectacles, owing to the fact that it is most difficult to get repairs promptly effected. This disadvantage makes exceedingly appropriate an invention relating to spectacle frames which has been submitted to the British Patent Office.

This device appears to be suited for shell or horn-rimmed spectacles made either of real shell or a synthetic material.

The principal object of the invention has been to reduce to a minimum the number of parts requisite to hinge the side arms to the lens-receiving frame, while producing neatness and strength in the hinged connection of the arms to the frame of the lens.

Another object is to surmount the difficulty of a shortage of high-grade metal alloy and also of labour and machines in the manufacture of spectacle frames.

A yet further aim is to furnish a type of hinge which will permit shell or horn-rimmed glasses to be made without laterally projecting lugs on the perimeters of the lens mounts. Therefore, as a result of this device, the spectacles can be worn with a gas mask.

The inventor points out that, at the present time, the conditions make necessary low nickel content metal alloys being used for hinges and other parts. This renders it extremely difficult to shape and manipulate the metal work and also makes the usual kinds of frame hinges unreliable and liable to break.

To obviate these drawbacks, the inventor has devised a simplified and sturdy hinge which also possesses the characteristic that very little skill is needed in its production and its attachment to the frames.

According to the invention, a hinge connecting a side arm to a lens frame comprises a member joined to the frame flush against the rear face of the part to which the arm is to be hinged and projecting rearwardly from the frame. And a pivot pin is passed directly through the member and the front end of the arm.

The information on this page is specially supplied to "Practical Mechanics" by Messrs. Hughes & Young, Patent Agents, of 7, Stone Buildings, Lincoln's Inn, London, W.C.2, who will be pleased to send free to readers mentioning this paper a copy of their handbook, "How to Patent an Invention."

To Save Matchsticks

A SAFETY match with a head at either end of its stick has made its début. The aim, of course, is to save wood—a necessary economy in these times. With the customary match a prodigal quantity of timber is thrown away. Very rarely is the whole length of the stick consumed.

The idea of a matchstick with more than one head is not novel. I have myself recently on this page referred to a kindred device. As a matter of fact, the originator of the Siamese-twin match in question acknowledges that the principle of his double-headed lucifer has been anticipated.

His invention is characterised by the fact that the matchstick is shaped to provide an enlarged centre part notched for easy severance of the charred portion. And this centre part is also rendered non-inflammable by impregnation with fireproof chemicals, in order that the flame may be automatically extinguished and thus prevented from reaching the other ignitable end. Obviously the latter would be covered by one's fingers while the first portion is being used.

In addition to saving wood this invention ensures that, if required, a second match is immediately available.

Carrot Confectionery

THE subject of an application recently accepted by the British Patent Office can perform the double rôle of a foodstuff and a confection.

The invention consists chiefly in impregnating carrots with hot syrup made with sugar, glucose and water.

One method of producing the article is to cut up into pieces of convenient size, after cleaning, a quantity of raw carrots. These pieces are placed in a receptacle and boiled in order to soften them. They are then immersed in boiling syrup consisting, as already mentioned, of sugar, glucose and water, contained in a closed vessel. To this, pressure is applied by means of compressed air or by the steam generated, in order to cause the carrot to be thoroughly impregnated by the syrup. The operation can be repeated in a syrup of the same or greater concentration, and the syrup may have added to it any desired flavouring or colouring matter.

The resulting product is a valuable foodstuff, as it contains all the essential nutrition of the carrot. It is pleasing to the taste and can be kept for a long period without deterioration.

The basic substance above described may be converted into a variety of forms of confectionery. For example, the impregnated carrot pieces may be dried and coated separately with crystallised sugar or with chocolate. They may be minced or crushed and made into paste by mixing with wholemeal flour and cocoa, to which nuts or dried fruits may be added.

Invisible infra-red radiation is enlisted to speed up manufacture of large electric transformers at the Westinghouse plant in Pennsylvania, to help expansion of power facilities for national defence. This battery of 129 infra-red lamps cuts the paint drying time for parts of large transformers from 70 hours to 50 minutes. They have a combined energy of 32,250 watts. Development of the infra-red lamps was recently announced by Westinghouse. The 250-watt units combine lamp and reflector in a single hermetically-sealed lamp. They produce a narrow, concentrated beam of radiant heat energy, with less than 5 per cent. of total energy emitted as visible light.

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.

Design of Electro-magnets

A HORSESHOE electro-magnet gives a short, strong pull, and a solenoid gives a longer but rather weaker pull. Is it possible to make a solenoid to operate on six volts that can pull four times its own weight; if not six volts, what do you consider the minimum? Could you please give specifications of one, with diameter and length of bobbin, diameter and length of core, number of turns, and size of wire? I can arrange for core to be fairly near centre so as to get good starting pull.—P. Bown (Northampton).

IT is necessary to differentiate between the "pulling" or attracting of a movable armature across an air-gap and the actual "lifting" power of a magnet when the poles and armature are in contact. For equal dimensions of iron core and length of magnetic circuit the ability of a magnet to lift is determined by the flux density or magnetic lines per square inch of cross-section, and the permeability of the iron, taken in conjunction with the exciting power in ampere-turns of the coil. When, however, there is any air-gap between magnet poles and armature the solenoid has the advantage over the horseshoe magnet owing to the smaller magnetic leakage of lines; in other words, the solenoid will operate over a longer range than the horseshoe type electro-magnet. A further advantage is gained by designing the solenoid with an iron jacket to form a good return path for the magnetic circuit, and dividing the central core into two parts, one fixed and one sliding. It would be impossible to suggest any figures or specification for making a "6-volt solenoid to pull four times its own weight" until the length of the maximum air-gap separating the fixed and movable iron core is stated. In any case, the voltage has nothing to do with the excitation or strength of magnet, which depends entirely upon the ampere-turns of the exciting coil.

Coloration Process for Iron

I AM desirous of knowing how to treat iron or mild steel to give it the polished antique effect that is given to iron work on reproduction furniture such as hinges, handles, etc. The same effect is given to iron when making old lanterns, fire-irons, etc.—D. McDermid (Harrogate).

YOU can obtain the effect which you describe on iron or mild steel in two ways:

1. Immerse the iron parts in melted saltpetre for about 10 minutes. Then remove them and heat them strongly.
2. Immerse the iron parts in a boiling solution of iron phosphate in ortho-phosphoric acid. Subsequently, well wash the parts in water.

Metalwork treated by either of the above methods requires finally to be rubbed down with a rag saturated with linseed oil. It may afterwards be thinly lacquered or varnished if thought desirable.

The above directions apply to the surface texture and coloration of the metalwork. The latter is often given an antique appearance by means of modifying its surface by means of hammering, beating or chiselling.

Repairing Rubber Boots

I HAVE been trying for some time to find a solution of rubber for repairing Wellington boots that have got cut or damaged, but without success. I have heard of such a solution which will stick leather to leather or rubber to rubber. A chemist has told me that carb. bi-sulph. will dissolve rubber. Would this make a good solution, or is there any way that I could vulcanise a small cut in rubber without any special tools?—S. Mawhinney (Draperstown).

BY the expression "carb. bi-sulph," your chemist friend obviously refers to carbon disulphide. This is not a particularly good solvent of most rubbers, besides which, it is a particularly unpleasant and a highly inflammable liquid to work with.

The best all-round solvent for rubber is hot naphtha, the rubber being finely shredded and macerated in this liquid.

With care, ordinary rubber solution should repair rubber boots fairly satisfactorily. A good plan is to dissolve some hard bitumen in naphtha and to incorporate some of the bitumen solution with the rubber solution, using the mixed solutions. But as most of the hard bitumens (as, for example, Gilsonite) are now virtually unobtainable, we do not think that this recipe will be of service to you.

We can only suggest, therefore, that you make a good thick solution of rubber in naphtha and that you use this for the repair. Ordinary rubber solutions are mainly solutions containing naphtha. Hence we do not think that any rubber solution in naphtha which you could make yourself would be any better than the ordinary commercial rubber solutions.

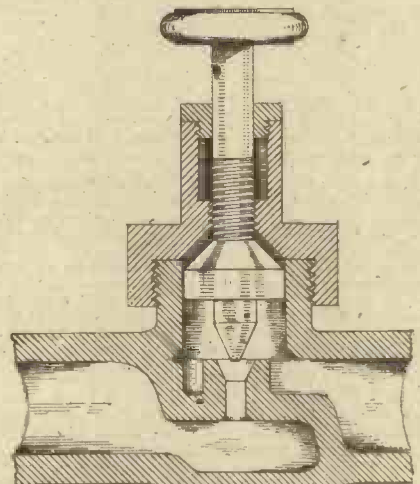
It is impossible to vulcanise rubber without special chemicals and apparatus because the vulcanisation has usually to be done hot and under pressure. At one time, portable vulcanising outfits were retailed commercially, but these were not successful and their use has long been discontinued.

Refrigerator Controlling Valve

I SHALL be grateful if you can give me a few details, and preferably a sketch, of a reducing valve for use with a sulphur dioxide refrigerator, which I am endeavouring to make.

Also, the name of any practical book on the subject of refrigeration (SO_2).—F. G. Crabtree (Stoke).

REDUCING and controlling valves for refrigerator use are mainly made either of semi-steel or of high-quality, close-grained cast iron. They may be either disc, domed or needle shape. The accompanying illustration indicates diagrammatically the principle of the commoner needle-type valve. The fine thread on the spindle extends through the valve opening as a tapered cone.



Section of a needle-type controlling valve for a refrigerator.

An excellent book on modern domestic refrigerators which is up to date and readily obtainable is:

Hal Williams: Mechanical Refrigeration. (Pitman, 1941.)

Other books on the same subject are:

Y. F. Wostrel and V. G. Praetz: Household Electric Refrigerator. 1938.

W. R. Woolrich: Handbook of Refrigeration Engineering. 1938.

A. J. Wallis-Taylor: Pocket Book of Refrigeration and Ice-making. 1934.

J. A. Moyer and R. U. Fitz: Refrigeration. 1932.

Rewinding Motor Armature

CAN you supply me with a winding specification for a small armature, details of which I give below? The motor from which this was taken is a small series wound job, used for driving a small pump, and was wound for 220 v. A.C. I have not disturbed the field coils, which are electrically intact, and I should like to rewind the damaged armature to be suitable for 240-250 v. A.C. It was unfortunately impossible to count the turns on the armature as the wire was sealed up with insulating varnish, but the original winding consisted of .006 (38 S.W.G.) enamelled wire.

I should also like particulars of connections to commutator, and position of same in relation to armature poles.

The remaining details are as follow:

No. of poles—12; No. of commutator bars—24; Diameter of armature—1-5/16in.; Length of armature—1-11/16in. Coil span originally was 5 poles. The bushes are in the same plane as centre line of field poles, i.e., horizontal.—G. Haynes (Harrow).

YOU have not stated the speed at which you wish your motor to run, and which will affect the number and size of conductors per slot. For driving a small centrifugal pump it will probably be near the mark if the armature is wound to run at 3,500 r.p.m. developing 1/30 h.p. on 240/250 volts A.C. as a series-connected motor, taking a current of approximately 0.2 amperes. The winding specification to meet these conditions will be 24 armature coils grouped two per slot, each coil containing 95 turns of No. 38 s.w.g. enamel and s.s.c. copper, spanning slots 1 to 5 inclusive. To set out the commutator connections, after making all coil junctions mark one armature coil whose opposite sides lie midway between the two field pole-tips, and bring the start and finish of the coil to the two adjacent commutator bars lying under the nearest brush. With the pitch of one coil set out in this way all the rest are then connected up in exactly the same sequence. Should the motor run in the reverse direction to the one required reverse the two ends of the field connections.

Compressed Sawdust

I SHOULD be greatly obliged for information on the following: For experiment I want to make a solid cylinder out of fine sawdust. Can you please tell me what pressure is necessary for this? Assuming the dimensions are 12in. x 4in., and that compressed air is available, how much longer than 12in. must the cylinder be to allow for compression, apart from the length taken up by the piston or ram? As a binding agent would Cerric or Bostik be suitable? I think fish glue is too sticky and smelly to use.—A. Daniels (Harwell).

THE precise compressibility of your sawdust depends upon (a) the average particle-size of the sawdust, (b) the hardness and/or moisture content of the material, (c) the degree of pressure applied. For these reasons, since we are not in possession of this necessary data, we cannot tell you exactly how much space to allow in your cylinder for the movement of the piston or ram. Taking an average, however, we think that by applying a pressure of, say, 60 lb. per sq. in., you should be able to compress the sawdust down to one-third of its original bulk.

Glue is a good binder for sawdust compression. Spread the sawdust out on a flat surface and spray it with a two or three per cent. glue solution, turning the material over frequently. After compression, the sawdust blocks can be swabbed over with a weak formalin solution (made up by mixing one part commercial formalin and four parts of water). This will at once insolubilise the glue binder and will render it perfectly damp and water resistant.

Other binders which have been used for sawdust compression are the various synthetic resins (or solutions of them), casein, china clay, pitch, bitumens, bentonite and natural resin, but, of these, we think that, in your case, glue will be the most satisfactory.

Fluorescence: Vandyl Chloride

CAN you give me some information on the following: (1) If fluorescence is caused by the short rays of light being converted into visible rays of a longer wavelength, is there any substance that will convert the longer wavelengths into shorter rays?

(2) Can you tell how to make vandyl chloride? I believe it is a straw coloured liquid having great solvent power.

(3) Where can I obtain coloured glass and X-ray protective equipment?—F. Prescott (Little Rissington).

(1) THERE is no known material which will directly convert the longer light rays into shorter light rays. It is, however, possible for long light rays (as, for example, red or infra-red rays), to act upon a suitable photo-electric cell and thereby to be converted (at least partially) into electric emissions.

(2) There are several chlorides of vanadium, but we are inclined to think that you refer to vanadium oxychloride, $VOCl_3$, which is a lemon-coloured liquid, boiling at 126.7 deg. C., and decomposed by water. It does not possess any exceptional solvent powers. You can make this compound by heating a mixture of pure sugar charcoal and vanadium pentoxide, V_2O_5, in a stream of dry hydrogen gas, the heating to be conducted at red-heat. The glass tube in which the mixture is contained is then allowed to cool, after which a stream of dry chlorine gas is passed over the mixture, which is again heated to red-heat. Vanadium oxychloride, $VOCl_3$, will then slowly distil over in a fairly pure state. The preparation of this substance is difficult, and we doubt whether you will be able to produce any vanadium pentoxide which, even in normal times, is a fairly expensive commodity.

(3) Coloured glass may be obtained from: Messrs. Chance Bros. and Co., Ltd., Smethwick, Birmingham; Protective screens and equipment for X-ray working is obtainable (in normal times) from any of the following firms: Messrs. A. E. Dean and Co., Leigh Place, Holborn, London, E.C.1; Messrs. Cox-Cavendish Electrical Co. (1924), Ltd., 46, High Street, Marylebone, London, W.1; Messrs. F. Davidson Co. (Optical and Electro-Medical Appliances), Ltd., 142, Great Portland Street, London, W.1.

Electric Clock

I HAVE a "New Haven" electric clock, the coil and pole pieces of which are missing. The current consumption is 1 watt at 200-250 volts, 50 cycles, and as I have no idea of the size of the original coil, I would be grateful if you would let me know the size and length of wire to use, and also the approximate size of pole piece on which the coil is to be wound?

The original armature which I have is 23 mm. diameter and has 40 notches cut in its perimeter. Should I cut corresponding notches in the pole pieces, and if so, how many per pole piece?—A. W. Cannell (Farnborough).

IT would be extremely difficult to offer any definite instructions concerning the design and winding of the field magnet for your electric clock, without drawings of the general lay-out and design. You have only given the diameter of the rotor as 23 millimetres, and not the depth; the stated consumption of one watt is also open to question. If this were correct it represents a current consumption of 0.004 amperes on 250 volts and the impedance of a magnetic circuit of such small dimensions would be scarcely higher than its ohmic resistance. Consequently the exciting coil on the stator would need a resistance of some 62,500 ohms. Even using a No. 47 s.w.g. enamel covered wire this would represent a coil weighing about 5 oz., altogether disproportionate to the job. We think you may have underestimated the watt consumption, and in any case the matter is one purely for trial and error methods, as it is impossible to make any close calculation. The only advice we can give you is that the pole pieces should embrace about three-quarters of the armature or rotor circumference, and the spacing of the slots on the inner faces of the pole pieces should match those in size and number on the periphery of the armature.

Soap Making: Curing Fox Skins

I HAVE tried caustic soda with ordinary dripping for making soap, but find it does not lather very well. Could you please tell me what is lacking? Also, is there a substance on the market that will cure fox skins, and where is it obtainable?—R. Potts (Morpeth).

YOU do not describe your method of soap making, and, for this reason, we are unable to point to any detail in which you may have gone wrong. However, if you have sufficient fat or grease available, it would be advisable to use tallow, lard or raw bone fat instead of dripping. This should be melted and you should then add to it exactly 14 per cent. of its weight of caustic soda, the soda to be dissolved in a convenient quantity of water. Boil the whole mass very gently for an hour or two and then add a quantity of common salt, which will throw the soap out of solution so that it can then be collected, pressed and dried.

The fact that the soap which you have made does not lather very well shows either (a) that you have not added sufficient caustic soda to the fat, or (b) that the time of boiling has not been long enough. Or possibly, both of these factors may have come into operation.

There is no special preparation which will cure a fox skin in one simple operation. However, you can cure a skin by the following method:

Trim and clean the skin on the flesh side with a sharp knife in order to remove all adhering particles of flesh. In this operation be very careful not to cut through the skin itself. Then dissolve 2½ lb. common alum and 1 lb. common salt in a gallon of water, and brush this solution on to the skin every day for five or six consecutive days. Now sprinkle bran or sawdust all over the skin, brush out, and nail the stretched skin to a board and dry it slowly. The skin should then be soaked in a weak solution of tannin for about a week. Such a solution can be made by boiling a quantity of spent tea-leaves in water. After the tannin treatment, the skin should again be brushed over with bran, nailed to a board and dried. Finally it is a good thing to rub black pepper into the skin to act as a preservative.

Transformer for Sunray Lamp

I HAVE a home-constructed carbon arc "sunray" lamp, for which I require a step-down transformer, and I should like the following data if possible:

Number of turns and wire gauge for secondary and primary windings; weight of laminated iron ore in pounds needed for efficient working. The input would be 230 v. 10 a. A.C. mains, and output would be approximately 76 v. 30 a. A.C. Would I require an additional resistance in the lamp circuit (secondary winding), and, if so, what form would this take, and the number of turns necessary? Diameter of carbon rods equals 10 millimetres.—Herbert A. Morgan (Martock).

A TRANSFORMER taking its primary input from 230 volt 50 cycle mains, and stepping down for an output of 76 volts 30 amperes should have an iron core 3in. by 3in. cross-sectional area, of Stalloy strips, measuring overall 10in. by 8in. by 3in. deep, with a centre opening of 4in. by 2in. for the coils. The weight of the core would be approximately 60 lb. On a 50-cycle circuit the reactance factor would be 1 volt for every 0.89 turns, and the primary will therefore require 205 turns of No. 13 s.w.g. copper wire, and the secondary 68 turns of No. 8 s.w.g., or its equivalent in copper tape. It would probably not be necessary to provide a resistance in the secondary circuit, if the transformer is wound with the primary coil on one of the long limbs of the core, and the secondary on the opposite limb, owing to the heavy voltage drop which would result from magnetic leakage when bringing the lamp carbons together on starting up the arc.

Electrifying Model Railway

I HAVE an 8in. gauge locomotive weighing, with load, about 112 lb., which I wish to propel with an electric motor at about 5 m.p.h. on a level track. Transmission would be a 20-1 worm drive.

I wish to electrify the track at a safe voltage, using as little current as possible. I have a car starter motor (6 volt) with series field, but this discharges a battery quickly, and I should much prefer to be supplied direct from the mains (230 volts A.C. 50 cycles), using a 25 volt output transformer and suitable motor.

Can you give me details of how this could be done and the type of motor required? Could the starter motor, or a ¼ h.p. 230 A.C. motor be used or converted for use?—J. K. Dixon (New Malden).

IF you contemplate taking current from the mains you must step down the voltage to about 25 to avoid risk, and if you wish to provide a power output of ¼ h.p. from the motor, you cannot obtain this without a consumption of about 10 amperes. The car starter motor is a very inefficient type on A.C. and you would be far better advised to obtain a standard fractional horse-power motor, series wound, controlling the speed by series resistance. The motor must have laminated fields as well as armature, and if you wish to rewind a 230-volt A.C. motor for low voltage we will supply you with a suitable winding specification on receipt of particulars of your armature dimensions, slots and commutator bars.

Removing Printers' Ink: Theatrical Make-up

I HAVE in my possession a number of business cards, and I wish to stamp out the number owing to change of address. Could you give me the name of a chemical that will remove printers' ink?

I am unable to get theatrical make-up locally, so could you give me the name and address of a well-known firm where I can obtain same?—T. Williams (Cardiff).

IT is quite impossible to remove printers' ink from paper or card without damaging the surface of the material. There is no chemical which will bleach the ink away. In view of this fact, we can only suggest that you have your business cards neatly overprinted with your new address.

Theatrical make-up can be obtained from the following sources:

Messrs. L. Leichner (London), Ltd., 30/32, Acre Lane, Brixton, London, S.W.2; Messrs. Phyllis and M. J. Harris, Ltd., 96a, Charing Cross Road, London, W.C.2; Butterfly Make-up Manufacturers, 277, Brixton Road, London, S.W.2; Messrs. Smiths, Theatrical Dealers, Oxford Road, All Saints, Manchester; Messrs. B. J. Simmons and Co., Ltd., 7 and 8, King Street, Covent Garden, London, W.C.2; Messrs. Evison and Payne, 83, Borough High Street, London, S.E.1.

Infra-red Rays from H.T. Battery

IN a case where electric mains are not available, will you inform me of the cheapest way of operating a small infra-red and radiant heat lamp of about 300 watts power? How long would a wireless high-tension battery (120 volt) last if it is possible to operate the lamp from it? Also, could I operate a vibratory massage machine designed to operate on 100-120 volts or 200-250 volts direct or alternating current, without the mains?—T. Porter (Portadown).

IT would be entirely impossible to operate a 300-watt radiant heat lamp or infra-red ray apparatus from a 120-volt wireless H.T. battery. The output capacity of such batteries is only a few thousandths of an ampere, whereas four or five amperes is the smallest useful current for running such apparatus. The same applies to electro-massage, a motor of ⅛ to ¼ h.p. being the smallest size serviceable for deep body massage applied by a vibratory body belt.

Ultra-violet Ray Apparatus

I DESIRE to subject the seeds of vegetable plants to ultra-violet rays. I have read of this being done in Russia with wheat, which yielded 50 per cent. more crops. Can you tell me what apparatus is necessary for producing ultra-violet rays? Please give particulars of any apparatus that can be constructed in an average home workshop. Please state also any publications on the subject.—A. Blackburn (Malton).

IN order to obtain fairly pure ultra-violet ray radiation you require a mercury-vapour lamp screened by an ultra-violet ray-passing filter, or alternatively an ordinary arc lamp similarly screened. If ultra-violet rays are not required pure, either of the above light sources may be used unscreened.

You cannot construct a mercury-vapour tube at home, and it is doubtful whether you yourself would have much success with the making of an efficient arc lamp. We would advise you to approach a dealer in electrical goods and inquire for a secondhand arc lamp or mercury-vapour tube. Suitable dealers in this class of goods are to be found among our advertisers.

Ultra-violet ray-passing screens can be obtained from Ilford, Ltd., Ilford, or from Kodak, Ltd. (Wratten Division), Kingsway, London, W.C.2, but they are necessarily very expensive.

For your own experiments we would suggest an ordinary unscreened arc lamp, run off the heating mains of a house-circuit. Seeds could be exposed to the light of such a lamp for a definite period of time, and subsequently compared in extent of germination with unexposed or unradiated seeds. Seedlings could also be experimented with in a similar manner.

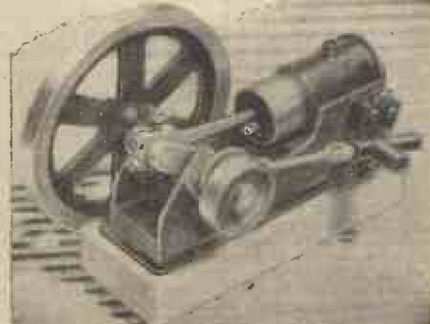
Astronomical Telescope

I WISH to make an astronomical telescope of about five or six feet in length. Can you please tell me: (1) Diameter and focal length of object lens and eyepiece lens. (2) Resulting magnification. (3) Length of telescope. (4) Suitable material for blackening inside of telescope? I am contemplating making the body of wood.—A. M. Barron (Poole).

(1) You will want an object glass about 4½in. diameter. The focal length will probably be about 66 inches. Buy two or three ready-made-up eyepieces. (2) Magnifications 40, 80 and 160 will be a good assortment. Huyghenian type is most suitable. (3) The exact length will depend upon the exact focus of the object glass. Make the tube a few inches longer than the focus and fit the object glass; then adjust the eyepiece temporarily until you can ascertain the exact length by trial. (4) Any dead-black paint (i.e., not a shiny paint).

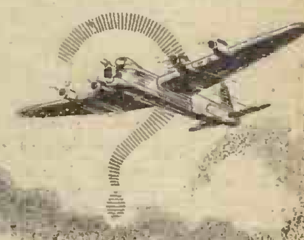
MODELCRAFT "PLANBOOKS"

MODELCRAFT, Ltd., 77, Grosvenor Road, S.W.1, have just issued another of their popular "Planbooks," entitled "How to Make a Model Oil Engine." It contains working drawings, sketches, and instructions on how to make a working model oil engine, using chiefly wood, strawboard, screws and glue. By following the simple instructions



The finished model oil engine.

a realistic miniature engine can be constructed with the aid of a few ordinary domestic tools. The completed model, after being painted and varnished, can be made to work on low pressure air of two or three pounds per sq. in., as supplied by a canister charged by a bicycle pump, or better still, by a foot or hand bellows. The accompanying illustration gives a good idea of the completed model. The price of the book is 2s.



THE Cyclist
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Comments of the Month By F. J. C.

Lt.-Col. Mervyn O'Gorman on Road Accidents

A MOST searching, exhaustive, and authoritative analysis of the cause and prevention of road accidents was made by Lieut.-Col. Mervyn O'Gorman at a recent dinner of the Roadfarers' Club, with Lord Brabazon in the chair. He appealed for the appointment of a scientific research board to investigate the problem. So important is his paper that we are publishing it *in extenso* in this and next month's issue. Here is the text of the paper:

The Roadfarers are well christened. The name not only calls to mind good roads and good fare, but heralds a welcome grouping of people who wish to move safely afoot or awheel. One day you may send a telegram to the Minister of Transport: "Treat the roads fairer and the Roadfarers will treat you."

British people want to be fair to underdogs and minorities—it's instinctive. But instinct is not too reliable as to which *is* underdog when there's a mix up of dogs. Only observation of the data can tell us that.

Our lack of road traffic data is proving dangerous. It is a more technical problem than it looks. Governments have followed the line taken by the majority; but a majority cannot design a battleship or solve a technical problem. Its kindly instincts are not often as well informed as they are well intentioned.

From considerations of this sort I shall avoid the sensational note about holocausts, motor massacres and moral turpitude. I am acutely aware of the real tragedies of heart-broken parents—old folks, little children and sturdy toilers hurtled out of life. True pathos resides there, but it stirs indignation—and indignation, though it gives spice to a talk, is poisonous to policy. Our need of a sound traffic policy is supremely urgent.

I have no revelations for you of the causes of these accidents, or of ingenious punishments to fit the crimes. I believe nobody has, and I'll tell you how I come to this view.

For 25 years the Air Ministry had a committee of 10 scientific men whose job it was to disentangle the origin of those aircraft accidents which seemed unexplainable. I was chairman of that committee (I claim no credit for myself, since the members did all the work). My job was to keep the bead on the target bull's-eye. I learnt much of how research work can disclose the causes of accidents by taking exact data on the spot, calculating possibilities, analysing alternative ingenious suppositions, making model experiments at the N.L.P. to check or refute any chosen theory, and then counter checks on full scale. By such methods every accident problem referred to us throughout those years was solved. They were quite as difficult as those of the road. In all that period no appeal was made to emotion. We might have been determining the movement of planets or microbes. Science won through by thinking out the implications of the data, and eventually it found not only the causes, but, incidentally, unexpected devices for general air safety.

Road traffic movement has never had any such study. It needs it. The stuff written about it in the last two decades has shown kindness of intention, sometimes embittered by loss or suffering, but often too much special pleading and too many emphatic assertions for which the writer gave no warranty. I can recall no impassioned plea for full and correct data; moreover, the so-called traffic experiments of the Ministers were conducted with an inanity past belief.

In the House of Commons Mr. Dalziell used to say that the sure way to applause was any assertion attacking motor users. Latterly those members who haven't yet aired their own superior humanity in this way are

Lieut.-Col. Mervyn O'Gorman.

beginning to notice how cheap this motor baiting appears to onlookers. Some day they will realise an English motor driver is just a man in no way different from another, save only that he has no organised group to defend him in the House of Commons. He is there an underdog. Drivers are often wrong—and so are pedestrians and cyclists, only there are 32,000,000 more pedestrians and 7,000,000 more bicyclists, all with votes.

Research

The body which should do the research must contain no Minister in quest of an excuse for his failures by imputing them to the "human factor" of all road users. There must also be no policeman desirous of "facilitating convictions," no road interests and no competing rail interests, but only persons competent to take measurements, records, conduct local experiments and use their wits. That means competent scientific observers who owe no allegiance to anyone but to truth. They must be under a business-like chairman with some knowledge of distribution questions.

In 1939 I advocated scientific research into traffic flow to Lord Alness's Commission. His lordship asked me: "Is not that, surely, what this very Commission is doing?" "No, sir," I replied. "The Commission is collecting opinions and suggestions, not verifying them." This view had not dawned on him. Anyhow, he recommended my research committee. Previously I had submitted that same, somewhat obvious, proposal to a Minister of Transport. He saw no personal advertisement in it, and replied (verbatim): "We have no need for your laboratory scientists."

Evidence

Here is a sample of evidence, a parable based on an objection that was once made to me: "What earthly effect do you think your scientific research can have in restraining a brute such as I saw at 3.30 p.m. on Tuesday last?

"The traffic along Main Street was at its height and flowing past the mouth of Little Street when a big Rolls swung round the corner into Little Street within a foot of a 'pram' which was being slowly pushed across the mouth of Little Street. Only Providence saved the child—and only a flogging is good enough for the brute! Nothing could excuse him!"

"*My reply:* 'Your facts are correct, except that the car was a "Baby Austin."' Nothing could excuse the driver on that statement. It happens that I was that driver.

"My car was in one of the two streams of vehicles, filling Main Street. I was proposing to drive across the other stream so as to turn into Little Street which was on my right. I had extended my hand to warn drivers behind me that I was waiting for a gap through which to cross the main stream that barred my access to Little Street. Little Street was empty of vehicles, but just as I entered it with a bus hard upon my flank, a nursemaid, holding a little boy by one hand, *and looking back at him*, pushed her 'pram' off the kerb to cross the road. The pram approached the side of my moving wheel. There was but one thing to do—to get myself clear of it before the maid had time to push it blindly into the side of the car. My shout caused her to start and scream; I expect it also made you look up. The static picture you saw, and correctly reported, was against me. To your view a brute was imperilling a child. On the other hand, the moving picture was in my favour. I saved a crash and perhaps a life. I refuse to apologise."

I relate this unimportant story to illustrate how honest eye-witness impressions do not, until inquiry has sifted the conditions, illumine the road problem.

(To be continued)

The ruins of Girnigo Castle, Caithness, Scotland.

Calleva's New Members

R. BROWN, the noted one-armed rider, and R. Haines have joined the Calleva Road Club.

"Tour de Trossachs"

A HILLY 35-mile course through the pick of some of Scotland's choicest scenery was chosen by West of Scotland Clarion C. and A.C. for their enterprising contribution to road sport, proceeds of which were given to the Cyclists' Red Cross Fund.

Hampshire Lads Overseas

MEMBERS of Hampshire Road Club overseas constantly keep in touch with members at home: A. Osgood is with the R.A.F. in Canada; R. Early with the Air Force Regiment in North Africa, and R. West with the Indian Army.

Morrison's New Role

FORMER champion of Glasgow Wheelers, and remembered for his amazing rides in Isle of Man massed start races, D. Morrison, now a sergeant in the R.A.F., has done no fewer than 25 operational flights over enemy territory.

Essex Cycling Union Founder Dies

COUNTY Alderman Charles Russel, J.P., former Mayor of Leyton, who died in his 75th year, was founder 52 years ago of the Essex Cycling Union, which had nearly 100 clubs and a membership of 6,000. The Union was responsible for arranging the old pre-1914 Woodford Meets which were held annually for 30 years.

Midland Combine

BIRMINGHAM Time Trials League and Coventry Cycling Clubs' Alliance are holding their road events in conjunction with each other. Team and individual championships of each organisation will still be staged.

Hull Thursday's Fine Record

TWO members of Hull Thursday C.C. are prisoners of war; two have been killed in action, and an additional 56 members are with H.M. Forces.

Southgate Resignation

SOUTHGATE Cycling Club has lost the services of A. J. Ballantyne as honorary secretary, but he is continuing as treasurer pro tem.

Southern Counties Activities

NO fewer than eight "25's"—including one for girls—in addition to a "50" are scheduled by Southern Counties Cycling Union.

21st Anniversary

WARRINGTON WHEELERS have celebrated their 21st anniversary.

Host for Cumnock

HAROLD BRIERCLIFFE, Glasgow clubman and journalist, has been appointed by the West of Scotland Cyclists' Defence Committee to act as "host" at the forthcoming Cumnock rally.

Thorpe's First Win

LEN. THORPE, Barnet C.C., had the distinction of making fastest time in the first London open road event—the Oak C.C. Hardriders' "25"—in which he clocked 1.14.30.

Johnstone Revive

JOHNSTONE WHEELERS, in pre-war days the strongest club in Renfrewshire, have revived.

Arab Cyclists

ERIC RHODES, Leeds Wellington C.C., who is in North Africa with the First Army, expresses surprise at the number and quality of excellent machines ridden in slipshod fashion by the natives.

Hampshire Combine Suggested

SEVERAL clubs in Hampshire, among them the Portsmouth C.C., Gosport C.C., Portsmouth North End and Hampshire Road Club, are to form a combine to provide time trials for those clubs whose members are not strong enough to arrange events of their own.

Walsall Road Club Trophy

TO perpetuate the memory of their late secretary, Walter Kendall, who gave 22 years' service to the club, Walsall Roads C.C. have allocated a magnificent trophy to their championship "50."

Signalman G. A. Eley

GEORGE ELEY, prominent pre-war London clubman, who recorded many fast times in open events, is now a signalman on convoy work with the Royal Navy.

Middle East Mileage

BATTERY SERGEANT-MAJOR JACK McLAREN, King's Lynn C.C. and Tricycle Association, cycled over 1,500 miles last year between duties in the Middle East. He has met a number of cycling chums in the desert, including Albert Wagg, of his own club.

Sam Scott Honoured

SAM SCOTT, familiar figure in London racing and social circles, has been made a vice-president of the Marlborough C. and A.C. It will be recalled that, as a "veteran," he won the N.C.U. tandem paced "50" some years ago. His win was a sensation of the season.

Ernie Mills's New Role

ERNIE MILLS, Addiscombe C.C. "flyer," is hon. secretary of a new club, the Ace and Tab Cycling and Athletic Club, which anticipates promoting a number of evening grass-track meetings in addition to large athletic and cycling meetings.

Wisbech Wheelers' Fine Record

FORTY-FIVE members of Wisbech Wheelers are now serving with the Forces.

Rapier Road Club's President

IN appreciation of his work for the club since its formation, E. H. Jones has been elected president of Rapier Road Club.

University C.C. Loss

ONE of University C.C.'s most promising roadmen, M. Scrivener, who was awarded a special prize for his outstanding "50" in his club's open "50" last year, has been reported missing, presumed killed, as the result of enemy action at sea.

Century C.C. Activities

CENTURY ROAD CLUB, one of the first of clubs to drop time trials for duration, have reconsidered their decision. Members are now permitted to take part in events. Club fixtures are planned, and one-time champion Frank Lipscombe is T.T. secretary.

Hull Hero

THE D.F.C. has been awarded Pilot Officer W. O. Schoon, pre-war member of Reindeer C.C., of Hull.

Larkin's Consistency

EDDIE LARKIN, Hemsworth Wheelers, celebrated his 14th consecutive racing season by winning a Medium Gear "25" with 1 hr. 5 min. 54 sec.

Cycling in Australia

AN 18-year-old Australian girl, Cynthia Hearl, competed in 23 track and road events last year and, in addition to beating all local records, won eight first prizes, six seconds and five thirds. She is a great admirer of Marguerite Wilson, Britain's premier girl rider, who contemplates returning to competitive work.

To Perpetuate the "Ordinary"

TO perpetuate the memory of the old "Ordinary" cycle, a new club, the Old Ordinary Bicycle Club, has been formed. J. Blake, 48, Grange Road, Hook, Surbiton, Surrey, is secretary.

West Hants Record

SEVENTY-ONE members of the West Hampshire Road Club are serving with H.M. Forces. The latest two to acquire their "wings" are Frank Phipps and Joe Taylor.

Road Sport in Ireland

AFTER two years' inactivity, the Irish Road Club have scheduled to promote two "50's," a "100" and a "12."

Saturday Time-Trials

THE innovation of the Norland Combine to hold a 25-mile event over roads north of London on a Saturday afternoon received the support of 46 riders. Fastest time was recorded by Len Thorpe, Barnet C.C., with 1 hr. 4 min. 9 sec.

Earnshaw Demobbed

HARRY EARNSHAW, who on the outbreak of war was putting up sensational record rides, has been released from the Royal Air Force to return to his work in the pits.

Club for St. Albans

EFFORTS are afoot to form a cycling club in St. Albans, Herts.

Holme Valley Wheelers

MEMBERS of Holme Valley Wheelers are nearly always faced with a climb of over 1,700ft. when returning from club runs, yet fixtures are carried out with unfailing regularity and with an average attendance of 20 members.

A Proud Record

FIFTY-TWO members of the St. Neots and District C.C. are serving with H.M. Forces.

Racing in South Africa

D. POWELL, one-time member of Brighton Mitre C.C., has been riding with success on road and track at Capetown and Port Elizabeth, South Africa.

Tees-side Activities

ONE of Tees-side's most consistent riders, L. Wilson, has joined the Stockton Wheelers, as his own club, Richmond C.C., has temporarily ceased active time-trialing.

Preston Bottle-neck

PLANS for a new Preston, familiar as the "bottle-neck" of West Lancashire, include a new ring-road round the town.

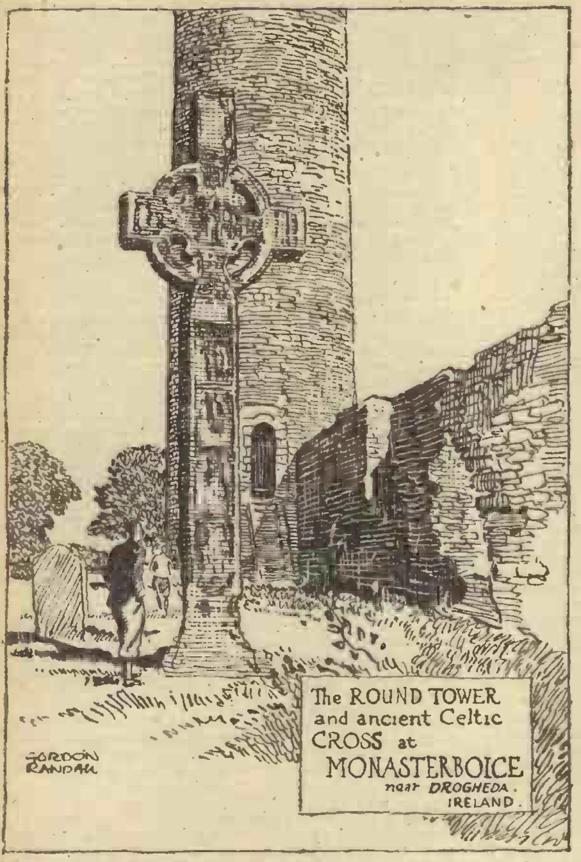
Reduced Format

THE 1943 Handbook of the Y.H.A. of England and Wales, which gives details of over 200 youth hostels, has been issued in a new reduced format, suitable for pocket or saddle-bag.

The youth hostel at Wanlockhead, in the Lowther Hills. Wanlockhead hostel is 1,500ft. above sea level, on the borders of Dumfriesshire and Lanarkshire, and is the highest in Britain.

Cyclorama

By H. W. ELEY



Where are the Tramps?

TO the man who loves and uses the roads, one of the interesting changes brought about by the war is the almost complete disappearance of the familiar tramp. All of us will remember that in pre-war days certain English roads abounded in picturesque if ragged and unhygienic vagrants. Presumably many of them have been drawn into the military net, and are in some branch of the Services. Others presumably have forsaken the rolling road and got some settled type of job. I always seem to remember that in pre-war days the Woodstock Road was one of the chief highways of the tramping fraternity. How often on a summer's day has one seen a ragged, unkempt tramp, squatting by the roadside eating a meagre meal of bread and cheese or mending dilapidated boots with the aid of a jack knife and bits of string! As *The Times* pointed out recently, in the old days we dealt hardly with tramps, vagrants and vagabonds. Many a tramp, years ago, has spent days in the stocks because of his wandering vagrancy. Repeated offences against the harsh laws of the time were punished by whipping, and indeed there are cases recorded where beggars were regarded as felons and sentenced to death. The interesting thought is that these rigorous punishments did not eliminate the tramp. . . . !

The English Weather

THE English have always been fond of talking about the weather—possibly because English weather was always an amazing thing. The day in the open air could produce an amazing variety of weather conditions—heavy rain in the morning, brilliant sunshine at noon and a thunderstorm in the afternoon and a chill, windy night. This year, the weather is a more frequent topic than ever, and few of us, I imagine, can recall a more amazing spring. One is tempted to picture the roads of England, if we all still possessed cars and petrol flowed in abundance as in times gone by! However, those of us who have been wise enough to take up cycling again can enjoy all the colourful spring-time beauty of the countryside with a freedom which is precious indeed. . . .

The Roadfarers' Club

I WAS privileged the other week to attend a cheerful, happy meeting of the Roadfarers' Club—that amazing organisation which has established itself in an incredibly short space of time as one of the foremost friendly associations connected with the road and the usage of roads. The venue was the Clarendon Restaurant, Hammersmith. The chairman was the president of the club, Lord Brabazon of Tara; the chief speaker, Lt.-Col. Mervyn O'Gorman, that silver-voiced orator who is such an expert on traffic problems and the whole intricate question of road accidents. The Colonel was at his best, and read a paper packed with helpful, constructive information about the whole question of road accidents. He condemned in no uncertain terms the thoughtless, unfounded criticisms which are so frequently levelled against motorists by sentimentalists who have not troubled to ascertain the real facts. He made a strong plea for scientific research into the whole question, and I was delighted to hear that there is a possibility that his admirable speech will be circulated in pamphlet form. It is high time that we got rid of the shallow thinking that obscures the realities of this vital matter. It is not sufficient to be sentimental about road fatalities—we have got to find the cure.

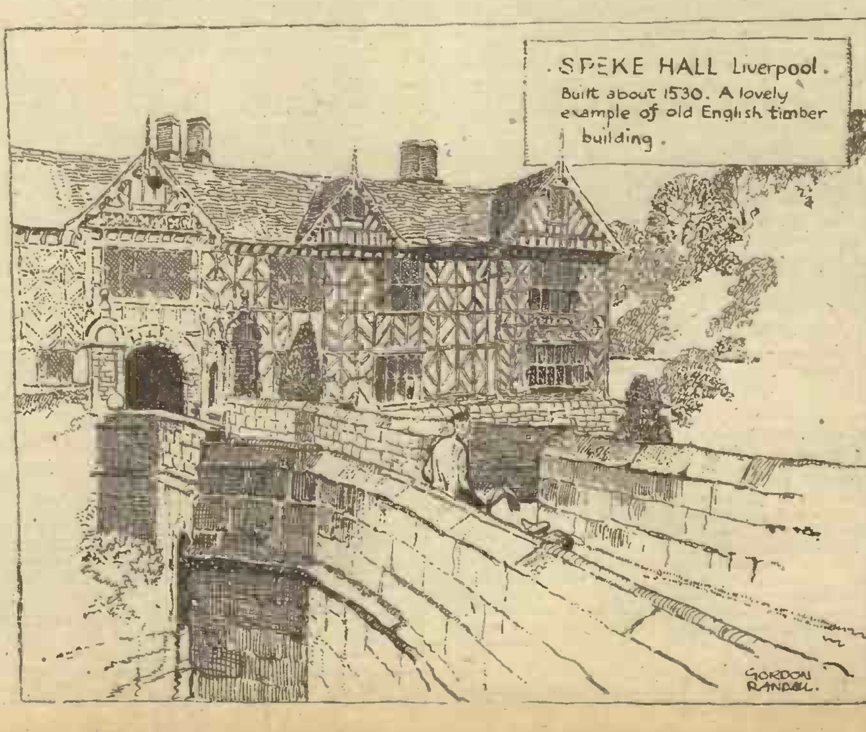
One of the charms of the Roadfarers' Club is that it embraces in membership all types of road users—it is not sectional and therefore its discussions have a balance and poise which is often lacking in organisations which only deal with one aspect of road usage. . . .

"Sammy" Bartleet

IT is perhaps hardly necessary for me to write any tribute to the revered memory of "Sammy" Bartleet—who has passed on, to leave great memories behind in the hearts of countless cyclists and men connected with the cycling movement not only in England but far beyond. I knew "Sammy" well. I knew his unique collection of old bicycles well. To say that "Sammy" was a "character" is to say too little, for his personality was unique. His knowledge of the evolution of the bicycle was unsurpassed, and I shall always treasure my memories of close contact with him when he was writing the volume "Bartleet's Bicycle Book." In that connection I had a lot to do with him in providing data and illustrations regarding the invention of the pneumatic tyre and early tyre history. A great figure has passed from us, but his memory will be kept green. . . .

May Day Customs

AS I write, the merry month of May is here and my thoughts have been travelling back to old-time May Day customs. We have lost a good deal by the disappearance of old traditional customs of the countryside. May Day used to be marked by dances on village greens; by children going from house to house with gaily decorated maypoles and singing spring-time songs. The day was the great opening of the spring and summer festival, and somehow the May Day celebrations suggested that King Winter had been definitely deposed, and Queen Summer had started her reign. I am afraid that these old customs have been swallowed up in the less romantic, more hectic period in which we live.



Wayside Thoughts

BY F. J. URRY

This Great Game

THE good old game of cycling is coming—indeed, has come—into its own, for I hear on all hands of people planning cycle tours and risking the question of accommodation, visiting country friends where they are sure of a welcome (provided they take their ration books), or fixing up at a centre from which they can tour some delectable district. For carefree movement cycling seems to be the only thing left with the exception of walking, and that mode of progress has definitely limited horizons, and, besides, is only for the really fit people. One could see this position coming soon after war started, for one could sense that the control of essentials would be far more rigidly enforced than was the case in 1914-18; but most of us did not want to believe it, with the result that thousands of people who would have bought the best bicycle obtainable in pre-war days now have to go on their lawful occasions aboard the best obtainable to-day. But the great thing is they can still move over this "green and pleasant land," and though the movement may be restricted, the change of scene, the exercise and the good fresh air are to be had without any serious handicaps. Yes, the active folk who can ride a bicycle are fortunate, they have a holiday every week-end if they care to take it, and a real adventure when a string of days links leisure time. That is the best of cycling: your enjoyment does not depend on the miles you ride—though even these may give you a thrill—but rather on the fact that you are free as the wind that blows to come and go, to hurry or lounge, to linger and rest, and to change the vista with every corner that you turn.

Recognition of Holidays

THE announcement that war workers are to enjoy a further extra day's holiday at Whitsun and August is a fine gesture by the Government of the recognition that holidays are an essential part of present-day working conditions. Those few extra days will be a boon and blessing to millions, many of whom will spend them along the road travelling few or many miles away from their usual surroundings—it doesn't matter very much about distances—and the refreshment of mind and spirit will be exhilarating. When I first started work, hours were long and holidays rare, indeed many a business man in those times boasted that he never took a holiday and could not understand the then modern craze for desiring one. I think the rapid spread of cycling altered that early Victorian viewpoint very considerably, and I'm quite sure it inaugurated the week-end habit in the minds of thousands. In my very early teens I was a regular week-ender—or at least as regular as the cash position would allow, for it must be remembered there was no Y.H.A. then, and undoubtedly had such a project been discussed it would have been frowned upon by our elders. Nevertheless, we could and did enjoy our week-endings at a cost of 3s. 6d., or, if we were flush, another eighteenpence would see us enhancing the outing with a ham-and-egg tea. They were good days even if we did work long hours, but probably not at such high pressure as we work to-day; and I believe, in looking back at them, the wide spread of the week-end habit by cyclists was the beginning of a more sanely charitable view on the holiday question as a whole. When this war is over I think we shall go farther along the road of leisure time and slowly but surely still reduce the hours of labour until Saturdays are free, and the other five days are limited to eight hours' work each. That may sound optimistic, even Utopian, but then so would the working conditions of 1938 have seemed to the folk in middle age had such changes been prophesied in 1913.

Ease Before Immunity

I SEE some comment has been made regarding the introduction of a double inner tube so that in case of puncture the spare half tube vulcanised inside the ordinary one can be inflated and the rider go on his way rejoicing. How much that extra half tube is considered to slow down the tyre is not given, but that it must make the going harder cannot be denied. Years ago we had a self-sealing inner tube, the outer portion of which consisted of a band vulcanised in contraction on the ordinary tube, and except in the case of big bursts it worked. But it made the tyre sluggish, as did the various sticky mixtures invented to defeat the puncture bogy. These varying notions of rendering a tyre puncture-proof, though partially successful in themselves, never found great favour with the cycling public, and that at a time when punctures were far more frequent than they are to-day. Now a puncture is a rarity, and except for the risk of broken glass, I do not average one a year. For such immunity we have to thank the improvement in road surfaces, but more credit, I think, is due to our tyre builders and rubber chemists who have made the body and sole of our cycle tyres marvellously tough, resistant and resilient. Most tyre trouble comes from using worn covers to the last gasp, or carelessness in failing to deal with cuts. I know my light tyres give me easy riding and trouble-free journeying for approximately 7,000 miles, after which I consider I have had my full value, and in normal times replace them. Nor should I like to handicap their easy running by the fitment of heavy double tubes, for the risk of puncture is small, and the trouble of repair in these days slight, when compared with the times before the invention of the sticky back patch.

The Ease of it

I AM lucky in the ownership of several good bicycles, all multi-speed equipped, and at the moment have no right to babble of their value because of that fact. Yet the subject is forced on me by the ease with which I have just ridden 70 miles in a trifle under six hours. The journey was necessary, and the bicycle was the only available vehicle with direct contact. I did not hurry, for though I was scheduled at the other end to arrive at a certain hour, I gave myself time by making an early start. And it was as well, for a steady wind faced me along the whole route to put a steeper pitch on the hills. Riding a machine with cyclo derailleur (68in. 60in. 45in.), I suppose most of the mileage was covered on the very moderate high ratio, the slopes being the job for the 60in. and the tough bits found the 45in. at work, but not very vigorously. It was easy, despite the wind, and I made nearly 40 miles before taking or needing an hour's rest, followed by a very easy hour of riding on the re-start, and quite a gallop near to journey's end with the thought of tea in the offing. Could I have done that journey on a single gear? Yes, but not so easily, of that I am certain; and I'm certain too that the post-war bicycle will not be considered complete unless it is multi-speeded. Such equipment not only makes a difference to one's ease of riding, but to the mental condition that suggests you are fitted to meet anything in the way of the elements, inside a cyclone.

"Cat's Eyes"

THERE seems to me a very considerable difference of opinion among cyclists whether cat's eye studs marking road traffic lanes are a danger or otherwise. As one who uses over seven miles of road so decorated every night and morning, I am bound to confess the danger view had not entered into my consciousness, anyhow not until the question was raised in a serious manner at a meeting convened for the purpose of guiding cyclists' interests. Then I paid more attention to the studs, and did what I had never previously done before, deliberately rode over them and, candidly, the impact was quite cushiony. Now those studs are usually well away from the road track a cyclist is likely to take, are about 15 yards apart except at turnings, when the distance between them is reduced to about five yards, to give warning, I suppose, to the traveller of the adjacent turning, and on the arch of the turning itself they cease altogether. Quite frankly I admit they have been helpful to me on black nights and foggy ones, and I can realise the assistance they can render to the driver under similar conditions; but I have never found them the slightest danger, certainly not to be compared to the steel studs marking pedestrian crossings, especially during wet weather. So far as I know no official protest against their service has been sent to the Ministry of War Transport, nor do I think it should be, because they are not placed in our direct path, and are certainly useful guides under difficult road conditions. We cyclists can "protest too much" on matters mainly concerning the easing of travel for other road users, with the results that if we do, when we have a real case of grievance to put before authority, our voice will be weakened if it grows querulous. We cannot go back to pre-motor roads or conditions—and I'm not sure many of us would want to—but we can help to make a decent job of the conditions as they exist by the kindly service of compromise, and the cat's-eye stud, to me, seems to be a good example of that system.

The New Blackout

WE shall certainly be in a more comfortable position as regards illumination next fall. After much discussion and many experiments the Ministry of Home Security have at last agreed to the simple expedient of blacking-out the top half of the front glass, and the use of a reflector painted white, but not plated. I have been pressing for this return to simplicity since the winter of 1939/40, and now it has come think we have gone as far as we can expect to go until the end of the war. As a matter of fact this simplification of the blackout regulations as applied to cycle lighting ought to result in all of us abiding strictly by the letter of the law, which is more than can be said for the old form of blackout. No doubt the lamp manufacturers will be helpful now the new regulations are known and can so easily be applied, so that far less excuse will exist for non-compliance with the new order.

Club Notes

Edwards for Lanarkshire

GEORGE EDWARDS, the former Nightingale C.C. flyer, has changed his club. He is now riding for the revived Lanarkshire Road Club.

R.T.T.C. Chairman

PILOT OFFICER A. H. GLASS has once more been elected chairman of the Road Time Trials Council.

Poor Support

LACK of co-operation from the promoting clubs is holding up the calculations for the wartime championship of the Scottish Amateur C.A.

Club Jubilee

THIS year the Darlington Wednesday C.C. reaches its jubilee. The club was founded in 1893.

Quieter Course

FOR its recent open 25, the West of Scotland T.T.A. used a new course in North Ayrshire. The change was made because of increasing congestion on the busy Renfrewshire road usually used.

Scottish Road Programme

A TOTAL of 73 road events will be held this season by the clubs and associations affiliated to the Scottish Amateur C.A. This is rather more than last year, and the total includes several opens on behalf of the Cyclists' Red Cross Fund.

Hundreds at York

SOME hundreds of members of the National Clarion C.C. met at Easter at York, for the 49th annual gathering of the club.

Massed-start Decision

AFTER supporting massed-starts on the roads at its annual meeting, the Douglas C.C. has reversed the decision at a special general meeting, and now opposes such events.

Late Starts Troubles

NOW that later starts are being made for Scottish opens, some of the riders are finding that the rising winds of the late morning make the going slower than the quiet of the early day.

Speedy Novices

SOME fast times were clocked in the West of Scotland T.T.A. Novice 25, but the speediest rider proved to be J. H. Walker, West of Scotland Clarion, who recorded 1 hr. 8 mins. 41 secs.

East Scots Time

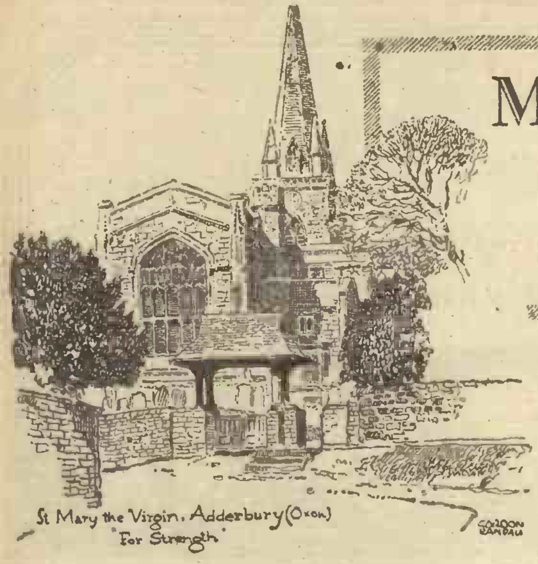
ONE of the fastest times of the early season was the 1 hr. 5 mins. 20 secs. clocked by Alex. Hendry, Glasgow Wheelers, in the Douglas C.C. medium gear open, in which gears were restricted to 72 in.

Douglas Presentation

SPEAKING to some 200 cyclists at the Douglas C.C.'s annual prize-giving, David Rattray, the Glasgow cycle trader who is Douglas president, said that he thought the sport and pastime would be better than ever after the war.

My Point of View

BY "WAYFARER"



St Mary the Virgin, Adderbury (Oxon) "For Strength"

IN the Government publication "Roof Over Britain," there is mention of an unnamed motorist who "had to smash up his car to avoid a suicidally-swerving cyclist." The statement lacks originality, is offensive, and is just about as one-sided as usual. It would be interesting to know exactly how much the motorist contributed to the cyclist's swerve. What was his condition? How was he driving? What warning did he give? Did he by any chance run so close to the cyclist as to *cause* the swerve? Personally, I am not convinced that the cyclist was intent on suicide! It doesn't ring true.

Looking Forward

IT speaks well for the eternal attraction of cycling that so many of us still look upon the pastime as one of the things that make life worth while—one of the things that give us something to anticipate week by week throughout the year. Over 50 years of wheeling experience stand behind me, and yet I find that "age cannot wither nor custom stale" the infinite variety of the game, which is just as fresh and delightful as it was in those far-distant days when I first mastered the art of balancing a bicycle. I say "just as fresh and delightful," but there is more in it than that, for experience has enabled me to drain the cup of happiness which I merely sipped half a century ago.

In the interim I have learnt how to ride a bicycle, how to get the best out of the game, where to go, and all the rest of it, with the result that I look forward right through the week to the arrival of Saturday, in the fairly certain knowledge that a few hours of liberty will be vouchsafed to me; that then I shall be able to obtain some strenuous exercise; that then it will be possible for me to do something in the way of assuaging my craving for fresh air. There is no "Black Monday" for me, for usually I have something pleasurable to look back upon in the way of my week-end jaunt, but each succeeding day of the week is better than its predecessor. Friday is a grand day, because it is the prelude to Saturday—and Saturday is full of promise, the performance of which adds a purple patch to life.

Sometimes, also, a spot of cycling is possible on the Sunday, and then my happiness is complete. These, of course, are simple pleasures—inexpensive pleasures—but long experience tells me that they are the best of all. In any event, I am satisfied with my circumstances, having regard to the fact that "there's a war on." My nose has to be on the "grindstone" for most of the week, but there come lucid moments when I can look back on the performance of last week-end: there come brighter gaps when I can look forward to the promise, the possibilities, of the week-end that is coming.

Departed Glory

ATTRACTED by a pile of metal scrap which was disfiguring the grass verge of a country road—one of the many such evil effects of these war-days—I dismounted to make a cursory examination. Departed glory was there in the shape of three cycle frames, one displaying the name-plate and the special fork-crown of one of our largest manufacturers. But "what a fall was there, my countrymen!" Gone the beauty of the glossy enamel which the bicycle had brought from its birthplace years ago! Gone the shining handle-bar! The frame was a study in russet, as though its recent abiding-place had been a river-bed. Gone all the glory, all the infinite possibilities, which belong to a good bicycle.

I found myself ruminating. Whose mount had it been? Had it taken its owner far afield, giving him the delights which come from exercise—and such exercise!—in the open air? Had it conveyed him to the distant portions of these gracious islands of ours and shown him the incomparable beauty which is to be found here, there, and everywhere? Through the agency of this magnificent instrument of travel had a cyclist been able to gaze from the Malvern Hills at the patchwork quilt of the Midland shires, and from the Bwlch y parc into the Vale of Clwyd, and from Morar to the full spread of the Hebrides, and from Slieve League at the pageantry composed of the mountains of County Leitrim and County Mayo, plus the eternal orchestra of the Atlantic creaming at the foot of Ireland's western wall? I do not know: these questions are not to be answered.

Colour Scheme

WE Britishers possess a reputation for our sombre habits of dress—a habit so firmly established that any radical departure therefrom is almost sufficient to bring on a Cabinet crisis. It appears to me, however, that the cycling boys and girls of to-day are doing their best to alter our habits in this respect. Whatever the results, the process, in my view, is commendable. I like the colour scheme adopted by our joyous young friends, ranging from the blues to the fawns, and thence to the reds, the greens, and the browns. There is no perceptible clash, and the scheme certainly does brighten up the Open Road.

On Easter Monday afternoon, as ever was, I had just finished negotiating a long-drawn-out hill in Shropshire, and had remounted my bicycle, when a bend in the road brought into sight a considerable group of young cyclists who were sitting on the grass verge, and even overflowing on to the highway itself—a thing you can do with impunity these days—having a "confab" of some sort. (A very nice spot for a committee meeting, I thought!) These lads and lasses were dressed in skirts, shorts, ice-cream jackets, lumber-jackets and jerseys, all of varied hues, and it struck me that the pattern of things was good to look upon—though, admittedly, I possess a strong bias towards cycling boys and girls, whom I view (in bulk) as the salt of the earth. The group certainly constituted a very pleasant dash of colour, which blended well with the surroundings.

As I went by with gathering speed, voicing the usual "Cheerio," I heard one of the girls say, obviously in reference to me: "And only a single gear!" I refrained from retorting: "Yes! and fixed at that! *And* only 63!" I felt more intent on getting to my chosen tea-place than on starting up an argument!

Heard Voices

PERHAPS the immediately preceding paragraph may justify me in remarking that I frequently hear voices which are not intended for my ears, but which concern me. The word "old" generally forms part of what I hear. For instance: "Here's old 'Wayfarer,'" or "Here's an old-timer," or "Hello! Granddad!" These heard voices are not to be resented, but on one occasion something was said which caused me to come to a standstill and retort, in the most friendly manner, that if the spokesman, who was fooling round on a bicycle, and thus wasting precious time, possessed some of my enthusiasm for the pastime in another 40 years, he would do well!

Curious Step

I AM mildly interested in a curious poster that has just made its appearance in a suburb through which I cycle daily. It is devoted to walking, and it gives a picture—no! not of a frying-pan, or a hypodermic syringe, or a rattlesnake, or a mouse-trap, but of a horse, and the wording consists of an urge to the populace to walk whenever possible, in order to relieve the pressure on public transport. The poster is the joint responsibility of the Ministry of War Transport and the Ministry of Labour and National Service. My interest, as I say, is of the mild type. I happen to be all in favour of walking—and I am certainly in favour of avoiding the use of public transport; so much so that I have not been in a train for nearly a year, and my average appearance in a bus or tram is far less than once a month. I go wherever I can on foot or on a bicycle. Why, then, only this mild interest in the dual Ministries' walking urge? Because I feel that, had the powers-that-be played their cards better, they might have done a bit of urging of the bicycle, as a tremendous saver of public transport. It is a great saver of time, too, and we are insistently told that "time is money." The authorities have not been too generous with their supplies of steel—and they have certainly made a mess of the cycle-lamp position. So, obviously, they are not in a position to boost the bicycle. And that's a great pity.

Notes of a Highwayman

By LEONARD ELLIS

A Mixture of Styles

ALTHOUGH there is a definite appeal in the Staffordshire villages they are not, on the whole, remarkable for their quaintness or their beauty. There are, of course, a few outstanding specimens that are very attractive, but as a class they are somewhat austere in their red brick. Unlike Shropshire, where black-and-white cottages abound, seeming to bring sunshine to a village even on a dull day, the old Elizabethan bricks tend to look drab and gloomy. A curious mixture of styles, Staffordshire and Shropshire, is to be found in Abbots Bromley, a favourite rendezvous of Midland cyclists. Here can be seen a fair amount of the Stafford red brick with several good examples of "magpie" that seem to have been borrowed from a neighbour. Apart from its appeal on this account, Abbots Bromley is most interesting from other standpoints. Here is an old market cross, 400 years old, standing on seven wooden pillars, and still in an excellent state of preservation. Market crosses are not too plentiful in this part of the country. Even older than some of its houses is the old Horn Dance. This now takes place early in September in connection with a fair, but its origin goes back many centuries and is religious in intention.

Robin Hood and Reindeer

A DOZEN people take part, all dressed in curious clothes and six of the men wearing reindeer horns on their heads. The other six are supposed to represent Robin Hood on a hobby-horse, Maid Marian, a jester, two musicians and a boy armed with a bow and arrow. The general belief is that the dance commemorates certain privileges won by the people in Needwood Forest during times of rigorous forest laws. The horns and costumes are kept by the vicar in the old church. The forest referred to is now only a shadow of its former self, and at one time was said to be nine miles across. To-day it contains some glorious woodland scenery, but only in isolated patches, where bluebells grow in the spring in profusion. Some of the finest oaks in England grow in Needwood Forest, but much of the timber has been felled in recent years.

The Market Cross, Abbots Bromley.

Around the Wheelworld

By ICARUS

At the Roadfarers' Dinner. Robert Williamson, Major H. R. Watling, O.B.E., J.P., E. Coles-Webb, Lord Brabazon, Lieut.-Col. Mervyn O'Gorman, C. G. Grey and H. W. Eley.

Mervyn O'Gorman and Lord Brabazon, chatting before the dinner.

H. W. Bartleet Passes

SO H. W. Bartleet has passed on. Nearly all his life he was associated with the cycling movement. He was actively associated with many clubs and was formerly manager of the famous Dunlop Pacing Team in the days when cycle racing, perhaps not so clean as it is to-day, would draw a crowd at Herne Hill, the Crystal Palace, or one of the many other tracks. Bartleet was an inveterate collector of photographs, old bicycles, and cycling literature, and I always prefer to regard him as the *librarian* of the cycle trade and pastime. If any problem, as to a date in cycling history, the name of an inventor, or the winner of a particular event arose, Bartleet was the man who most often was approached. He would then consult the contemporary journals, but, unfortunately, as journals of the past were not so carefully edited as they are to-day, they were quite often wrong, and hence so was Bartleet. It is true that the journals often corrected their mistakes in the following issue, but as the journals were not indexed, reference to the articles did not guide him to the correction. H. W. B. was one of the earliest contributors to this journal. His own book on bicycles, which is really a catalogue of the machines in his private collection, was sponsored by the Dunlop Rubber Co., but it did not do well, and itself contained some errors.

Apart from errors of fact, there were technical errors. For example, the book says in dealing with the Velocipede, that it is propelled by pushing the feet *forwards* on the ground. This, of course, would propel the machine backwards. In the hectic early days of THE CYCLIST, I well remember Bartleet calling to see me with a copy of this book, and when I indicated after a cursory glance the many mistakes, H. W. B. readily admitted them, although it was some time before he could see that he was wrong about the Velocipede. When C. A. Smith presented the original B.R. Cup to the club of which he was formerly a member, one of the vice-presidents of that body (oblivious of the fact that the dates were engraved on the cup itself), asked Bartleet to ascertain the dates of the events on which C. A. Smith made the winning rides. Here again, as the cup proved, Bartleet was wrong.

His collection of old bicycles, which later he generously presented to Coventry, contained several machines which are wrongly labelled. The most glaring error, however, concerns a bicycle which achieved fame—the machine upon which Hume, who died a few years ago, raced in that famous meeting at the Queen's College Sports, Belfast, 1889, when pneumatic tyres were used for the first time in a race.

Mrs. Jean McClintock, Dunlop's daughter, told me, however, that Hume's bicycle was destroyed. When I was busily engaged in preparing the Special Number of THE CYCLIST, to celebrate the Centenary of the Pneumatic Tyre, I ascertained from Hume himself that his machine was destroyed. Yet, prominent among Bartleet's collection is a machine carrying the label that it is Hume's machine upon which he rode in that famous race. Apparently it is not, and now that I have indicated the fact I hope that the Coventry authorities will investigate and endeavour to ascertain whose machine it was and whether it is entitled to a place in a collection at all. Bartleet was a keen admirer of that energetic cycling historian, H. H. Griffin, whose monumental work on the history of the bicycle occupied him in research for many years. Originally published by George Bell and Sons, Ltd., it remained out of print for many years until the copyright was purchased from George Bell, Ltd., by the proprietors of THE CYCLIST. This book was serialised in our weekly issues. Griffin, the historian, is dead. Bartleet, the collector, has joined him. They have both left their mark upon an industry and a pastime whose ranks are rapidly being denuded of those links with the lustrous past and the early days of our industry. A man of strong personality, it was natural that he should make many enemies as well as friends. He was, however, the first to acknowledge when he was wrong, and our pastime is the poorer by his parting. There is no one left imbued with the same desire to collect and collate. And so there will be a lacuna between Bartleet's passing and the arising of one to take his place.

Lieut.-Col Mervyn O'Gorman reading his paper on road accidents.

The Charlotteville "50" Result

I REGRET that I was not able this year to be present nor to assist in the Charlotteville C.C. open "50" on Easter Sunday. This is one of the few events I like to attend. The first three places are: 1, F. Pape, Ealing Manor, in 2 hrs. 10 min. 16 sec.;

2, G. H. Fleming, Ealing Manor, 2 hrs. 10 min. 47 sec.; 3, D. K. Hartley, Dukinfield C.C., 2 hrs. 12 min. 25 sec. The team results are: 1, Altrincham Ravens C.C., aggregate 6 hrs. 45 min. 29 sec. (Team: K. Radford, C. Farebrother and R.A. Bamforth); 2, Ealing Manor Road Club, aggregate 6 hrs. 48 min. 12 secs.; 3, Dukinfield C.C., aggregate 6 hrs. 50 min. 38 sec.

Giving Our Tyres a Longer Life

IT is a hard grim fact that over 90 per cent. of the world's natural rubber resources are in enemy hands.

Accordingly, every rubber tyre is a precious possession which deserves the most careful treatment. Every cyclist should regard his mount as being shod with equipment that may be irreplaceable. Here are some points which should be borne in mind in order to give your tyres the longest possible life. Under-inflation is the cause of 99 per cent. of premature cycle-tyre failures. Pump your tyres up hard, and you will reduce tread wear to a minimum.

Slow punctures or perished valve rubber are subtle thieves of tyre miles. Such faults should be dealt with immediately. Valve rubber does not last for ever, and if the pressure in your tyres is being lost, the valves should be tested. They should be renewed at once if there are signs of perishing. If, though the tyre be inflated before each journey, there is a slow puncture, falling pressure will cause fatigue and failure in the casing. Avoid riding a bicycle over the kerb or into a pothole except at low speed, as such an impact will often cause a fracture.

Except in emergency, brakes should be used gently. Fierce braking causes excessive wearing of the tread rubber. Fast cornering has a similar effect on the tread rubber, and also throws great strain on the canvas casing. Take corners gently. As oil is harmful to rubber, care should be taken to keep tyres free from it. Especially should you try to ensure that oil from the hub does not find its way down the spokes and become absorbed by the rim tape.

If the wheels are running out of alignment, excessive wear on the treads will result. Feathering of the tread pattern will reveal this condition.

See that the driving wheel is correctly adjusted, as otherwise there may be chafing of the tyre walls. Take great care when you are fitting and removing tyres, as damage may be done to both cover and tube. Use only levers which are properly designed. A badly fitted tyre will wear unevenly and quickly. The rim tape should be fitted centrally, or the tube will be damaged by contact with spoke-heads and nipples.

Road Accidents—March, 1943

OF the 529 persons killed on the roads of this country in March, no fewer than 151 were children. The injured numbered 9,238 and included 1,904 children.

Although these figures show an improvement compared with March of last year, the number of road deaths is till above the pre-war level. The proportion of children among the victims of road accidents has risen from about one in six in March, 1939, to about one in five.

Death of Hans Renold

HANS RENOLD is another of the pioneers who has gone. He was responsible for introducing a piece of bicycle equipment—the chain—which deserves to rank in importance with the pneumatic tyre. He took the keenest possible interest in bicycles, and in the company with which his name was associated, and wrote many papers on the subject of chains and chain transmission, which his company manufactured not only for bicycles, but for all forms of transmission. He was in his 91st year.

The Roadfarers' Club Dinner

MERVYN O'GORMAN was the principal speaker at the Roadfarers' meeting at the Clarendon on April 16th, when the subject was "Road Accidents," reported elsewhere in this issue. This important and exclusive national club has held many meetings at which important road topics have been debated. This latest meeting, however, was even more successful. Nearly 70 members sat down to dinner under the chairmanship of Lord Brabazon of Tara. Around the tables I noticed Major H. R. Watling, O.B.E., J.P.; Robert Williamson, Francis Lewcock, C. G. Grey, Captain Bowen, W. G. James, J. Callway, W. J. Bassett-Lowke, D. H. Brown (County Surveyor for Warwickshire), Major A. Warren Lambert, J. M. G. Rees, Colonel E. Jenkins, C. A. Smith, Major Morfey, J. D. Daymond (chairman of council), E. Coles-Webb, J. A. Masters, W. H. M. Burgess, A. H. Bentley, W. Hinds, T. D. Bell, Peter Hunter, Maurice Newnham, Sir Arrol Moir, H. W. Eley, J. E. Rawlinson, Dudley Noble, Rex Coley, A. J. Ballantyne, W. J. Mills, A. T. Bradford, T. D. Osborn, E. P. Richford, R. A. West (secretary), H. C. Scotto, H. W. Payne, T. M. Craft, and H. C. North. Mervyn O'Gorman was convincing and devastating in his attack on our road problems, and his appeal for scientific research into the causes of accidents. His facts and figures were masterfully marshalled. C. G. Grey responded, and, incidentally drew forth a tribute from Lord Brabazon. The toast of the Press was in the hands of W. J. Mills, with a reply by Mr. H. W. Eley, and the toast of the Chairman was proposed by Major H. R. Watling. It was a most interesting evening.

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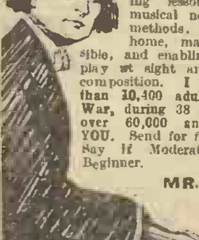

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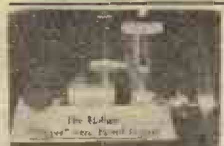

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