PHOTO-ELECTRIC CELLS

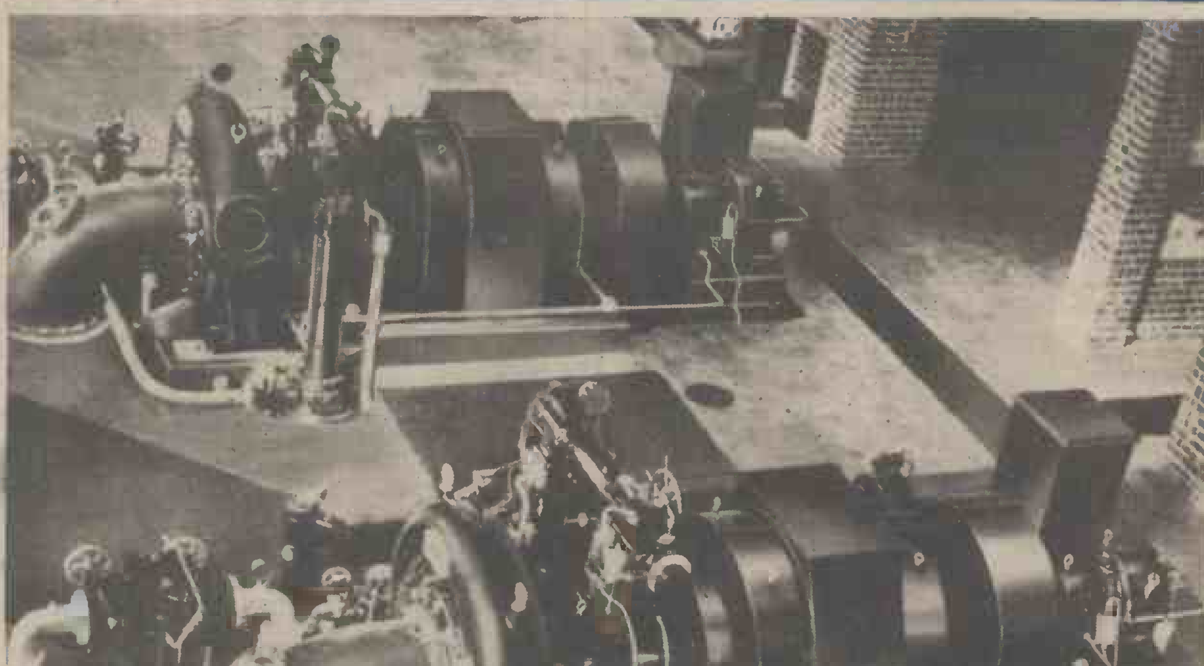
NEWNES

PRACTICAL MECHANICS

9D.

EDITOR: F. J. CAMM

SEPTEMBER 1946



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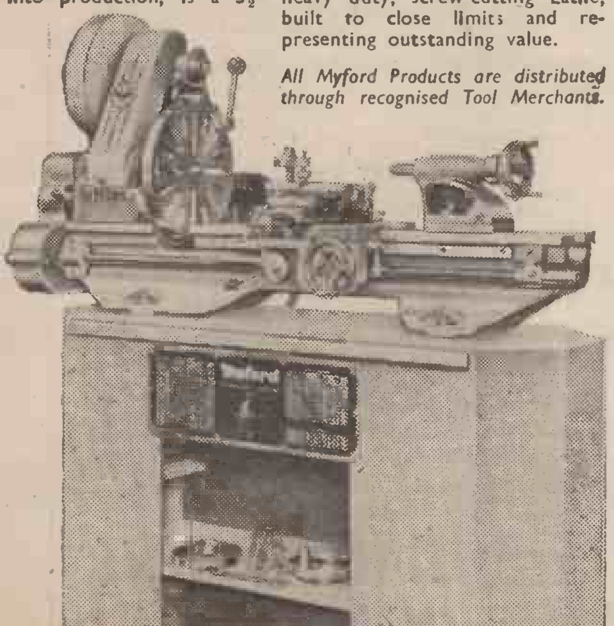

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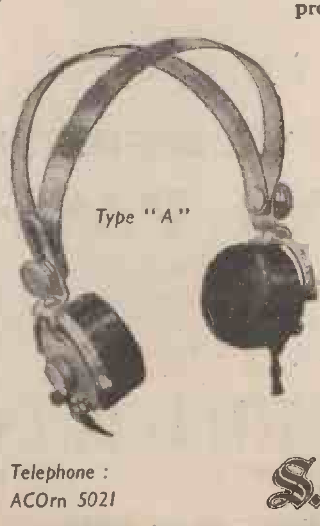

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PRACTICAL MECHANICS

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

Editor: F. J. CAMM

VOL. XIII SEPTEMBER, 1946 No. 156

FAIR COMMENT—BY THE EDITOR

The Model Engineer Exhibition

OUR readers are cordially invited to visit our Stand No. 14 at the Model Engineer Exhibition now running at the Horticultural Hall. Apart from the full range of our technical periodicals and books, as well as blueprints, which we shall exhibit, readers will be able to inspect my new automatic pump for bicycles and motor-cars which inflates the tyres as you go along.

The pump will be shown fitted to an ordinary bicycle. It may be attached to any bicycle by means of two screws, and the pumps will keep the tyres inflated even when they are punctured. A valve is incorporated to ensure that the tyres are not over-inflated. It is almost effortless in operation. Its great advantage is that it may be attached to any bicycle without structural alteration of any sort, and it represents a most important step forward in pneumatic tyre technique.

Our telephone number at the exhibition is Victoria 3385, and the attendants will be able to inform readers as to when I shall be available.

The exhibition itself, the first since the war, will contain a great variety of ingenious working appliances, model railways, model aircraft, inventions, model boats, tools and materials. My old friend, Percival Marshall, is to be congratulated upon reinstituting this national exhibition so soon after the war.

German Patents

A CONFERENCE to consider the question of the future treatment of German-owned patents in Allied countries took place in London recently. Delegates attended from Australia, Belgium, Canada, Czechoslovakia, Denmark, France, Luxembourg, Netherlands, Norway, Union of South Africa, United Kingdom, United States of America.

The chairman of the conference was Sir Harold Saunders, the Comptroller of Patents in the United Kingdom.

Patents taken out by Germans exist in varying numbers in all countries of the world. Complete unanimity prevails among the Allied Nations that in no circumstances shall any such patents within their territories revert to the former German owners, and the question as to how such rights shall in future be disposed of presents many difficulties. A strong sentiment prevails that it would be unfortunate if the continued existence of these patents should constitute an obstacle to international trade.

As a result of the discussions at the conference, the representatives of France, the Netherlands, the United Kingdom and the United States of America have signed an accord which will have the effect of making all patents of former German ownership now controlled by their Governments, and in which there is no non-German ownership now controlled by their Governments, and in which there is no non-German interest existing on August 1st, 1946, available within their respective territories to all nationals of the countries partly to the accord without payment of royalties or without any requirement to manufacture within the country where the patents exist. The representatives of Australia, Canada, Czechoslovakia, and the Union of South Africa have agreed to recommend to their respective Governments that the accord should also be signed on behalf of those Governments.

Representatives of Belgium, Denmark, Norway and Luxembourg feel that the special difficulties which exist in their countries render it necessary for their Governments to give a more detailed and closer examination of the provisions of the accord before coming to a decision as to their policy.

As stated above the accord has been signed by four countries, and it remains open for signature by other members of the United Nations and by neutral countries until January 1st, 1947. It will come into force as soon as it has been signed by three further countries provided they sign before the end of 1946.

International Contest for Power Driven Model Aircraft

THE Society of Model Aeronautical Engineers recently held their annual Contest for the Bowden International Trophy, at Heston Airport, London.

This contest was confined to machines equipped with miniature internal combustion engines, and the rules had been drawn up to bring out the inherent flying qualities of the machines and to demonstrate the control which the owners have over the machines whilst in flight.

There were visiting entrants from Holland, France, Ireland and Belgium. Some interesting machines with tiny engines ranging from 1 c.c. capacity (about the size of a thimble) to 10 c.c. (which is about as large as an egg cup), competed.

Machines driven by the new Auto Ignition engines which are entirely devoid of the usual ignition equipment also took part and afforded an interesting comparison with the orthodox power plant.

Training for Electronic Engineers

THE rapid development in electronic science and its new applications in the last few years has created a great need for technical training, and there is an urgent necessity for such training to be provided in Great Britain if we and our Empire are to retain our position in the forefront of this new industry. Such training will be required on a much wider and deeper scale than can be handled by existing facilities. It must provide an effective combination of basic training and practical experience.

This has been realised by E.M.I., Ltd., who have embarked upon a courageous educational enterprise. They were one of the pioneers of television, and other allied electronic applications. They developed the electronic television system which amazed the world and was adopted by the B.B.C. in 1936.

This company backed by its great resources has now decided to create an organisation which shall provide training over the whole sphere of the electronic sciences catering for the needs of all types of students.

A new organisation known as E.M.I. Institutes, Ltd., has been formed, charged with the ambitious duties of providing schemes of training which shall become Empire wide and later world wide. The scheme is designed ultimately to ensure for the Empire an ample supply of scientific workers who will play their part in securing leadership for Britain in this new sphere of scientific development. The new institute will be governed by Professor H. F. Trewman, M.A.(Cantab), M.I.E.E., M.I.Mech.E., whose qualifications are widely known. Prior to the war he was responsible for controlling the technical training of officers for the various technical branches of the army. E.M.I. Institute as a first step have acquired the London Radio College for their new headquarters. Those wishing to take up training should write direct to E. M. I., Ltd., Sheraton Works, Hayes, Middlesex.

Electrical and Chemical Queries

WILL readers please note that owing to staff shortage we are unable to deal with electrical and chemical queries. Whilst we are dealing with the subject of queries, may we point out that we cannot undertake to prepare special designs, nor to answer queries which involve the preparation of illustrated articles.

End of Volume XIII

THIS issue completes Volume XIII, and readers are advised to obtain a copy of the index, which may be obtained for 10d., post paid, from the Publisher, George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2.

Aircraft Heating Systems

Details of Components and Duct Installations

By BASIL JACKSON, A.R.Ae.S.

AN efficient heating and ventilating system is a necessity for all modern aircraft. Due to the high altitudes at which military and civil machines operate, both cockpit and passenger cabin air temperatures must be maintained within reasonable limits. It is also necessary to install means of heat control in aircraft which cruise at moderate altitudes, because cabin air temperatures, in such cases, are also governed by local climatic conditions.

There are two main systems in use, viz:

(1) Heating air by means of a water boiler.

(2) Heating air directly by a muff-type heat exchanger.

Both systems make use of the engine exhaust gases as a source of heat, but differ in the method of application. Dealing with the boiler system first, a diagrammatic arrangement of a typical layout is illustrated in Fig. 1. It will be seen that the main components required are a water tank, boiler, and radiator. The boiler is constructed around the engine exhaust manifold and is connected by a pipe to the underside of the water tank. The hot exhaust gases raise the temperature of the water in the boiler and generate steam, which is passed to a small radiator inside the aircraft. Cold air, drawn in by an intake fairing in the slipstream, flows through the radiator and condenses the steam. The cold air picks up heat in the radiator and is passed into ducts, where it emerges at certain points in the cabin and cockpit. The water resulting from the steam condensation is returned to the boiler.

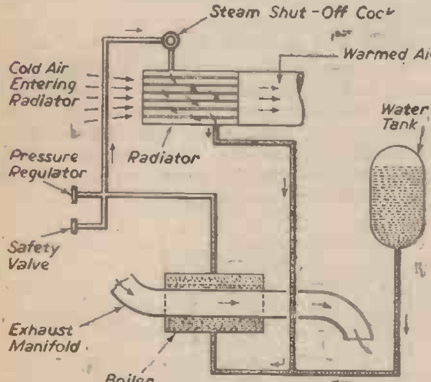


Fig. 1.—*Steam heating system.*

The steam pipe from the boiler to the radiator is tapped by a pipe incorporating a pressure regulator. This operates on the spring-loaded diaphragm principle, and maintains a constant pressure in the system. When the pressure rises above the permitted maximum, excess steam is ejected through the regulator outlet. Adjacent to the regulator, and from a union on the main steam pipe, is a safety valve. This is set to blow off at a slightly higher pressure than the normal working pressure of the regulator and is installed in case the latter fails to operate.

Water Tank

The water tank, if mounted some distance from the boiler, may be manufactured from aluminium (Fig. 2). The shell is made in three pieces: a main body constructed from sheet and welded along the seam, and two semi-spherical ends, beaten from flat sheet. Two circular stiffening members are riveted inside the extremities of the body before the end pieces are finally welded to it. The rivets are ⅛in. in diameter, and pitched at approximately 1in., a soft aluminium washer being inserted under each rivet to maintain a watertight joint.

A filler neck is welded to the upper end of the tank in such a position that the tank cannot be completely filled. The lower end of the neck is flanged and shaped to the contour of the tank. A threaded sleeve, of aluminium alloy, is riveted to the top of the neck, and to this is screwed the filler cap.

The water pipe outlet connection at the tank base consists of an externally-threaded adaptor welded to the shell.

Mounting of Tank

The tank is mounted on a cradle bolted to the fireproof bulkhead in the engine nacelle (Fig. 3). The cradle is constructed from aluminium alloy and has two straps of the same material hinged at the outside edge.

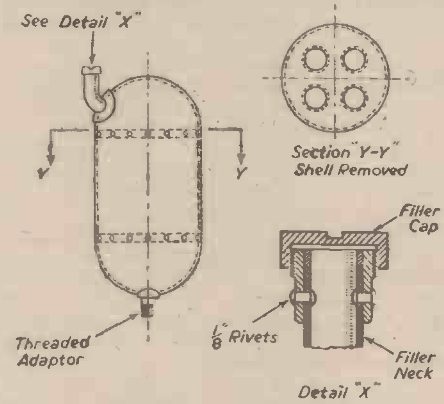


Fig. 2.—*Construction of water tank.*

These straps are located around the tank and bear on the shell adjacent to the two internal stiffening members to prevent distortion. A 1/16in. thick strip of cork or felt is cemented to the inside of each strap to reduce the risk of chafing due to vibration in flight. It will be seen that the two trunnions in the cradle serve as anchorages for the turnbuckles at the extremities of the straps.

Boiler Construction

The boiler can either be constructed integrally with the exhaust manifold or made separately and thus detachable for inspection purposes. An example of the former method of manufacture is shown in Fig. 4. The outside shell is of steel, similar in specification to that used for the manifold, and is made

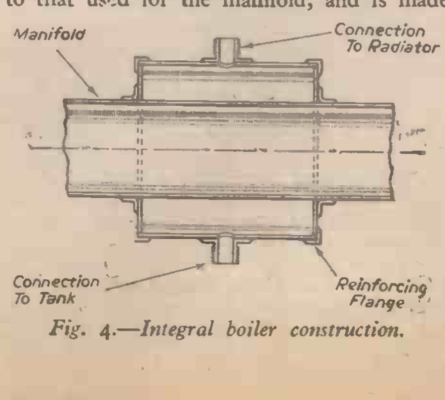


Fig. 4.—*Integral boiler construction.*

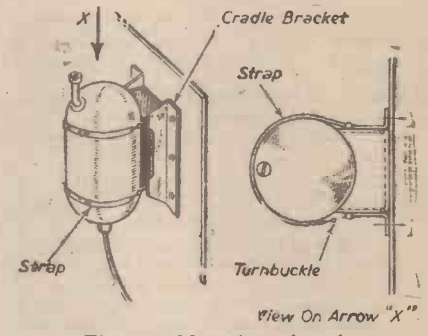


Fig. 3.—*Mounting of tank.*

from flat sheet bent to shape and welded along the longitudinal seam. The circular end plates are butt-welded to the main body and attached to the manifold by welding around the periphery of the hole. A reinforcing flange is then welded around the joints.

The inlet connection from the water tank pipe comprises an adaptor with a steel flange, which is welded to the bottom of the boiler.

A detachable type of boiler is illustrated in Fig. 5. The circular end plates, in this instance, are not welded directly to the exhaust manifold, but attached to a steel sleeve. This is bolted to the manifold, the bolts assembling in slotted holes in the sleeve to allow for the expansion of the two manifold sections when heated.

Detachable boilers are sometimes constructed from brass, in which case the seams and joints are brazed. Whatever the material used, it is important that the boiler be subjected to a bench test before being installed on the aircraft. The usual practice is to fill the boiler with compressed air at a specified pressure to ensure that the seams do not show signs of failure.

Radiator

This consists of a large number of .008in. thick copper tubes approximately 12in. long and with a common diameter of .25in., positioned lengthwise between perforated metal frames (Fig. 6). The ends of the tubes are sealed to the frames in such a manner that a space of .05in. exists between the external surfaces of neighbouring tubes.

The tube array is then covered with a thin steel or copper casing, which is attached to the frames at each end. A steam pipe adaptor connection is riveted to the upper surface of the casing at the forward end and another, for carrying water, is similarly attached on the lower surface at the aft end.

This type of radiator is a scaled down version of the normal oil cooler used for aero-engine lubrication systems.

Installation

The radiator is commonly mounted in the cabin roof of twin-engine aircraft and sometimes on the fuselage side of single

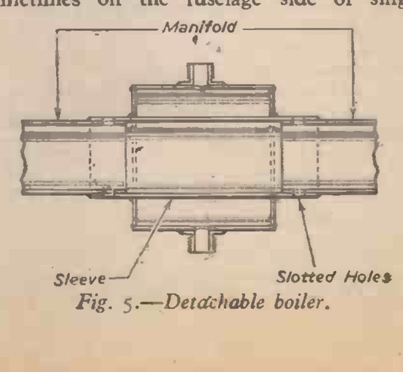


Fig. 5.—*Detachable boiler.*

engine machines. The frames are carried inside an aluminium fairing, the forward section of which forms an air intake in the slipstream. The frontal area of the intake is approximately twice that of the radiator, and has a by-pass duct leading over the top of the radiator. A butterfly valve is incorporated in the by-pass, and is controllable from the pilot's cockpit. By this means, the pilot can vary the proportion of heated and cold air admitted to the cabin. This is in addition to the steam shut off cock which prevents steam from entering the radiator. Thus cooling air can be ventilated around the cabin as local weather conditions dictate.

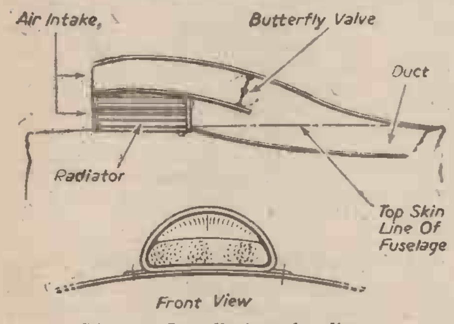


Fig. 6.—Installation of radiator.

The large diameter duct from the rear of the radiator is made from welded aluminium sheet. It is carried along the cabin roof for a short distance before branching off into smaller ducts which lead to specific warming stations in the aircraft. On military machines these stations include the astrodome, all gun turrets, navigator's and radio operator's compartments, and the pilot's hand and foot warmer outlets. Sometimes a duct is used to discharge heated air between a transparent panel, attached to the windscreen structure, and the windscreen glass to prevent the formation of ice on the outside surface of the latter.

As an alternative to aluminium, branch ducts may be manufactured from plastic impregnated laminated paper. This makes a very light duct possessing good heat insulating characteristics.

Where maximum flexibility is required, as in the case of the pilot's hand warmer, the fixed duct is connected to one which can be manœuvred into various positions. These ducts are approximately 2in. diameter at the outlet and are made from aluminium. They are built up on the domestic gas hose principle, the aluminium strip being flanged and spirally wound into pipe form.

In some heating installations the whole of the cockpit is warmed by fitting extractor fairings in the skin plating of the nose fuselage. Fig. 7 shows a typical layout based on this system. The main duct from the radiator is not branched forward, but empties hot air into the centre portion of the fuselage. The heated air is then drawn forward into the cockpit, due to the pressure drop caused by cold air being withdrawn into the slipstream.

On large airliners it is often necessary to provide each passenger with an individual hot air control. This is accomplished by leading the main ducts along each side of the fuselage, between the outer skin plating and the cabin wall panels. Adjustable louvres in the wall panels can be opened in intermediate stages to suit personal requirements.

The steam and water pipes connecting the boiler to the radiator are of corrosion-resisting steel, and are lagged with asbestos tape, ¼in. thick and 1in. wide, to curtail heat losses.

Precautions

The system is filled with distilled water. If impure water, or even tap water, is used, the life of the boiler and the pipelines is considerably reduced. Another important point is that the complete installation has to be drained if the aircraft is grounded in freezing weather conditions.

Muff-type Heat Exchanger System

This system differs from steam heating, in that the temperature of the ingoing air is raised directly by the engine exhaust.

It will be observed from Fig. 8 that cold air enters the pipe protruding forward of the exhaust manifold and passes through a muff constructed around the latter. The cold air picks up heat from the exhaust gases and in turn reduces the temperature of the manifold. This is an advantage, as the working life of the manifold is thereby increased.

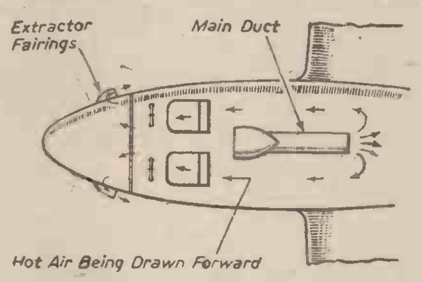


Fig. 7.—Ducting system for multi-engined aircraft.

Leaving the heat exchanger, the warmed air is conveyed in a duct to the valve chamber.

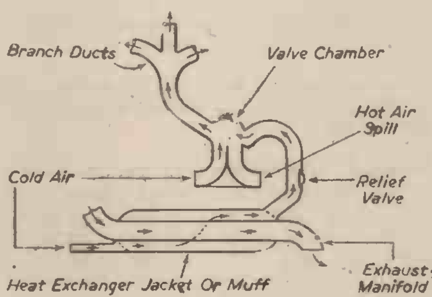


Fig. 8.—Muff-type heat exchanger system.

This consists of a flat-sided circular aluminium box with four outlets around the periphery. A central spindle carries a butterfly valve which is inter-connected, by a rod linkage, to a lever in the cockpit. The various settings of the valve are shown in Fig. 9. Duct "A" conveys cold air from an intake under the fuselage and ventilates the cabin. Duct "B" is a spill outlet for the hot air from the heat exchanger when only cooling air is required. Intermediate positions of the control lever vary the proportion of hot to cold air.

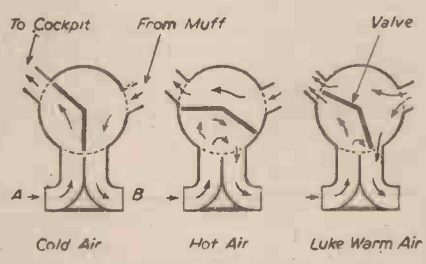


Fig. 9.—Settings for valve chamber.

As a safety precaution, a relief valve is located in the duct adjacent to the manifold muff. This is connected by wire control to a small lever in the cockpit, and is operated when the air admitted to the interior of the aircraft, even when diluted with cold air, becomes excessively hot. On some machines this valve is thermostatically controlled and electrically connected to a warning lamp on the dashboard.

The fairing over the external air intake is produced from aluminium sheet and welded to a stiff flange which is screwed to the fuselage skin. The large diameter duct from the muff to the valve chamber is of light gauge steel, lagged with asbestos tape. The remainder of the ducts in the fuselage are made from aluminium, or laminated paper, similar to that used for steam heating systems.

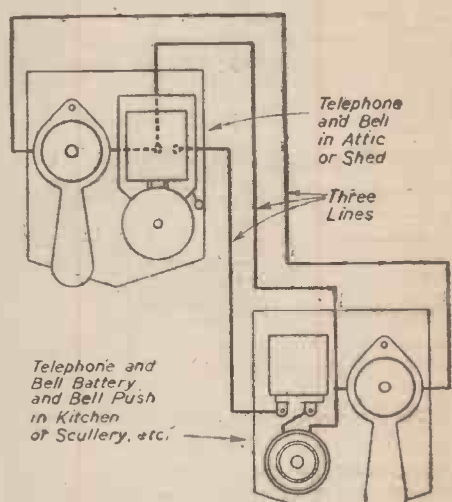
The muff is manufactured from heat-resistant steel and is welded integrally with the exhaust manifold. Muffs are sometimes built with baffles riveted inside in order to guide the incoming air in a more precise manner around the manifold to pick up a greater amount of heat.

The problems connected with the heating of pressurised cabins are numerous. The air, in this case, is heated after it leaves the compressor, and the difficulty, at present, is that of successfully humidifying large volumes of hot air. If this is not done efficiently, the heated air will be uncomfortably dry.

On aircraft powered by pure jet or turbine driven propeller engines, the cabin may be warmed by passing cold air into heat exchanger jackets around the jet efflux pipe.

Home-workshop Telephone: A Correction

In the article on A Home-workshop Telephone, which is published in our August issue, there is a slight error in the connections given in the wiring circuit, Fig. 6, on page 395. The bell push is shown directly connected across the battery terminals. One of the leads to the battery should, of course, be broken to take the push, as indicated in the accompanying diagram.



Amended wiring circuit for home-workshop telephone.

Photo-electric Cells

Some of their Applications for Industrial Purposes

By P. BOUSFIELD

IT is surprising how many ways there are of utilising photo-electric cells in science and industry. Some of these applications will be dealt with in this brief survey of the subject, and they are none the less interesting by reason of the diversity of their use.

As it would be rather pointless to describe here the complete circuit connected to the cell arrangement in an article concerned with applications rather than design, let us assume that the reader has already familiarised himself with the general principle of electrical circuits and just refer to the electrical operating factor as the "circuit."

Basically the photo-electrical cell device is composed of the following:

(a) A source of light.
(b) an intermediate space, and
(c) a light sensitive cell,

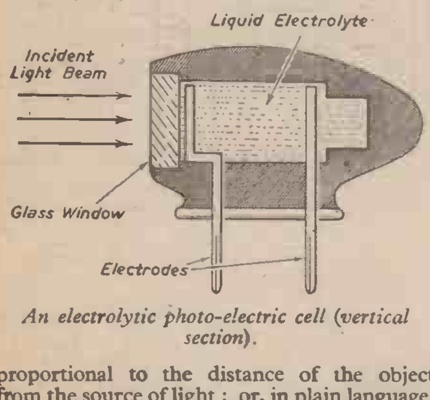
and, of course—the operative "circuit."

To understand the applications, we must firstly refer in brief language to these three components—one at a time in the same order as set out above.

(a) Source of Light

This we consider quite simply as an ordinary electric bulb—just as we use in the home; but with an important proviso, which is that whereas domestic bulbs are of widely spaced wattage, the "light source" of our electric cell device may require to be of a carefully calculated intensity according to the medium present in the intermediate space (b), and the effect required upon the "light sensitive cell," (c)—which factors are dealt with below.

While mentioning the light source we might, in passing, remember that the intensity of light at a said object—as at (c)—is inversely proportional to the distance of the object from the source of light; or, in plain language, if you go twice as far from the light it will be half as strong, or intense. But variations of (b) will affect this!



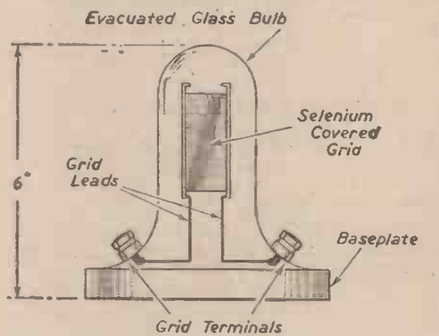
An electrolytic photo-electric cell (vertical section).

(b) The Intermediate Space

It is this space which provides all the interesting variations, and from which proceed all the interesting applications of the photo-electric arrangement. The reader will readily appreciate that if the light source is designed to influence the light sensitive cell at a distance from it, then the extent of the influence of the light on its counterpart (c) will not be the same if acting through ordinary air at (b) as it would if there were something at (b) which caused the light to be absorbed either partly or entirely. Here, then, is the key to the industrial usefulness of the device—and the scope of these mediums will be dealt with as the final section of this article.

(c) The Light Sensitive Cell

This can be referred to objectively as the receiving end for the light for which it is the sensitive recipient and by which it is activated in conjunction with the circuit. For the purpose of this article it is sufficient to understand that the cell is sufficiently sensitive that the slightest appreciable modification in the intensity of the light as received can be recorded by suitable apparatus; so let us now turn to the really interesting angle of this modern device which is its manifold applications.



Section through a selenium conductive photo-electric cell.

General Applications of the System

The first application which comes to the mind of the writer is that which was used at the Science Museum in South Kensington some years ago. Perhaps a number of readers have operated the device without knowing it! In this case the medium at (b) is the human being passing between the light source and the cell. In this way every person passing through a turnstile or barrier can be counted. Of course, there must be an interval—if people went through in a bunch this would only constitute "one" medium; but a turnstile (which actually may be a "self recorder"), spaces the people out and enables the cell to register each person as "one" medium and record as such.

The system has a widely different application where it is applied for recording the frequency of trains. In some of London's underground tube stations the train entering the station becomes a medium of light interference in the path of the photo-electric cell device there installed, and through the medium of the circuit and subsidiary mechanism the exact time of the "interference" is suitably recorded and gives interesting statistics, e.g., the "rush hour" train service as compared with other times of the day.

Taking again a very different example—amongst many—we can study in brief how the cell device can be usefully employed on board ship. In some of the latest applications the medium is sometimes "smoke" or even "oil," and whatever the use may be it is always a question of a variation in the "medium" (b) which it has been stated can be solid, or liquid, provided that the components are designed to give the required amount of reaction according to which type of "interference" of the light is under consideration.

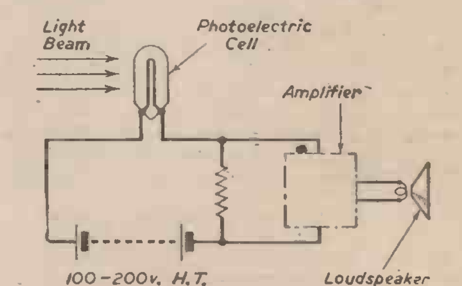
Applications Embodying Alarm System

The article would be prematurely concluded if reference were not made also to the fact that in the "circuit" may be incorporated an alarm system. The particular usefulness of an "alarm" device is that when conditions are not as they should be, there will be an audible reminder for, shall we say, the captain on the ship's bridge or the engineer in the engine-room, according to where the audible alarm is caused to operate.

With an alarm bell in the circuit a warning of — shall we say — fire in the ship's holds can be given when, for example, the smoke from a fire passes between the light source and the light sensitive cell. What then happens is that the smoke causes obscuration at the medium (b) and thereby makes or breaks the circuit (according to which arrangement is used), and this activates the bell and gives the required warning.

Concluding Remarks

The writer would like to add that when the medium of interference is something only semi-opaque, such as smoke or oil, then the light source must be of a more mathematically determined intensity and, generally speaking, the completely obscuring mediums are more easy to cater for than those which are either slightly or partially opaque.



The photo-electric cell incorporated in this circuit is made to operate a loudspeaker.

The Victoria Falls Hydro-electric Plant

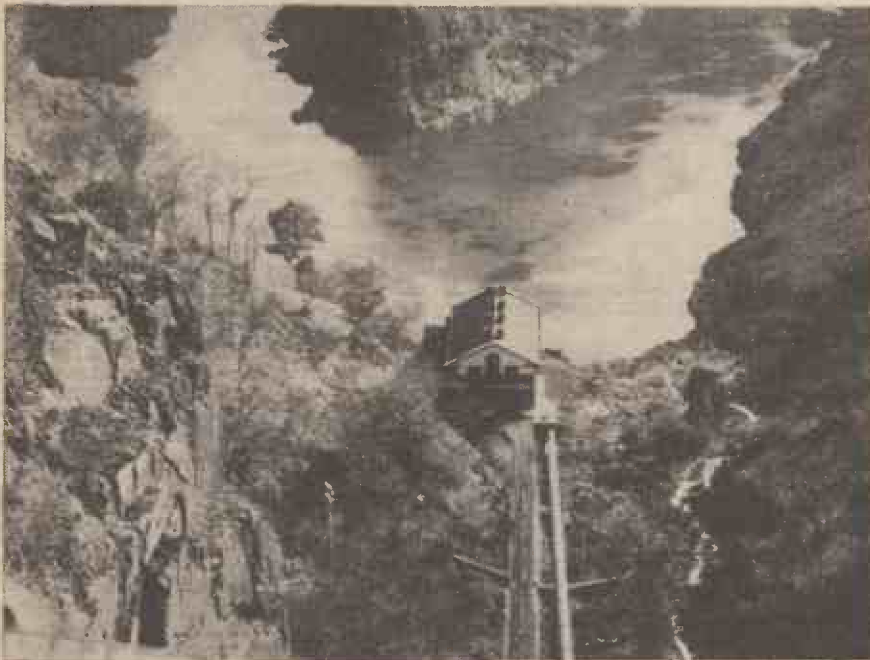


Fig. 1.—Victoria Falls power station. The lower portion of the track is seen beside the pipeline.

Details of this Important Undertaking by The English Electric Company on the Zambesi River, in Southern Rhodesia

THE Victoria Falls and Transvaal Power Company completed in 1938 a very successful hydro-electric scheme at the Victoria Falls on the Zambesi River, and though this development is small in capacity, it is of particular interest since it is the first to be undertaken at the famous Falls and is completely automatic.

About 30 years ago a proposal for supplying the Rand with power from the Victoria Falls was studied, the overhead transmission line was to be 700 miles in length, and the pressure 150,000 volts. Owing to technical difficulties this project could not be realised at that time, but the Power Company retained its right to develop the power at the Falls if required at some future date, and the scheme just completed is the outcome of that arrangement.

The generating station is situated in the third gorge, known as the "Silent Pool," at a hairpin bend in the river about two miles downstream from the Falls. It contains two 1,000 kW. automatically controlled units, the purpose of which is to generate power for transmission over a distance of about seven miles to the town of Livingstone, until recently the capital of Northern Rhodesia, and also over a distance of about two miles to the Falls Hotel which, with the generating station itself, is in Southern Rhodesia.

Towards the end of 1936, a comprehensive contract was placed with The English Electric Company for the power station and sub-station equipment to the arrangement and specification of the London Engineering Department of the Power Company, comprising water turbines, generators, transformers, switchgear, cables, etc. On March 16th, 1938, the new power station was opened by Sir Hubert Young, K.C.M.G., D.S.O., Governor of Northern Rhodesia, who, by pressing a button, started up the first unit under automatic control, and Lady Young afterwards switched in the supply to Livingstone.

In addition to the two purposes mentioned above, the plant will be able to supply any small industries which may spring up round the town of Livingstone, and since Northern Rhodesia is a wealthy and rapidly developing Colony, Livingstone may eventually become the centre of an active industrial area.

Several factors rendered the contract more than usually difficult to carry out.

The power station site is very remote, all plant after conveyance by rail from Livingstone had to be unloaded into trucks on a narrow gauge railway and pushed by native labour some two miles to the top of the gorge. It was then lowered down a very steep gradient by a steam-operated hoist. The track, which runs beside the 42in. diameter pipeline, is shown in Fig. 1.

The climatic conditions are damp and tropical and were exceptionally trying for the erecting staff, the engine-room temperature at times reaching as much as 110 deg. F. Such conditions were also somewhat unfavourable for the operation and maintenance of the instruments, delicate relays and other apparatus necessary for an unattended station. With the ready co-operation of Mr. N. Brooksbank, the Chief London Engineer of the Power Company, all these difficulties were, however, overcome, and The English Electric Company once again demonstrated its capacity for the successful execution of comprehensive hydro-electric work in remote places and under unpromising conditions.

Owing to the fact that the site is a famous beauty spot, great care was taken by the Power Company in South Africa to obviate disfigurement, and this has been so successful that the power station and penstock are practically hidden by vegetation from passers-by. Fig. 1 shows the unobtrusive nature of the building, which harmonises with its surroundings.

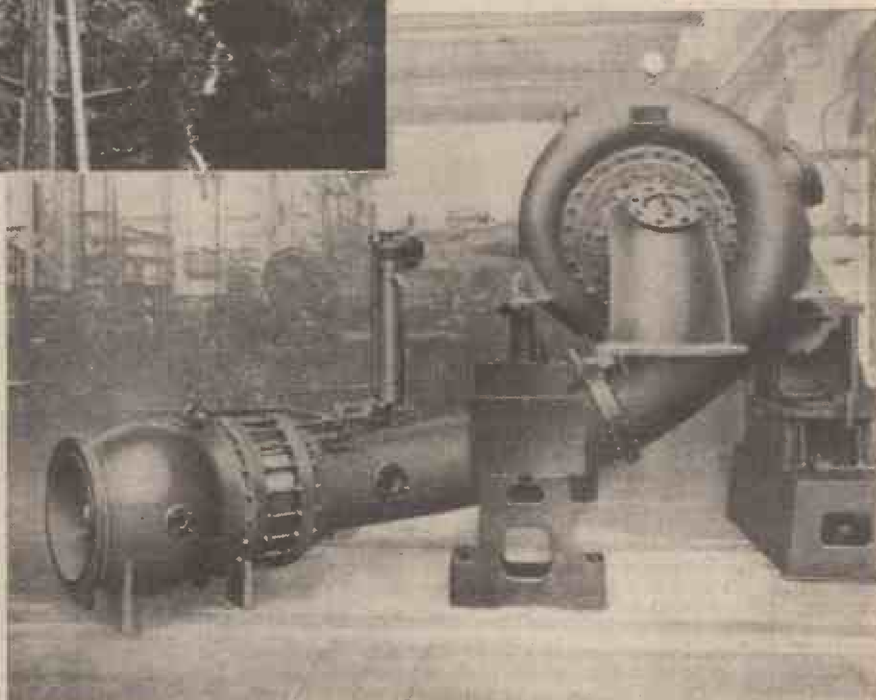


Fig. 2.—One of the 1,450 h.p. horizontal reaction water turbines and cylindrical balanced main valves (for the Victoria Falls plant) assembled at Rugby Works.

As already mentioned, the station is designed to run automatically and is unattended, the reason being that this type of plant is economic and efficient, also the situation of the station renders it unsuitable from the point of view of health for the prolonged attendance of operating staff. Consequently, a daily visit of inspection is all that is necessary.

The plant and equipment are of an interesting character, and a description of their principal features now follows :—

Hydraulic Equipment

The water is conveyed from the Zambesi River to the settling tanks and forebay by means of a deep canal half a mile long. From the latter the water is drawn off through screens and an isolating valve into a single 42in. diameter pipeline and thence to branch pipes feeding the two turbines.

The turbines are of the horizontal-reaction type, each has an output of 1,450 h.p. under a net head of 347ft., and runs at 1,000 r.p.m. They are of the overhung type; that is to say, the turbine runner is mounted upon an extension of the generator shaft, the complete unit having only two bearings.

The turbine spiral casing is mounted upon an extension of the generator bedplate and the combined unit is thus very rigid and compact and characteristic of the company's hydro-electric design.

The turbine runner is made of solid stainless steel with polished streamlined vanes, and is bolted to a forged flange on the generator shaft. The spiral casing is logarithmic in form and made of special cast iron stayed with high-tensile steel bolts located round the centre flanges. This method of staying, though costly, is more satisfactory which has been many times described in various publications. It is in operation all over the world, and is completely reliable and satisfactory.

The governor actuator is mounted upon the servomotor, and the latter operates the turbine regulating ring. The servomotor is closed by a strong spring, so that an ample force to close the turbine is available under all conditions; the opening side is under oil pressure controlled by the actuator, the area of the cylinder being sufficient to overcome the spring as well as the resistance of the turbine gates.

In accordance with the company's recommended practice, the actuator is gear-driven from the turbine shaft, and a flexible steel blade couples the pendulum to the driving shaft. This blade renders the system self-aligning.

The oil pressure for the governor is supplied by a pump gear-driven from the main shaft and an alternative supply is given by a rotary

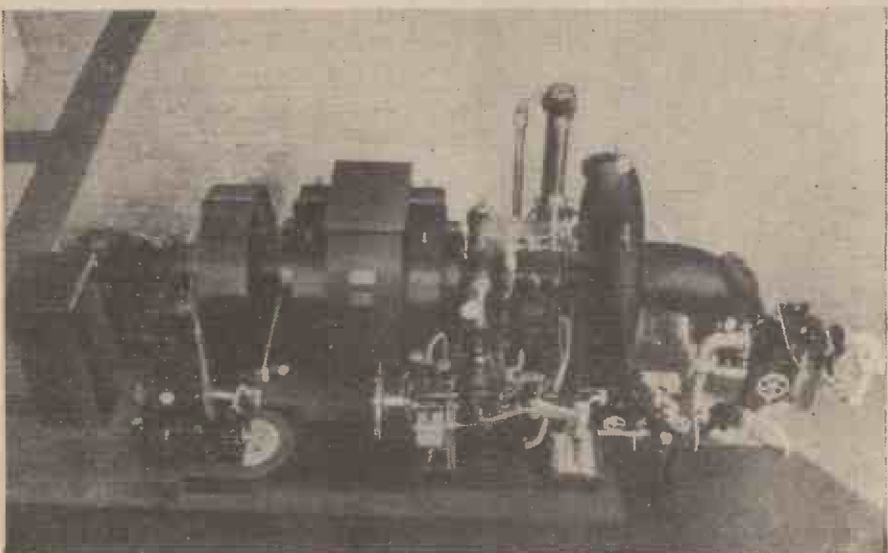


Fig. 3.—One of the 1,450 h.p. generating sets in the Victoria Falls power station.

in the case of high-pressure turbines than stay vanes cast integral with the casing, since the latter occupy much space in the water stream, and are liable to contain poor metal due to cooling stresses.

Hydraulic end-thrust is minimised by the provision of an exhaust pipe which conveys to the draught tube any leakage water passing through the gaps between casing and runner, thereby preventing the building up of pressure behind the runner crown.

Regulation is effected by well-balanced swivel gates connected by levers and links to an outside regulating ring. The links are designed to break well before the elastic limit of any major part is reached in the event of an obstruction preventing one of the gates from following the regulating ring.

The links can be held in stock as inexpensive spare parts and are easily renewable in service.

Turbine Details

The overhung type of turbine is easily dismantled and the runner and surrounding parts can be reached by simply removing the suction bend. The bearing alignment is not disturbed in the process and there is no necessity at any time to remove the spiral casing, which is therefore cast in one piece with its bottom part embedded in concrete.

To obtain complete security and stability an amply dimensioned Michell thrust block is incorporated in the inboard generator bearing, and the bearing pedestal is tied by two strong stays to the turbine cover. Each turbine is provided with an oil-pressure governing system of the company's standard design, oil pump incorporated in the governor base and driven by a small water turbine of the impulse type. There is no need in the present case for an oil-pressure receiver or reservoir, since only the comparatively slow opening of the servomotor is accomplished by oil pressure, closure being effected by a spring, whilst the pump is capable of supplying all the oil required; this is a distinct simplification.

The turbine inlet valves are of the company's cylindrical balanced streamline type and due to their reliability are particularly well suited to an automatic station. These valves have also been many times described, and it is only necessary to say here that the design ensures safe closure under emergency conditions without water hammer, and also balance and control by comparatively small forces practically independent of the actual discharge through the valve.

While the valve is hydraulically operated it can be electrically controlled from the switchboard either to open or close.

On the upstream side of the cylindrical balanced control valve a hand-operated sluice valve is provided, so that each unit can be completely and independently isolated from the pipeline when required.

Fig. 2 shows the turbine assembled with inlet piping and main control valve at Rugby Works, whilst Figs. 3 and 4 show the complete units on site. In the left foreground of Figs. 3 and 4 can be seen the turbine-driven oil pumping set for supplying oil to both governor and bearings, in the centre is the governor servomotor surmounted by the actuator, and in the right foreground are the duplex oil and water strainers. Through the latter passes the water for cooling the bearings and for cooling the air in the closed-circuit ventilating system of the generator.

Generators

Each of the two generators has an output of 1,000 kW., 1,250 kVA. at 0.8 power factor, 3,300 volts, 50 cycles, and runs at 1,000 r.p.m. All rotating parts are designed safely to withstand an overspeed of 1,850 r.p.m.

The generators are of the horizontal salient-pole type fitted with two pedestal bearings on bedplate and with shaft extension to carry the turbine runner.

The stator frame is built-up of steel elements welded to form a rigid and strong frame. The steel wrapper plate is welded to the outer edges of the frame and forms an efficient chamber for conveying the air to the bottom chimney. The stator winding is of the basket type in open slots with two coil sides per slot, the whole winding being suitably braced to withstand stresses set up on short circuit. The ends of the machine are enclosed by segmented sheet-iron shields.

The rotor body consists of a high-grade steel forging in one piece with the shaft, and dovetail slots are machined in the periphery of the forging for retaining the poles and winding. The poles consist of steel laminations riveted between cast-steel endplates.

The field winding consists of copper strip wound on edge on a metal spool from which it is insulated by a mica lining. Fans comprising duralumin blades are provided at both ends of the rotor.

A flywheel consisting of rolled-steel plates is mounted upon the shaft at the slipring end of the machine between the rotor body and the bearing, and this, taken in conjunction with the rotor, provides an ample flywheel effect to fulfil the speed regulation guarantees. The inertia thus provided also allows a turbine relief valve to be dispensed with under the hydraulic conditions prevailing in the present case. The shaft is extended beyond the bearing to take an overhung-type exciter.

The pedestal bearings are ring-lubricated and, as already stated, the driving-end pedestal has incorporated in it a Michell type double-thrust bearing.

Both thrust and journal bearings are fed with oil from the turbine governing system, and a thermostat is provided in each to make contact at a predetermined temperature to shut down the set.

Ventilation is on the closed-circuit principle, the cooled air being drawn into the machine from an intake in the alternator pit, by the rotor fans, through fan shields bolted on to the end covers. The air is distributed through the machine to the bottom chimney, which is centrally situated between the fan shield openings. A short length of trunking connects the bottom chimney to the cooler, which stands on one side of the machine and is readily accessible to the station crane.

Switchgear

The power is transmitted from the generating station to the Falls Hotel at 3,300 volts, which is the generating voltage, and to Livingstone by means of a 22,000-volt transmission line.

The whole of the switchgear, transformers and connections for the power station and the two substations at Falls Hotel and Livingstone formed part of the company's contract, and this equipment included the automatic control gear.

The 3,300-volt power station switchgear is of the built-up sheet-steel truck and cubicle type, totally enclosed and vermin-proof and arranged for floor mounting. The pillars are of the company's standard design and the oil circuit breakers have a rupturing capacity of 50,000 kVA. Generator and feeder pillars are provided together with a metering cubicle and Merz-Price gear for the generator neutrals.

The control board consists of black enamelled slate panels and includes the automatic control panels, the generator control panels, and the exciter and automatic voltage regulator panels.

Other power station gear and equipment include the generator neutral earthing equipment, field suppression switch pedestals, station battery with control panel, trickle charger and motor-generator set, and 220-volt floor-mounting combination fuse-switchboard.

Automatic Control

The two generating units in the power station run unattended, the engineer in charge having his living quarters some six miles away.

For the present only one unit will be run at a time, but in future, when the load increases and further units are installed, automatic synchronising will be required, and the present control gear is so designed that this feature can be added with the minimum of disturbance.

Tests for automatic changeover from one unit to the other showed that only 2½ minutes is required to regain continuity of supply if one unit should fail.

The starting impulse is given by a push button on the control panel in the power station, and thereafter the running up of the turbine and the going into service of the generating unit is entirely automatic.

The sequence of operations is as follows :—

(1) On the starting impulse being given, a master contactor closes.

(2) The closing of the master contactor causes the main valve to open slightly, allowing pressure to build up in the turbine spiral casing.

(3) The building up of normal working pressure in the spiral casing enables a pressure device to cause the main valve to be opened fully.

(4) When water is admitted to the spiral casing it is also admitted to the pump turbine and to the oil and air coolers. The pump turbine runs up and provides pressure oil for the governor and bearings.

(5) Oil pressure being available, the governor takes limited control and starts gradually to open the turbine gates.

(6) The turbine begins to rotate and as a consequence :—

(*a*) The gear-driven oil pump starts to build up pressure.

(*b*) The field starts to build up, causing the voltage regulator to commence bringing the voltage to normal.

(7) The occurrence of oil pressure in the gear pump causes the turbine-driven pump to shut down.

(8) When the speed approaches normal the governor takes full control and the alternator voltage approaches normal.

(9) By means of a time-delay relay a steady condition is attained, whereupon the solenoid of the main oil circuit breaker is energised, the circuit breaker is closed, and the start is then complete.

For shutting down :—

(1) The master-contactor is de-energised and this cuts off the protective circuits and closes the governor by means of its oil valve solenoid.

(2) At the same time the main valve closing contactor is energised, causing the valve to close by means of its motor.

(3) As the governor closes, the turbine gates reach the no-load position and the main oil circuit breaker is tripped.

(4) When the main valve is fully closed a limit switch cuts off the valve motor and at the same time the oil-pump turbine comes to rest.

Protective Devices

Automatic protection is given against any of the following :—

Sustained over-current.
Over-voltage.
Over-speed.
Alternator field failure.
Internal faults.
Overheated bearings.
Oil failure.
Exceeding of normal starting time.

Substation Equipment

At Livingstone the incoming 22 kV. supply is transformed down to 2,200 volts by means of two 750 kVA. 3-phase oil-immersed self-cooled indoor type transformers provided with on-load tap-changing equipment.

The 2,200-volt switchgear is of the truck and sheet-steel cubicle type comprising transformer and feeder pillars, metering equipment, and tap-change control cubicle. The equipment at the Falls Hotel substation comprises a 3,300-volt truck-type switchboard for controlling two 200 kVA. transformers of a similar type to those installed at Livingstone, and a tap-changing control cubicle is also provided.

For local distribution there is a combination fuse-switchboard for the 400/230 volts, 3-phase system.

(*By the courtesy of The English Electric Company, Ltd.*)

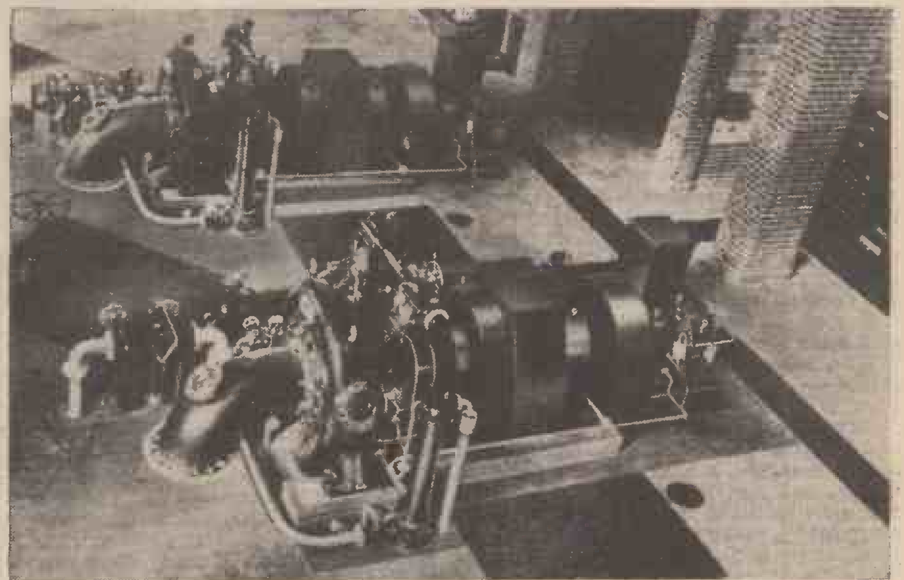


Fig. 4.—The two generating sets, viewed from the turbine ends.

Any of the aforementioned would cause the unit to shut down and the main oil switch to trip.

In the event of the running machine shutting down, the other machine will automatically come into operation.

When any further units are installed, the next machine will run up when the running machine approaches full load. This sequence will repeat as necessary until all available plant is running.

Civil Aviation Notes

Ferrying Vehicles by Air

ONE of the most attractive arguments in favour of transporting motor vehicles by air is that, in computing costs for this method of carriage, material and man-hour charges for crating may be ruled out. Taken in conjunction with the unrivalled speed and flexibility of air transport, this fact makes " air ferrying " of vehicles a sound commercial proposition.

There is to-day no aircraft in the world more suitable for vehicle-ferrying than the Bristol Freighter. Its roomy interior, to which wide nose doors give unobstructed access, makes the loading and unloading of cars an extremely simple operation. With the doors fully open, the car can be driven up a low ramp—the door sill is only 4ft. 6in. from the ground—and then secured in place by means of the ample tying-down points provided. Some indication of the space available in the Freighter is given by the fact that 7ft. 6in. headroom is provided throughout most of the hold, while the width between the sides is 8ft.

Another particularly cogent argument for the use of the Freighter on work of this kind is the great economy of its operation and its ability to land almost anywhere, being able to take off and land within a comparatively short distance on unprepared ground. With a specially strengthened strip on either side of the floor of the hold to take vehicles with a wheel load of up to 5,000lb., the Freighter is the first choice for this specialised transport purpose.

Gas Turbines to Power Air-liner

THE Theseus, the first Bristol gas turbine unit to be produced, may well be the first Bristol turbine to be fitted to a civil aircraft. It has been stated by Sir Frederick Handley Page that the third version of the Hermes air-liner will be powered by four Bristol Theseus gas turbine engines; supplanting the four Bristol Hercules engines of the earlier versions of the Hermes.

The first gas turbine airscrew unit in the world, the Theseus combines airscrew and jet, about 80 per cent. of the power output being taken to drive the airscrew and the residue being utilised in the form of a jet. The third version of the Hermes will have a fuselage 13ft. longer than the first and will carry 64 passengers, as compared with a maximum of 50 passengers for the Hermes I. Installation of Theseus engines will raise the cruising speed of the aircraft to 335 m.p.h., equal to the maximum speed of the Hercules-powered version. All three types will have pressure cabins and will be air-conditioned, enabling them to fly in the sub-stratosphere and " get above the weather."

Rocket Propulsion

The HWK 109-509 Walter Engines

By K. W. GATLAND

(*Continued from page 388, August issue*)

THE design of the Walter aircraft engines was *regenerative*; that is to say, the fuel component of the liquid propellant was circulated prior to its injection for burning through a cooling jacket encompassing the combustion chamber and nozzle. In this arrangement the fuel acts to cool the motor, and, conversely, to vaporise the fuel by pre-heating, with the result that there is a marked gain in the thermal efficiency.

Another important factor of regenerative design is that the inner wall of the combustion chamber can be quite thin and yet withstand full combustion stresses.

One of the first experimenters to employ this system was the German, Dr. Eugen Sänger, who first demonstrated his fuel-cooled rocket motor in 1931. This unit has been fully described in an earlier article (PRACTICAL MECHANICS, March, 1945, p. 200), and it will be recalled that the one essential requirement was a high pressure fuel-feed system, and that Sänger achieved his very successful results in the use of a Bosch diesel pump which permitted pressures within the jacket of 450 to 2,200 lb./sq. in. As the fuel-feed pressure must necessarily be greater than that resulting from combustion, the stress directed on the firing wall of the chamber acted toward the axis of the motor. Thus, the inner wall was of a much thinner section than could otherwise be employed, and of an appreciably higher order of conductivity. All outward directed pressure was absorbed by the outer shell, which could be of heavier construction as it was not subject to extremes of temperature. This explains the reason why no particularly high-grade steels were used in many of Germany's most efficient rocket motors, including the V-2, when motors employing highly durable materials in their construction but not regenerative operating, were disrupted after merely a few seconds' firing.

The only rocket powered interceptor to see service during the war, the Messerschmitt 163BO was fitted with an HWK 109-509A1 Walter engine. This photograph shows the landing skid and tail-wheel fully extended. The main wheels, attached to the skid, were jettisoned once the machine was airborne.

Since the time of Sänger's early experiments, a number of other motors employing the same principle had been developed, many of which were featured in tests carried out by the American Rocket Society.

It was, in fact, Nathan Carver, a member of this group, who provided a further important contribution toward solving the problem of motor burn-out, which when combined with Sänger's scheme made the possibility of efficient liquid rocket engines a certainty.

This was, of course, the "concentric-feed" principle which Carver first demonstrated

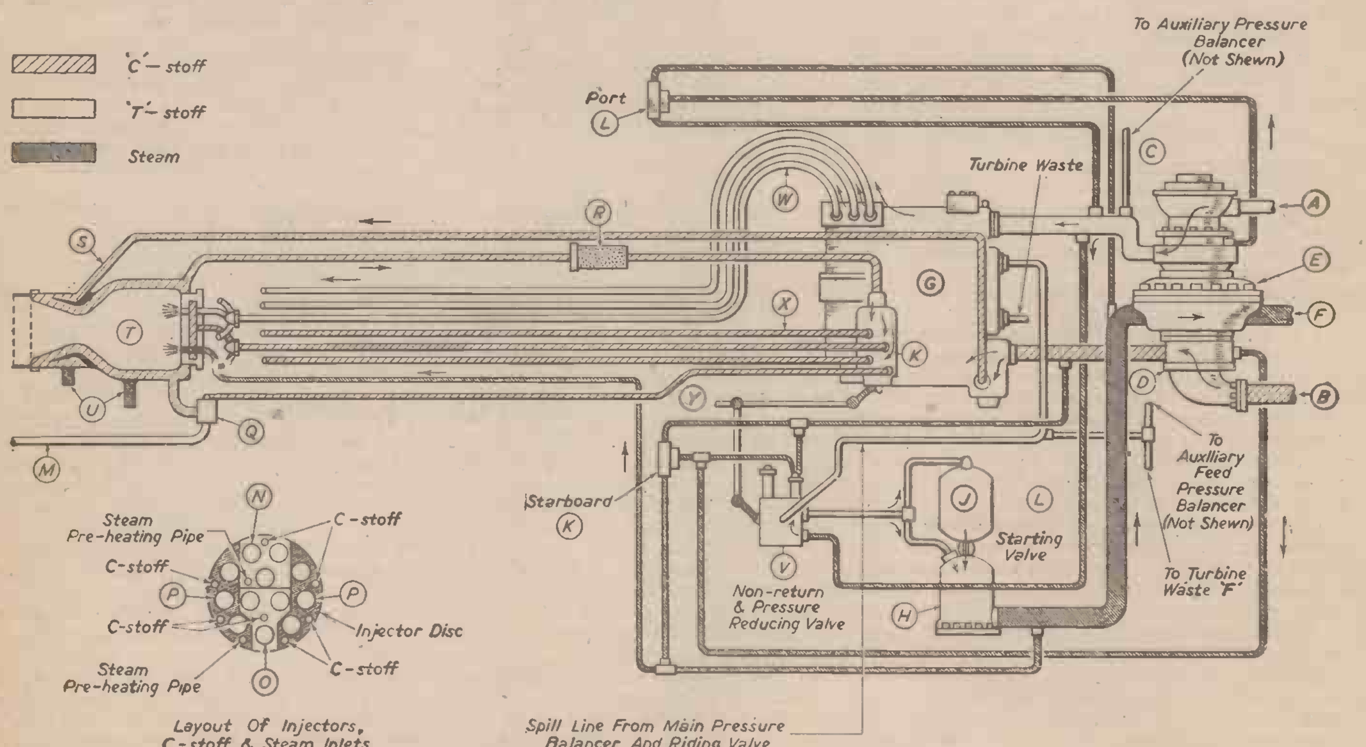


Fig. 76.—Diagrammatic layout of the HWK 109-509C—main system. The cruising motor has been omitted for clarity.

A. T-stoff inlet from tanks.
B. C-stoff inlet from tanks.
C. T-stoff pump.
D. C-stoff pump.
E. Turbine.
F. Steam exhaust from turbine.
G. Distributor. (Main pressure balancer.)
H. Steam producer.
J. Starting reservoir.
K. Control valve.
L. T-stoff to turbine.
M. Scavenge pipe.
N. Stage one.
O. Stage two.
P. Stage three.
Q. Scavenge valve.
R. Filter.
S. C-stoff inlet to jacket.
T. Combustion chamber.
U. Supports for auxiliary motor.
V. Turbine control valve.
W. T-stoff feed lines.
X. C-stoff feed lines.
Y. Pilot's control lever.

NOTE: All notation in the text refer to this figure.

during the small-scale rocket aeroplane trials at Greenwood Lake, N.Y. in 1936 (PRACTICAL MECHANICS, February, 1945, p. 158) and which was later taken up with even greater success by other technicians of his Society, principally, R. C. Truax and J. H. Wyld. His associates, in fact, produced several concentric-feed regenerative types which in conception were essentially nothing less than small-scale versions of the power unit of the V-2.

As the result of similar and more intensified research which was proceeding under military supervision in Germany, the prototype engine of the A4 long-range rocket appeared, and with it the motors of the Messerschmitt 163 series.

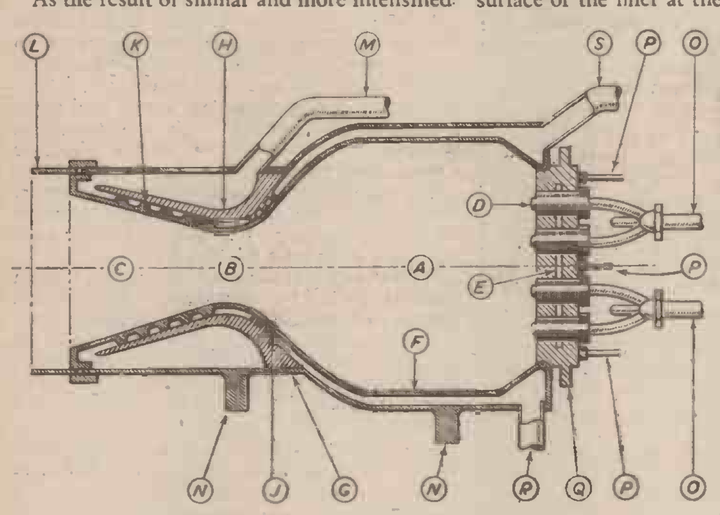


Fig. 77.—Sectional diagram of the HWK 109-509C combustion chamber.

A. Combustion chamber.
B. Nozzle throat.
C. Nozzle mouth.
D. Injector.
E. Orifice for C-stoff entry into injectors.
F. Inner shell of combustion chamber.
G. Outer shell of combustion chamber.
H. Concentric-flow section.
J. Helical vanes on concentric-flow section.
K. Helical vanes on inner shell.
L. Outer shell over nozzle.
M. Coolant inlet.
N. Supports for auxiliary motor.
O. T-stoff inlets.
P. C-stoff inlets.
Q. Injector disc.
R. Drain pipe.
S. Coolant outlet.

The HWK 109-509 Walter Units

The HWK 109-509 engines (the HWK 109-509C main system is shown in Fig. 76) comprised two main sub-assemblies: (a) the rocket motor, and (b) its turbine-driven pumps, accessories and controls, separated by approximately 4ft. of feed lines, these being completely encased by a metal conduit which transmitted the thrust. In the case of the 109-509A1 unit, the total weight (less propellant) was only 814lb., while the amount of T-stoff and C-stoff necessary to operate the Messerschmitt 163BO during its four minutes period of powered flight was 3,418lb. and 1,031lb. respectively.

The combustion chamber (Fig. 77) was constructed of rough forged carbon steel, being of cylindrical section rounded at the head and flowing into a convergent-divergent expansion nozzle. Its length was approximately 11in., the internal diameter 9.50in., the volume 825 cu. in., and the throat area of the nozzle 5.15 sq. in.

The inner walls were only $\frac{3}{8}$in. in thickness, yet able to withstand temperatures of nearly 2,000 deg. C. and pressures approaching 24 atmospheres. An $\frac{1}{8}$in. average gap separated the inner and outer walls of the motor through which the C-stoff coolant flowed.

Of rolled carbon steel construction, the outer shell of the motor was seam-welded, the nozzle being joined to the chamber portion at the mouth. A 6.50in. diameter disc, on which were mounted the injector valves for the propellant, was also welded—at the head of the chamber.

Situated in the space between the inner and outer shells of the nozzle was a concentric flow section, ensuring a rapid and even flow of coolant around that most vulnerable portion of the motor. This was an aluminium alloy casting and embodied three helical vanes situated to coincide with the convergent section of the nozzle, intended to swirl the C-stoff evenly around the liner in its path to the fuel injectors. A further set of five vanes was attached to the outer surface of the liner at the divergent section.

The propellant entered for combustion at the chamber head, passing through twelve pressure actuated valves mounted on the disc plate. The latter was machined from carbon steel bar, while the separate injectors, which screwed into the plate, were of stainless steel.

Operation of the Motor

The oxydiser passed down the centre of each valve, but upon entering the chamber, was deflected outwards from the axis by means of a cone.

This cone was obviously the crucial part of the injector, and being spring loaded, not only prevented blow-backs but also acted as a regulator.

It will be seen from the figure that the supply of fuel to the motor was through a main distributor (G), and that a pipe first brought the C-stoff to the coolant jacket. The fuel solution, having circulated around the motor, was then filtered and delivered back to the distributor, passing through a control valve where its pressure was regulated prior to being fed for combustion. All of the pipes, to and from the motor, passed inside the metal thrust conduit, the fuel pipes branching out into subsidiary feeds just before reaching the head of the combustion chamber. These, of course, fed into the twelve injectors.

Apart from flowing through a filter and control valve in the distributor, the T-stoff fed directly from the pump into the chamber. There were seven inlets and these led into a cavity inside the injector plate, the fuel passing again through filters and then into the injectors via an annular orifice surrounding the deflector cone, finally entering the chamber and mixing with the oxydiser. Combustion took place spontaneously at the deflector cones, each injector providing its own "concentric-feed."

The T-stoff underwent vigorous decomposition, liberating nascent oxygen, which was burnt with the alcohol as the main source of heat. Actually, the violent reduction of the peroxide, under heat and catalytic action, also released mass in the form of superheated steam, adding materially to the weight of the exhaust.

In order to overcome the possibility of explosions when the motor was expended of propellant, it was necessary to drain any C-stoff that remained from the coolant jacket. This was catered for by a pipe which passed from the jacket at a point beneath the chamber to a valve (Q). All the while the turbine-drive of the pumps operated, this valve was closed, but when the pumps ceased to function and pressure fell off, the valve was allowed to open and the remaining fluid in the jacket passed out through the scavenge pipe (M)

Starting

The starting procedure consisted first in working the pumps, but this did not entail releasing propellant to the combustion chamber with its voracious consumption of approximately 1,000lb. per minute. The pilot initiated the turbine drive by moving the lever of his control quadrant to "Idling," energising the starter motor and opening the tank flow-cocks. This electric starter, which was geared direct to the turbine shaft, drove the pumps at low power, causing the feed-lines to fill with propellant. The pressure, however, was not sufficient to overcome the valve setting in the main T-stoff line to the steam producer, which activated the turbine.

In units which were not fitted with electric starters, there was an auxiliary starting reservoir which contained sufficient T-stoff to operate the turbine for six seconds, thereby allowing time for peroxide from the main supply to reach the steam generator. A by-pass line fed back a small quantity of peroxide into the steam generator (H), and the turbine quickly developed sufficient power in the pumps to operate the normal feed to the steam producer. The bypass then automatically cut out.

This procedure was necessary each time the motor was re-started after the aircraft has been gliding with power off.

The Steam Generator

The steam generator comprised a porcelain-lined pressure vessel with a wire cage fitted inside in which were distributed a number of porous pellets impregnated with calcium permanganate and potassium chromate. From the reservoir, the T-stoff fed by gravity into the generator, where, upon meeting the catalyst, there resulted a violent decomposition into super-heated steam and gaseous oxygen. Actually, the peroxide was sprayed on the catalyst from the top of the generator, and the cage itself rested on a perforated sheet of metal near the floor of the container. A large pipe conveyed the steam from the base to the nozzles of the turbine, and after operating the rotor, the waste gases were vented to atmosphere.

Fig. 78.—Diagram showing the layout of the main components in the HWK 109-509C Walter bi-fuel rocket engine.

In the developed engine HWK 109-509C, two small pressure lines ran from the main steam pipe to convey pressure to the ejector valves (K and L), which were provided for the purpose of extracting air from the pumps when the power has been cut for any reason. This was, of course, a safety measure to prevent airlocks and to afford protection from explosions which might otherwise have occurred. The steam used here was eventually exhausted into the combustion chamber, being also used to pre-heat the fuel during starting operations.

The Turbine-pump

In order to maintain pressures of the order of 350-360lb./sq. in. in the feed lines and motor jacket, it was obvious that the solution did not lie in the use of gas-operated pressure chargers. The difficulties confronting the designer of a mechanical driven pump were enormous, and had it not been found possible to use concentrated hydrogen peroxide as the steam producer, it is doubtful whether either the rocket fighters or the V-2 would have performed anything like as well as they did, for reciprocating engines and the extra fuel entailed meant so much more unwanted weight.

The pumps of the HWK 109-509 were called upon to supply over 20 lb. of propellant for every second the motor was operating under conditions of maximum thrust and at a pressure sufficient to maintain a combustion chamber pressure of over 350lb./sq. in.

The turbine group comprised a single-stage turbine with two centrifugal impellers mounted on a common shaft at either side. Machined from chrome steel, the 10in. diameter turbine rotor was housed within an aluminium alloy casting. The T-stoff impeller was manufactured from 13 per cent. chrome steel, while the materials of the fuel impeller were not so critical so long as copper was avoided in the alloy. It was, however, usual to employ aluminium or aluminium alloy, although chrome steels with an optimum percentage of 18 to 21 chromium was a possible alternative. Their housings were also of chrome steel.

For the remainder of the feed system, the hydrogen peroxide lines were of aluminium alloy, though, of course, not containing copper, while the fuel solution was carried by pipes of mild steel.

From "Idling" to "Power"

Immediately sufficient pressure was registered on an indicator in the cockpit, the pilot moved his throttle lever into the first gate. This caused the propellant to feed through three of the injectors (N). The second power phase brought into operation three additional injectors, while the third and final setting functioned the remaining six.

In the case of the improved HWK 109-509 motors, there was in addition to the main rocket motor a cruising chamber, the complete layout of which is shown in Fig. 78. The auxiliary chamber, which was supported beneath, was also regenerative, but had only three injectors. It operated at a fixed power, the 109-509C version developing fully 880lb. thrust.

For climb, both chambers were operated to obtain maximum power, but for cruising, the main motor could be cut out, the use of the auxiliary chamber providing a better solution than simply throttling back on the main system. This enabled a given thrust in the lower power setting to be taken over by the smaller chamber, with the result that efficiency was much improved and a lower propellant consumption obtained.

Performance Data

In the combustion chamber, the chemical energy of the propellant was converted to heat energy, 1,430 C.H.U. being theoretically available for each pound consumed. The maximum thrust resulting from the main chamber was 4,400lb. with a combustion pressure of 353lb./sq. in. and a chamber temperature of 1,950 deg. C.

With the thrust averaging 3,700lb., however, the temperature was reduced to between 1,750 and 1,900 deg. C. The propellant ratio was then between 3.7 and 3.3 to one.

The thermal efficiency was found to be in the region of 28 per cent. at maximum thrust, falling to something less than 10 per cent. at the maximum setting. This poor value of efficiency was, of course, favourably offset by the inclusion of the cruising chamber in newer designs. The reason for this is obvious in that the smaller throat area and chamber volume permitted higher pressures than would have been possible in the larger motor with the same number of injectors in use.

(To be continued.)

Items of Interest

Exhibition of Non-utility Furniture

EXPERTS met in London on April 25th to look at some 1,000 designs for non-utility furniture submitted for inclusion in the Government-sponsored "Britain Can Make It" Exhibition, which opens this month at the Victoria and Albert Museum.

Permits will be issued for the timber required for constructing the selected designs, and from this range of furniture the final selection for the exhibition will be made.

New furniture will be an important feature of the exhibition—displayed in furnished rooms and in nurseries, gardens, offices, and restaurants.

Since there will be complete freedom in the choice of materials for the furniture exhibits, British manufacturers will have the opportunity of showing that the restrictions of the war years have not affected their leadership in design and craftsmanship. It is anticipated that some of the furniture selected will be based on the wartime advances in new techniques and new materials.

The large number of entries for this section is evidence of the keen interest displayed by British manufacturers in the "Britain Can Make It" Exhibition. It is also a remarkable tribute to the resiliency with which British furniture manufacturers are facing problems of reconstruction.

Non-utility post-war developments in all kinds of consumer goods will be shown at the exhibition, which is being organised by the Council of Industrial Design and financed by the Government. No space is being sold, for all exhibits are to be carefully selected to illustrate the best in British industrial design. Selections for other sections of the exhibition will be made later in the summer.

The exhibits are to be chosen by experts drawn from a panel of selectors under the chairmanship of Lord Woolton.

The Audiometer

THE audiometer was first used to record sound in 1910. Since then it has recorded traffic, Dame Nellie Melba, H.M. the King, Chamberlain, Churchill, gunfire, Hitler's voice and most imaginable sounds. It operates by direct recording, unlike the "talkie." Used in study of Underground Railway noises and for the silencing tests on Imperial Airways. This instrument made the first known records of London's traffic long before era of talking pictures. (See illustration below.)

Comfort for Air Transport

TO add to the comfort of passengers travelling in an aircraft means have been devised to minimise transmission of sound and other vibrations to the interior of the cabin and other compartments of an aeroplane.

A further object is an improved method of regulating the temperature of the cabin.

The invention comprises an aircraft compartment in which an inner cell or chamber is suspended through the medium of resilient vibration—damping members attached to members of the outer frame. The arrangement is such that except at the points of its suspension, the inner cell compartment is entirely surrounded by an airspace sealed from the outer atmosphere.

The transmission of sound and other vibrations depends to a large extent upon the existence of rigid physical connections. And, in order to prevent or at least minimise such transmission, it is important that the smallest practical number of suspension mountings be employed. Then the conducting efficiency of such physical connections as are essential can be reduced by incorporating resilient damping means at the minimum cost of added weight.

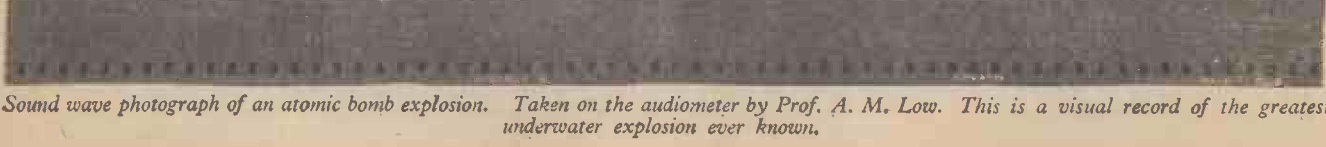
The device provides also for circulating through the aforementioned surrounding air space of the compartment a current of air or gases in such a manner that it flows over the outer surfaces of the inner cabin. The temperature is regulated above or below the atmospheric temperature which it is desired to maintain in the cabin.

Portable Fire Alarm

WHEN people retire to bed at night the remains of fuel in the grate are sometimes left burning. In these circumstances sparks from the grate are a not uncommon cause of a fire.

To guard against such a contingency, there has been devised a portable fire alarm which can be placed on the hearthrug. In case of fire, this automatically sounds an alarm of sufficient duration to awaken the occupants of the house.

As no electrical connections have to be made, the device is readily portable, and can be carried from one room to another and used where it is most required.



Sound wave photograph of an atomic bomb explosion. Taken on the audiometer by Prof. A. M. Low. This is a visual record of the greatest underwater explosion ever known.

The Story of Radar—9

Centimetric Research : Surface Warning Development : Shore Stations

(*Concluded from page 362 July issue*)

A SERIES of modifications giving increased power, accuracy and reliability brought the three original gunnery sets to a high state of efficiency. Their great day came when the modernised version of the set which had shadowed the *Bismarck*, sent the terrible salvos of the *Duke of York's* great guns tearing into the *Scharnhorst*.

Centimetric Research—The New Magnetron

The scientific effort which made possible the gunnery sets, had concentrated on transmitting and receiving technique on the shortest decimetric wavelengths considered practicable with the valves available at that time. Although this was adjudged the most useful line of investigation in 1938, it was realised that still shorter waves in the centimetric band would have important applications if a type of valve giving sufficient power could be produced. Success still seemed a long way off in the summer of 1940, but by November two developments in valve research had led to striking results which were being demonstrated by the Air Ministry Research Establishment at Swanage in surface detection trials against the target of a submarine. These developments were the greatly improved performance obtained by inter-Service University and industrial laboratory teams from the "strapped" magnetron and the production at H.M. Signal School's Bristol laboratories of a new type of velocity modulated valve to provide the centimetric local oscillation frequency required for the receiver.

A new centimetric team was hurriedly formed at the Admiralty Signal Establishment into which the experimental section of H.M. Signal School had now grown, and went to Swanage for six weeks' liaison work. They returned to Eastney with an improved version of the Swanage apparatus and set to work to produce a centimetric surface warning set which could be fitted in a ship as small as a corvette.

The Answer to the U-boat

The defeat of the U-boat to secure our supply life-line had by now become one of the most urgent problems of the war. Asdic detection badly needed support in locating surfaced U-boats and centimetric "R.D.F." looked like supplying the answer.

The essence of centimetric development was to provide detection of the smallest possible target to the limit of the horizontal beam produced, i.e., up to the horizon. Just as a bigger bulb or a further concentration of the beam is required to extend the range of a motor-car headlamp, so either the power of the pulsed transmissions must be increased or the beam more concentrated to increase the range of detection of a Radar set. No further increase of power from the magnetron was possible at the time. Efforts had therefore to be devoted to concentrating the beam. This, in the case of surface warning sets, may be regarded as shaped like a cigar. Narrowing this in the horizontal plane increased its concentration and improved bearing accuracy, but the beam must be allowed adequate vertical depth or it would be impossible to prevent it from rolling off the target with the motion of the ship, a motion which was likely to be extremely violent both in quality and quantity in corvettes and other small ships.

The very high frequencies of the centimetric waveband presented peculiar difficulties due to the losses which occurred in feeder connections. Even with the special types of feeder cable by then available, the lengths used had to be severely restricted. This necessitated the mounting of part of the actual transmitter and receiver immediately behind the aerials, the whole having to be protected from the weather by a small hut somewhat like a lighthouse lantern with windows made of Perspex.

The Radar officer climbs the mast to inspect the aerial on the S.S. "Canterbury," which now makes the trip between Dover and Calais in connection with the "Golden Arrow" service.

Type 271 Goes to Sea—Periscope Detection

Early in March, 1941, a prototype set was installed in the Flower Class corvette, H.M.S. *Orchis*. Once again predictions were amply justified, even so small a target as a submarine's periscope being detected at a useful range. The time had come to take chances again. Components for some 150 sets were ordered, increasing to 350 in May. By the end of July 25 ships were fitted or being fitted. So urgent was the requirement for this set, which was given the title Type 271, that 12 models were actually made at Eastney by Admiralty Signal Establishment Staff. Type 286 cathode-ray tube display units were gutted and rebuilt for the Type 271, one hundred of these being converted at the Eastney laboratory whose staff made up for lack of mass production experience with keenness and enthusiasm.

Results in the form of increased U-boat sinkings and changes in the enemy's submarine tactics were not long in coming. The navigational value of Type 271 also made it extremely popular. No wonder that the ability to manœuvre a ship with confidence in busy or restricted waters at night or in bad visibility which it bestowed savoured of magic to the sorely tried officers on escort work in the Western Approaches Command and elsewhere.

Nor were small ships the only ones to benefit. The new surface warning sets were soon fitted in all types of ship that could carry them. Mast platform sites and larger aerial reflectors were possible in the bigger ships which gave greater range. Before her gunnery sets came into play, the *Duke of York* first located *Scharnhorst* with her Type 273, a big ship version of Type 271.

The sensitivity of these sets was a revelation in surface warning. The detection of a submarine's periscope during the trials in H.M.S. *Orchis* was no freak result. Ship's lifeboat and rafts were located at night, enabling survivors to be picked up. Even gannets and other large seafowl produced echoes on occasion to the puzzlement of the operators.

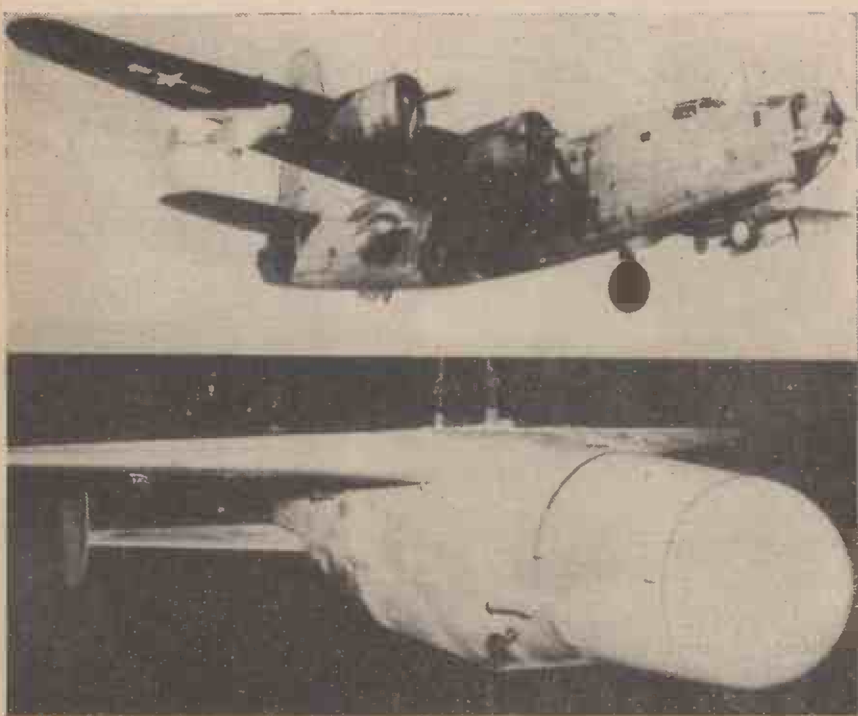
Turning the Tide in the Battle of the Atlantic

On the East Coast and later in the Channel centimetric sets working both ashore in the C.H.L. system and afloat, gave warning of and shadowed the elusive E-boat. But it was in Western Approaches that Type 271 scored its greatest successes, first stemming and then completely turning the tide of the U-boat war in our favour at a most critical period.

Time and again, U-boat commanders found themselves being inexplicably detected and attacked by the escorts before they had time to fire their torpedoes effectively. It was said in jesting tribute to "R.D.F." that many of the D.S.C.s awarded for the sinking of U-boats after the advent of Type 271, had "Admiralty Signal Establishment" stamped on the back of them.

Radar in the Merchant Navy

As soon as sets could be spared, Type 271 and 273 were fitted in merchant ships, beginning with the *Queen Mary*, *Queen Elizabeth*, and other large and fast liners, both British and Allied. Type 286 P and the "suitcase set" which followed it were also being fitted in the Merchant Navy to provide air warning, a godsend to ships who could not afford to keep men continually closed up at their guns. Merchant Navy radio officers were given special instructions in maintenance and D.E.M.S. operators were provided.



A Radar-guided "Bat" bomb, as used by the U.S. Navy against the Japs. The top illustration shows a Navy Privateer patrol bomber with a "Bat" slung under each wing.

Surface Warning Development

Meanwhile, work on a more powerful magnetron was going forward. Passing the increased power from the magnetron to the aerial was once again a serious problem. Cable feeders were not suitable and waveguide technique was introduced in their stead. The theory of wave guides was established by Lord Rayleigh many years ago, but it had never before been possible to produce transmission of sufficiently short wavelength to warrant their use in place of cables.

Briefly, a waveguide is a metal tube the dimensions of which are related to the wavelength of the radio waves which it is desired to pass through it, in such a way that they go through the tube and come out of the other end with comparatively little loss in power. Ingenious methods were used to ensure correct reflection at corners in the guides and also to overcome the difficulties presented by the rotating joints necessary with revolving aerials. When the first sets using waveguides were fitted, difficulty arose in convincing the electrical fitters and coppersmiths at the dockyards that these metal "flues" were electrical feeders not voice pipes, and that it was therefore within the province of the electricians to install them. However, after explanations, excellent co-operation was obtained.

P.P.I. "Picture" Presentation

A naval version of the Plan Position Indicator (P.P.I.) map type of display, previously described, was introduced. The value of the P.P.I. display was immense. It gave the operator an instantaneous "view" all round the ship, providing at a glance the disposition of own and enemy units in the vicinity. The picture it gave could be taken from warning sets used either for air or for surface detection.

Coupling of the P.P.I. picture with the ship's gyro compass provided an orientated picture with the "paints," as the echo indications are sometimes called, on their true compass bearings. If this were not done, the whole picture would be affected by each change of the ship's course.

More Aerial Problems

Centimetric development had made it possible to use "cheese" or "dish" shaped metal reflectors to focus the transmission into the desired narrow beam; but automatic continuous rotation was also essential for good P.P.I. display which added further weight. An additional mechanical requirement was vertical stabilisation to keep the beam horizontal irrespective of the roll and pitch of the ship. This would permit of further concentration of the beam in the vertical plane, giving more power.

The answer to the stabilisation problem was found in the automatic pilot used by aircraft. The gyro element in this device, popularly known as "George," was adapted for use with the new aerial. The new aerial now weighed nearly three-quarters of a ton and presented ship designers with a pretty problem in top weight, but the difficulties were overcome and the results justified all the headaches.

Height Finding

Height finding with the metric wave air warning sets can only be carried out in ships by noting the fluctuations in strength of the echoes as the aircraft passes through the lobes of the Radar beam. These lobes may be visualised as taking the form of a giant bunch of bananas with the stalk at the transmitting aerial and the smallest banana at the bottom.

The echo increases in size as the target enters a lobe, and diminishes as it enters the gap between the lobes. Results can be compared with a chart prepared from observations made on aircraft flying at known heights during calibration trials.

But the highly directional beam now available with the new centimetric set suggested a less laborious method. If controlled elevation of the aerial were provided the set could be used for determining the position of aircraft in three dimensions instead of in two, in the vertical plane as well as in the horizontal, in fact, for direct height finding.

This called for extremely accurate measurement of the angle between the horizontal and a line drawn from the ship to the aircraft and necessitated vertical stabilisation of a very high order of efficiency, a mechanical problem as formidable as any yet presented by the electronic development of Radar itself.

Applying the Radar "Picture"

In addition to height finding, the new centimetric set's P.P.I. map display made it a valuable target indication device on which an accurate picture of all surface targets and low-flying aircraft approaching the ship could be seen and the ship's armament brought into action accordingly.

Continuously rotating aerials and P.P.I. display were similarly providing improved plotting information from the long range air warning sets which enabled fighter direction to be carried out from ships in much the same manner as on land.

In the skiatron, a magnified P.P.I. picture is projected on a ground glass screen, the bright echo "paints" appearing as magenta coloured "sausages" which can be marked with a pencil thus enabling plotting to be carried out on the display unit itself. The advent of Radar had now provided ships with a complete picture of all targets near at hand and, in the case of aircraft, far beyond visibility. Surprise attack was virtually impossible and the co-ordination of the Fleet's defensive and offensive armament was and remains largely dependent on Radar information alone.

Further development of centimetric Radar has supplemented the "suitcase set" originally designed for small craft and coastal forces, with a compact equipment giving P.P.I. display and a greatly improved performance. This set was produced in Canada and has proved most successful. Other developments, including the application of centimetric Radar to gunnery, are proceeding and there is no sign of any slowing up in the astonishing speed of advance maintained since the Navy's first Radar sets were installed seven years ago.

I.F.F. and Beacons

The power of Radar to detect aircraft at far beyond visual limits and surface craft at night and in poor visibility made it essential to provide some method of identifying echoes from our own forces, i.e., "friendly echoes."

The answer was the device known as I.F.F. described in Section 5. The fitting of this type of equipment in the Navy was extended to practically all craft as soon as possible. Latterly, the requirement to distinguish individual ships and aircraft has been met by providing coded responses.

The development of fighter direction from aircraft carriers and other ships fitted with air warning Radar is also largely dependent on the Radar identification afforded by I.F.F.

Radar beacons giving accurate information of the distance between them and the interrogator are of particular value in homing aircraft on the convoys for air escort work and in guiding them back to a "happy landing" on the flight deck of their present carrier.

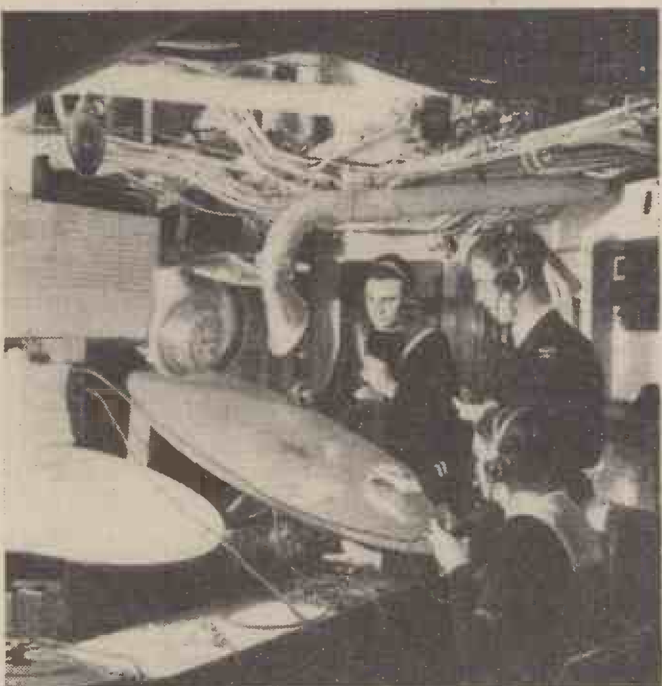
Shore Stations

Not all the Radiolocation development and installation undertaken by the Navy has been for ships and aircraft, however. There were important shore requirements, too. The defence of the main operational Home Fleet base at Scapa Flow was the primary consideration in 1939, but it was evident that similar commitments for "R.D.F." cover would arise in respect of all ports and bases liable to air or surface attack.

The Navy was therefore closely concerned with the development of the C.H.L. cover described in Section 4. Production of the new C.H.L. equipment designed to intercept low flying aircraft was not expected to commence until the end of the year, but Scapa could not wait.

Arrangements were made for a number of partially developed C.H.L. sets to be modified at Cambridge for both air and surface coastal watching, and these were installed at strategic points in the Orkneys and Shetlands. The installation was carried out by young Cambridge scientists who were given special temporary commissions in the R.N.V.R.; working under exceedingly difficult conditions on bleak and remote sites, they secured Scapa Flow against surprise attack.

Meanwhile, the success of the decimetric team in producing the close range A.A. rangefinding set was providing the answer to another shore "R.D.F." requirement, that for a close range surface plot of all surface craft in the approaches to important harbours and bases. Making use of the gunnery set's highly directional beam, a modified version of the equipment was produced which, when installed at harbour entrances, enabled the position and movement of any craft in the vicinity to be plotted. These sets were used in conjunction with the controlled minefields forming part of the harbour defences and, in the event of attack, would have shown when an enemy ship was passing over any one of the mines which could then be detonated from the shore controlling station.



During the first peacetime spring cruise of the Home Fleet last March, Radar was used for the first time in these manœuvres. Approaching aircraft are picked up by Radar plotted in this room by the Flight Directive Officer. When they are spotted a warning is sent to all ships. During the manœuvres a Mosquito attack was made on "Nelson," the 'planes using rockets and cannon.

By 1942, a complete inter-Service coastal chain giving cover against attack by surface ships or low flying aircraft, had been established. The Navy contributed the stations forming part of Scapa Flow's defences, supplied a large proportion of the required centimetric equipment of the Type 271 series, and provided W.R.N.S. plotters and operators. This surface warning coastal chain was taken over by the R.A.F. and operated for the benefit of all three Services.

In the following year tip and run raiders became a serious menace on the South Coast. The new version of Type 271 using the higher-powered magnetron transmitting valve was in production, but ship-fitting was temporarily held up owing to difficulties with the rotating waveguide joint required for the aerial. Numbers of these sets were hastily mounted on trailers and deployed round the coast with Navy and R.A.F. crews.

Their value in detecting the sneak raiders quickly became apparent. In one instance two minutes' warning of the approach of a tip and run raider, given by a Naval-manned trailer set near Dover, enabled 300 children to take cover at Ashford, Kent. The school they had just quitted was destroyed.

Similar Naval trailer sets working as complete mobile units with their own auxiliary equipment carried in lorries, did valuable work in the invasion of Italy and on D-Day, bringing their sets into action over difficult country and often under fire. They were manned by Naval and Royal Marine personnel in charge of R.N.V.R. officers. The work called for considerable initiative and self reliance, as these units had to find their own sites, arrange their communications and plotting organisation according to the current tactical situation, and get into action as soon as possible.

Naval shore "R.D.F." Stations also did important work overseas. At the edge of a 1,100ft. icebound cliff on a remote corner of Iceland, a special "arctic-proofed" Type 271 was installed to keep day and night watch on the vital Denmark strait between Iceland and Greenland, so that no German raider or striking force could pass without the Navy being warned. The set was landed in 1942 and set up in record time by an expedition led by Naval "R.D.F." officers.

The severe weather for which this part of the world is noted lived up to its reputation. Until more permanent buildings took the place of the original camp it often seemed that the station would become airborne and be swept off the cliff in the terrific winter gales. In 1944 a higher-powered set with P.P.I. display was installed. Life at such a place is not unlike being permanently on an Arctic expedition, but volunteers were always forthcoming both for the station in Iceland and for others on sites the reverse of chilly, but also remote at Perim, near Aden, and Chacahacre Island, Trinidad

"Special Sea Dutymen"

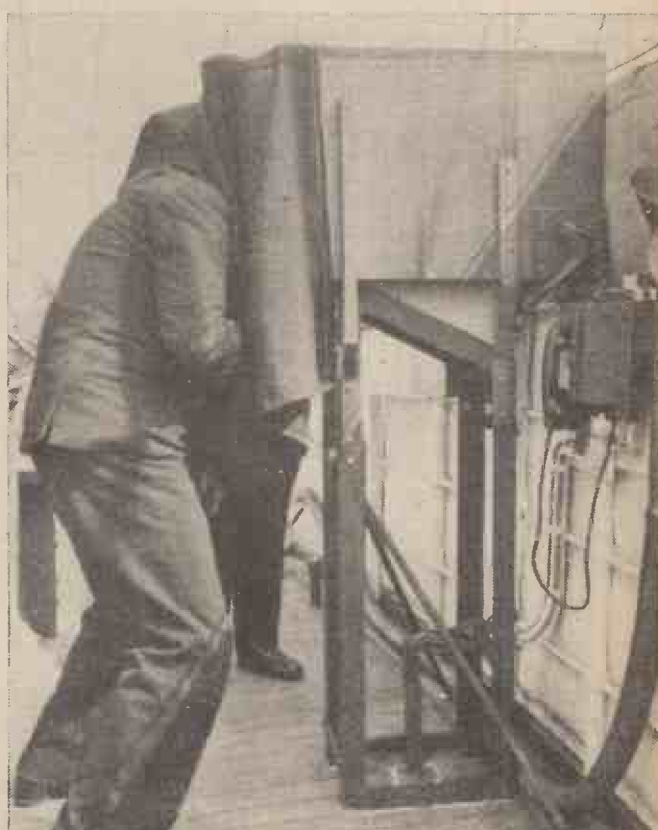
It has been said of Radar that no single invention has so revolutionised naval warfare since steam supplanted sail.

Join a ship with us for just one operation. "Special Sea Dutymen" goes the pipe, and the ship makes ready for sea. A large proportion of these sea dutymen consist of R.P. and R.C. Radar operators, who check up on their equipment and report their readiness before we sail.

The surface warning Radar is ready to con us out of harbour if the visibility closes down. Once at sea this set and the masthead aircraft warning Radar for the Radar component of the ship's look-out team, watching sea and sky with I.F.F. and interrogators ready to identify friend from foe and in turn to identify us to our own forces.

If there be a lurking enemy, ship or aircraft, the early warning provided by Radar enables us to get our blows in first. Our gunfire is aimed by the gunnery Radar sets, feeding their precise measurements of range and bearing to the control machinery. If we attack with airborne "strikes" carried out by the Fleet Air Arm, our fighters and torpedo bombers will be watched and directed to the enemy by the same aircraft warning Radar which is keeping constant track of the hostile aircraft. No matter what the activities of the King's ships, Radar is now an essential tool for all their operations.

The three Fighting Services joined forces as never before; the Radio Board, directly responsible to the War Cabinet, gathered together the leaders of research, production and operational use and, under their guidance, inter-Services committees agreed on common requirements, research effort and supplies. It may, perhaps, be said without fear of the superlative that Radiolocation was Great Britain's greatest single scientific achievement of the war.



The Captain on the bridge of the S.S. "Canterbury" looking at the Radar screen on the repeater.

A Scale Model Pedal Racing Car

Constructional Details of a Realistic Toy Runabout for a Small Boy

By B. W. FRANCIS

WHEN contemplating the construction of this model the first thing I did was to find out the wheel diameter, wheelbase and track of a typical racing car such as an Alfa-Romeo or E.R.A. I then drew out a plan view, side elevation and front view of car I intended to make to approximately one-eighth scale of the full-size car.

Wheel Construction

The chief difficulty was wheels, and these I made by means of "formers," which I had to search for amongst junk in my garage loft. I wanted the diameter of these to be about 12in., and then work out the proportion of the rest of car from this measurement. I found an old Ford Model BB flywheel and a bevel pinion housing from a two-ton Ford lorry. With these and a piece of oak I made the wheels. I chiselled out an oak block to the shape of the "tyre" and beat a circle of 24g. iron into it, turning it round continually while doing it. The bevel pinion housing was then nailed rigidly to the bench and a piece of 3/16in. rod nailed into the bench, but about ½in. or so protruding above the housing. The circle of iron was then placed on this and beaten both inside and outside, the inside making the hub and the outside corresponding to the place where rim should be. After alternating between these two formers several times I had a circle resembling a side of a

Front view of the finished pedal-driven model racing car.

wheel. This piece was then laid on to the flywheel and the edges beaten down over it all round (this lip being about ½in.). This lip was then beaten right over, using the back of flywheel as an anvil. After making two of these pieces I made a strip 1½in. wide to go round the wheel, then clamped the two side pieces together with a 3/16in. bolt with this piece between and then brazed all round the joints. For the rear wheels a piece of conduit tubing brazed right through wheel does for hubs, and for the front wheels I brazed on two old pedal-bearing cups. The accompanying sketch shows a sectional view of the front hub, etc. The "tyres" are made by cutting off the tread from a 26 x 1¾ Dunlop carrier cover (one tyre making two tyres for wheels). After cutting to the right length, they are joined by two staples made from 1/16in. steel rod. If these are put in between the tread pieces the joins are hardly noticeable. These tyres are then stretched on, and the complete assembly is very strong and light and makes a very realistic and reliable wheel.

Mudguards are 26 x 1¼ cycle ones with centre bead.

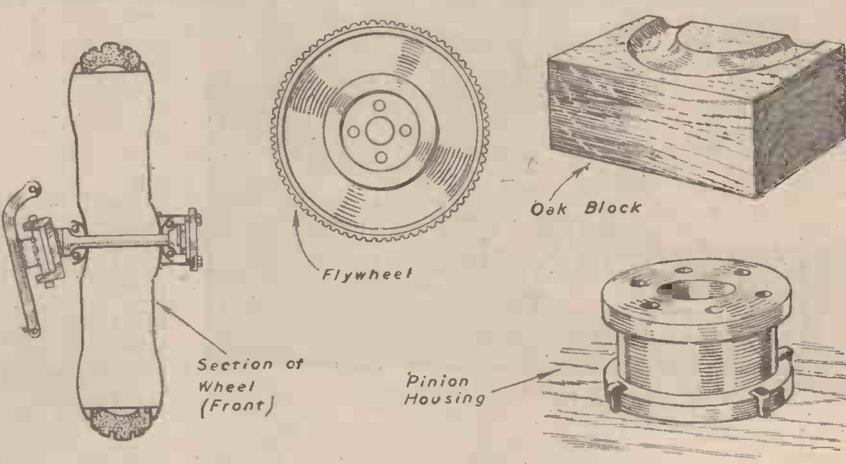
Rear and underside views of the model pedal racing car.

Chassis Details

The body, chassis, exhaust pipe, etc., were made of 26g. sheet iron, the tail being three pieces welded together and beaten out. Chassis holes were cut with a chisel. The rear axle was made up and welded; wheel and crank bearings are 1⅛ × ½ × 5/16in. ball races. Rear suspension consists of laminated leaf springs, with two clutch springs encased in a housing resembling a shock absorber, acting as "helper springs." Front springing is of the independent type with a single transverse laminated spring made up of pieces of laths from a Morrison shelter and hardened. The steering wheel is also made of laths brazed to a circle of 7/16in. iron. Gear and sector for steering have teeth made with a file, and approximately one turn of wheel is needed to turn wheels from right to left lock. In order to give the steering wheel a position as nearly vertical as possible a universal was made, and this can be seen in the inverted photo, just inside the body near the dash. Track rod ends and drag link ends are car throttle ball joints. The brake-drum is a car piston head fixed to wheel (the one not operated by pedals).

Brake Lining

The lining is a slither from an old fan belt riveted on. This brake is very efficient, the lever having a racing type ratchet. The car weighs 42lb. complete and can be pedalled up a 1 in 8 gradient by my son aged 3½ years. The seats I upholstered in rexine with the usual pleats, and the instruments are just painted circles of iron. The windscreen is of safety glass, and is adjustable. The car is painted—the body in maroon, chassis in blue, also the wheels. The exhaust pipe and mudguards are painted in aluminium.



Details of wheel construction.

The Calculating Machine

Its History and Basic Principle

By F. W. COUSINS

(Concluded from page 391, August issue.)

THE "Millionaire" calculating machine patented by O. Steiger was the first machine to operate by true multiplication.

The machine fundamentally consists of three parts:

(a) The multiplication mechanism.
(b) The carrying mechanism.
(c) The recorder.

(a) The multiplication mechanism consists of nine tongued plates originally designed by Bollée. They are in fact mechanical representations of the multiplication tables from one to nine. Each individual plate is shown in Fig. 21.

(b) The carrying mechanism consists of parallel toothed racks as shown in Fig. 22, where the mechanism of the machine is presented in simplified form, and the index below refers specifically to this figure.

Crank	C
Multiplication Lever ..	L
Markers	M_1, M_2, etc.
Result Dials	D_1, D_2, etc.
Pinions	P_1, P_2, etc.
Tongued Plates ..	T
Racks	Z_1, Z_2, etc.
Bevel Wheels	B

That the drawing should be succinct the axle and result dials for pinion P_5 only are shown, but these are duplicated eight times on the actual machine.

If now any pinion such as P_5 is moved by its marker M_5 across the toothed racks, Z_1, Z_2, Z_3, Z_4, etc., that pinion is brought into correct relationship with the digits of the multiplication table from one to nine (there being nine racks, Z_1—Z_9). Manipulation of the multiplication lever L brings the desired tongued plate T ($x \times 5$ in Fig. 21) into position. Rotation of the crank C thrusts the tongued plate on to the racks Z_1, Z_2, Z_3, etc., causing them to be moved according to the undulations of the plate T. The pinion wheels P are thus rotated in accordance with the linear travel of the racks and the bevel gearing B records this travel by rotating the result dials D.

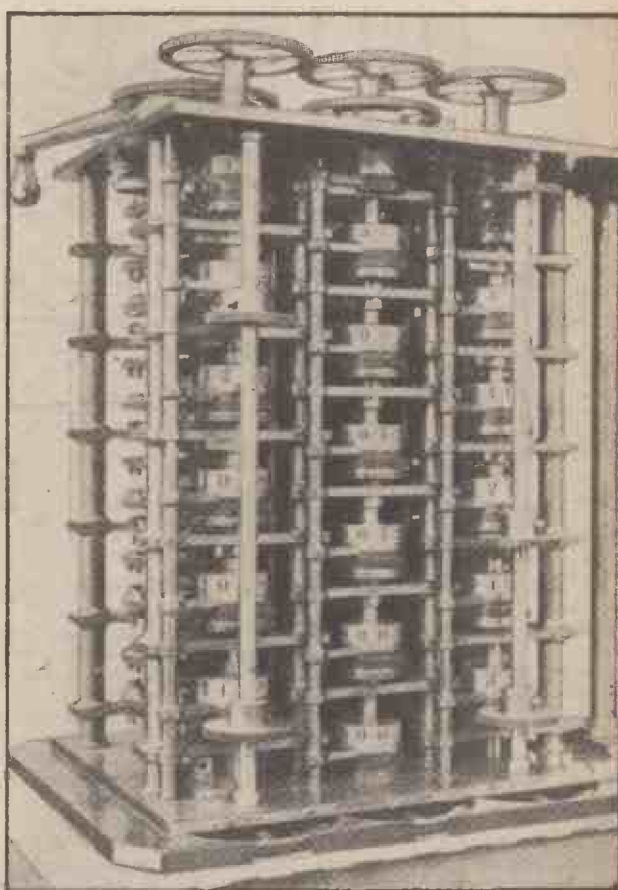
In the actual machine a clever construction of the crank mechanism arranges for the racks to be thrust against the tongued plate twice for one rotation of the crank, imparting linear travel to the racks for the tens undulations and the units undulations on the tongued plate; this is not shown in Fig. 22.

Babbage Differential Engine

The differential engine of Charles Babbage provided an interesting departure from the general trend of thought. Babbage foresaw the value of an engine which would print mathematical tables and set to work to perfect such a mechanism.

This type of engine would be of great use to a maritime nation such as Britain, which had spent more money than any other nation on the study of longitude and the preparation of Lunar tables and the like for navigational aids. Accordingly the British Government financed his invention, but misunderstandings which occurred prevented the successful completion of the engine.

The basic principle is most easily shown from a study of simple tabular values and the accuracy of the table as a whole. The object of the differential engine was to calculate and print a series of tabular values. To do this it used the system of differences, which had the advantage of giving at any point a ready check on the accuracy of the entire series of tabular values—a most pleasing device.



Babbage's difference engine, showing the multiplicity of gears and numbered drums.

Circumferences of Circles

Consider the table of circumference of divers circles when the diameter is changing in equal intervals.

Diameter	*Circumference*
1	3.1416
2	6.2832
3	9.4248
4	12.5664
5	15.7080
6	18.8496
7	21.9911
8	25.1327

There are two ways of computing such a table:

(a) Multiply the diameter in each line by π (3.1416).

(b) Start with 3.1416 and add 3.1416 at each succeeding change of diameter of 1 unit.

The advantages are then found to be as follows:

Case (a).—Each value capable of error due to errors in multiplication. An error in one value will not alter any other value.

Case (b).—Any error in any value will *seriously* alter *all* following values; but if we calculate the *final* term of the table directly we have a *check* on the accuracy of *ALL* the figures in the *entire* table. No such advantage as this occurs in system (a).

Consider a table of square numbers, 1, 4, 9, 16, 25, 36, 49, 64, etc., and a table of 1st order differences and 2nd order differences:

No.	Square	1st order diff.	2nd order diff.
1	1	1	
2	4	3	2
3	9	5	2
4	16	7	2
5	25	9	2
6	36	11	2
7	49	13	2
8	64	15	2

A table of cubes with 1st, 2nd and 3rd order differences gives a similar state of affairs.

No.	Cube	1st order diff.	2nd order diff.	3rd order diff.
1	1	1		
2	8	7	6	
3	27	19	12	6
4	64	37	18	6
5	125	61	24	6
6	216	91	30	6

It will be seen that tables of this kind can be carried to any extent by the simple addition of successive differences if the constant difference is known.

An example from Babbage himself reads as follows:

Table for $y = x^2 + x + 41$.

Then, the table of differences for the values of x from 11 to 14 are:

x	y	Δ_1	Δ_2
11	173		
12	197	24	2
13	223	26	2
14	251	28	2

It has been found that all tables most

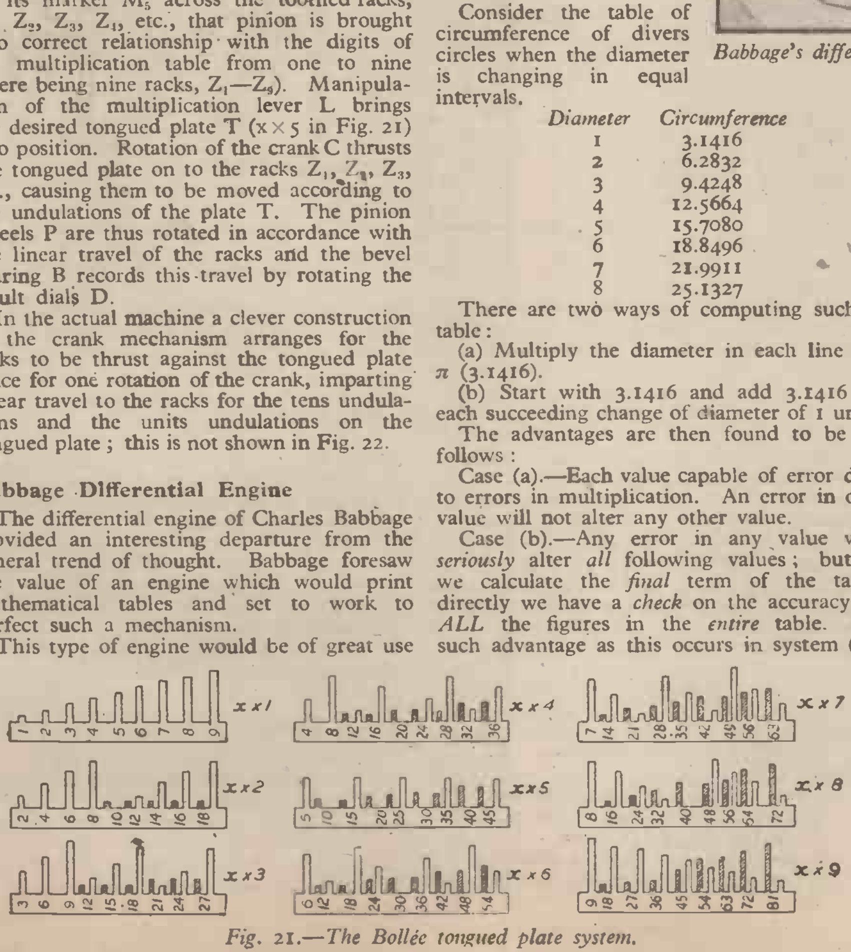


Fig. 21.—The Bollée tongued plate system.

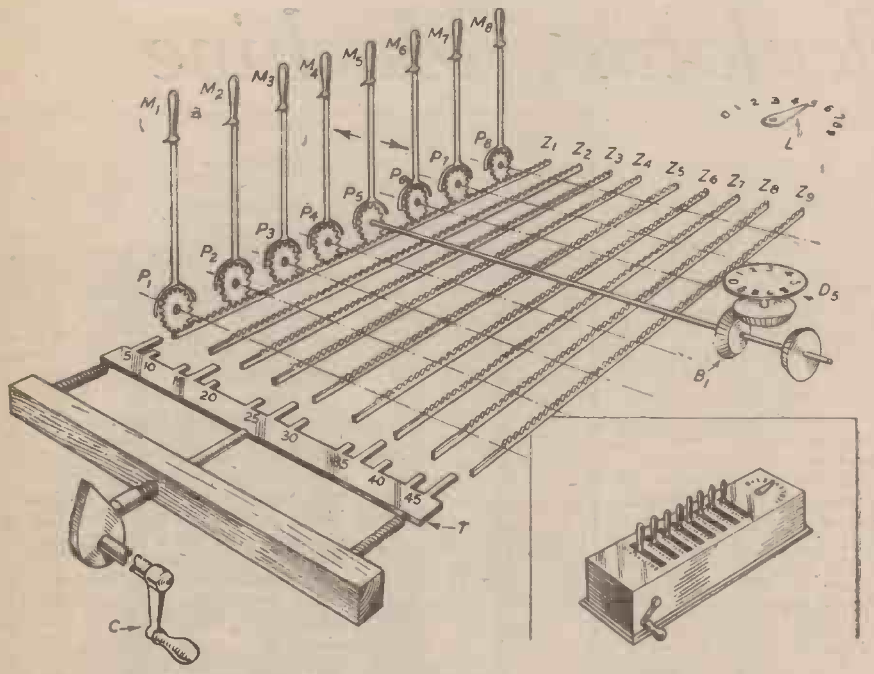


Fig. 22.—Simplified mechanism of the Millionaire machine. (Inset exterior view.)

important for practical use relating to astronomy and navigation can, although they may not possess any constant difference, still be calculated in detached portions by this method.

The machine partially assembled appears in the illustration on the preceding page. It embodied some of the finest English workmanship and the gearing is of superb manufacture. As the tables show in elementary fashion so the machine operated, calculating by the continual addition of numbers in several columns, the results being carried over to other columns. The whole engine upon completion was to have 20 places of figures of six orders of differences.

Differential Analysers

The mechanical integrator usually makes use of a variable gear, the gear being able to vary continuously. Kelvin explained the use of the mechanical integrator for the solution of differential equations, but failed to perfect a really satisfactory machine due to the low-power output from the friction drive.

Machines of this basic type called differential analysers are now in existence, and the difficulty of the low-power output from the friction drive of the integrator has been overcome by the use of a torque amplifier.

The basic unit of the differential analyser is the integrator, and this is shown in diagrammatic form in Fig. 23.

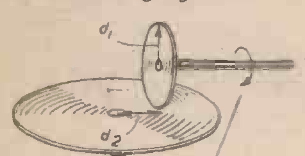


Fig. 23.—Integrating wheel.

The vertical wheel is driven by the horizontal disc. The disc is so mounted that the contact point between wheel and disc can be varied at will.

The gear ratio is thus proportional to the distance from the disc's centre to the point of contact of the wheel.

Any continuous gear will serve as an integrating mechanism. If the ratio "r" of a variable speed gear is varied as the driving shaft is rotated the total rotation of the driven shaft is $\int r\,dx$.

On the latest machines a graph can be plotted on an input table and a photo electric cell follows the graph with great accuracy.

This motion is transmitted by complex gearing to the disc and wheel shown in Fig. 23, giving the lateral displacement d_2. A special geared pencil marks a solution on an output table and provides the solution to the input table values. (See Fig. 24.)

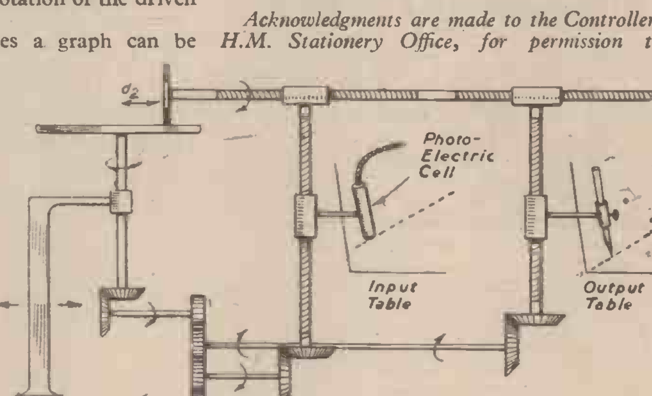


Fig. 24.—Diagram of a type of differential analyser.

Machines are continuously being invented to deal with differential and integral equations, others to aid harmonic-analysis and solve complex simultaneous equations. This article cannot hope to deal with such an array. It will, however, become obvious to the reader that if a machine or device has a motion or characteristic which can be represented by a mathematical equation, then that motion or characteristic is a tool for the possible solution of that equation.

Useful Books

To the reader who desires a more detailed account of the many machines I give a synopsis of the literature I have found a vital source of information:

"Calculating Machines," by K. S. Phillips, B.Sc. Vol. 12, No. 45. Institution of Electrical Engineers.

"Mechanical Integration: 34 Kelvin Lectures." By Prof. D. R. Hartree, M.A., Ph.D., F.R.S.

"Babbage's Calculating Engine, 1889," by H. P. Babbage.

"Newcomen Society Transactions," vol. 13-14, 1932, 1934.

"Encyclopædia Britannica."

"Arithmetik, 1678," by W. Leybourne.

"Calculating Machines," by Feldhaus.

Catalogue of Science Museum. Mathematics I.

"Modern Instruments," by Horsburgh.

"Nature," vol. 149, 1942, pages 462-5; vol. 150, 1940, page 508.

"Pascal: Life and Genius," by Morris Bishop.

"Calculating Machines," by L. T. Comrie.

Acknowledgments are made to the Controller, H.M. Stationery Office, for permission to reproduce the photographs on pages 342, 389 and 391 from the official Catalogue of the Collections in the Science Museum (Mathematics).

Power for the "Brabazon I"

FIRST official news of the engines to power the giant Bristol 167 or "Brabazon I" air-liner was given by Mr. John Wilmot, the Minister of Supply, recently in answer to a question in the House of Commons. Listing the British civil aircraft now in production and those likely to be in production before the end of 1947, the Minister revealed that the "Brabazon" would be powered by eight Bristol Proteus engines of 3,500 b.h.p. each.

The Proteus is a gas turbine airscrew unit, and this was the first official intimation that Bristol had in hand a gas turbine unit additional to their Theseus I, preliminary details of which were announced last December. Mounted in pairs and completely buried in the wings, the eight engines will drive four contra-rotating propellers, giving a cruising speed of 350 m.p.h., at 35,000ft. plus.

The Minister also disclosed the "Brabazon" will have an all-up weight of 284,000lb., a range of 5,000 miles and night accommodation for 72 passengers. Previously the all-up weight had been given as 110 tons; the figure given by the Minister, therefore, exceeds this by 15 tons.

Radio Control of Models

IT has now been announced that radio control of models is again permitted. The G.P.O. have allocated a frequency of 460.5 mc/s for this purpose, but no licence is to be issued at present. Before such apparatus is brought into use, however, notification must be sent to the G.P.O. Such notification should be addressed to the Radio Branch, W.2/6, Engineering Department, G.P.O., London, E.C.1, quoting reference 16311/46. Any radio equipment designed for the remote control of models must be of such a nature that the maximum power radiation does not exceed 5 watts and that there is no radiation outside the limits of 460-461 mc/s.

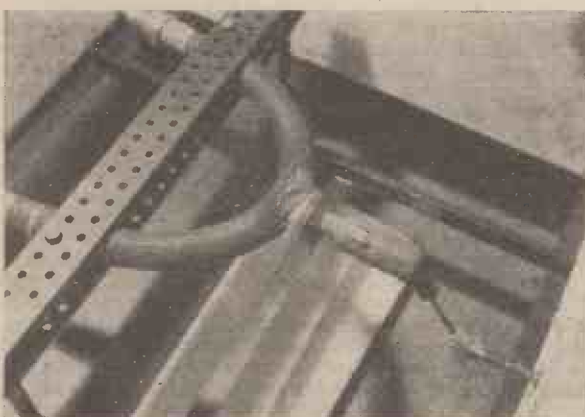
Flameproof Flexible Pipes

A Noteworthy Dunlop Invention for Eliminating Fire Risk in Aircraft

A CONSIDERABLE quantity of data has been amassed, particularly during the war period, on the cause and severity of aircraft crashes. From this data it has been established that if the fire risk can be eliminated the proportion of serious crashes would be very considerably reduced.

The majority of fires in the air are induction fires, which, of course, take place in the engine nacelle, and can be isolated by a fireproof bulkhead. A considerable amount of development work has been done on fire extinguisher systems, but it is quite apparent that, with an induction fire, it will be necessary for the engine to function satisfactorily for a short period during which the airscrew is feathered, petrol supply switched off, etc., and the fire in the nacelle extinguished.

The use of flexible pipes for fuel and oil system on aircraft engines is now well established, and it is quite obvious that the usual type of flexible hose would rapidly fail if exposed to fire, particularly a petrol fire such as occurs in the engine nacelle. In view of this it has been necessary to develop a flexible pipe which will withstand not only the normal arduous conditions of service such as hot oils and fuels, vibration, etc., but also an engine fire without failure for a period which will allow fire combative measures to be taken.



A special rig for testing the fire-resisting properties of the pipe. The pipe has to withstand the flame for a period of five minutes without leakage.

Testing the Pipe

A considerable amount of work has been carried out in order to determine a suitable test which can be applied to a flexible pipe in order that it will meet these conditions of service. The following test is at the moment established.

The flexible pipe, fitted with the appropriate fluid, i.e., petrol or oil, at the maximum pressure likely to be met in the particular system in which it is to be used, is bent to its minimum bending radius. The hose is then subjected to the flame of a blow-lamp head of defined nozzle and other dimensions, directed on the outside of the bend of the hose at a specified distance from the surface of the hose. The flame temperature is in the region of 1,000 deg. C. The hose must satisfactorily withstand this flame for a period of not less than five minutes without leakage.

The Test Apparatus Used

Various types of test rig have been tried in order to obtain a consistent flame. The apparatus now used comprises a fuel metering and control unit coupled to a special blow-lamp head. The fuel is metered to the lamp at a constant pressure, and the rate of burning is carefully controlled, ensuring uniform flame temperature. During the test the internal pressure in the flexible pipe increases due to thermal expansion of the fluid within the hose. Arrangements are incorporated in the rig to enable this excess pressure to be bled off during the test, and to maintain a reasonably constant pressure in the hose.

The severity of this test can be imagined when it is pointed out that within a few seconds of the start of the test the outer cover of the hose becomes a glowing red-hot mass.

Two types of hose have been developed which will satisfactorily meet the requirements laid down. The more popular is the wire-reinforced high-pressure type of hose. This comprises a synthetic lining tube over which is braided successive layers of cotton, high tensile wire and cotton, the whole being finished with an outer cover of synthetic rubber specially compounded to resist the action of the flame. In certain cases a layer of asbestos braiding is incorporated in the construction in order to further improve the flame resistance.

Synthetic Lining Tube

The second type consists of a synthetic lining tube, specially compounded to resist the action of oils, fuels, etc., which is reinforced by braidings of a specially treated heat-resistant cotton. Incorporated in the construction are layers of heat-resisting materials, such as glass fibre and asbestos, the outside of the hose being finished with a similar flame-resistant synthetic cover to that previously mentioned.

The first-mentioned type is to be preferred in that it is possible to maintain a smaller outside diameter for a given bore size; at the same time it should be borne in mind that the weight is somewhat greater owing to the use of high tensile wire as a reinforcement.

Both of the above types have been successfully subjected to the most stringent tests. Tests have been recorded where the high-pressure type of pipe has withstood the flame test for a period in excess of 90 minutes, with an internal pressure of 300 P.S.I. without signs of failure or leakage.

SUSPENDED BOMBS

A NOTABLE device which relates to the subject of bombs has been patented by a British inventor. He points out that in aircraft battle tactics it frequently happens that the enemy approaches from behind.

The object of the additional invention is to provide an effective defence against this method of attack. The new proposal is to lay a screen of floating bombs in the wake of the aircraft threatened from the rear.

The bombs are each fitted with a parachute attachment so that, when discharged or projected from the defending aeroplane, the bombs are suspended in the path of the enemy.

In the case of furnishing a barrage against air-raids, these bombs may be launched by a number of aircraft.

A supply of cartridges, each complete with projecting charge and bomb with parachute attachment, may be carried in any suitable part of the machine, such as the tail. And they may be fired either in series or groups from the bomb projector.

The bomb projector is of the barrel-less type in which bomb-containing cartridges are carried in sleeves serving as tubes for projecting the bombs. And they are accommodated in links connected into a belt passing over a rotatable drum. This co-operates with a multiple firing device for simultaneously firing a number of bombs. The device is automatically cocked by the rotation of the drum.

A mechanic applying a blow-lamp to the piping as a further test of its flame-resisting properties.

Miniature Slide Projectors

Present Position and Principles as a Guide for Constructors and Purchasers

By M. K. KIDD

THERE are five or six miniature slide projectors coming on to the market. These instruments will be expensive, but the home constructor can obtain quite good results by adapting existing apparatus.

The projection of a transparency is the very finest way of reproducing a photograph, and this is especially true of colour photographs. It is relatively easy to produce a reasonably satisfying transparency in colour, and at a low cost, but an equally good colour print is vastly more difficult and expensive. For education and some industrial purposes, also, a still picture is as good, or even better, than a moving film, and very much less expensive.

But the weight and bulk of the old-fashioned full-size lantern slides, and their high cost in commercial production, has led to much research into the use of miniature projectors, using strips of 35 mm. film, or alternatively, small size slides.

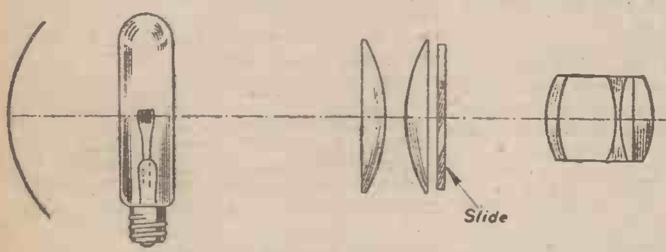


Fig. 1.—Double condenser system.

The Sizes in Use

There is some confusion about sizes, due to the fact that the original film-strips produced mainly for educational purposes carried pictures the same size as the normal 35 mm. cinema, viz., 18 mm. by 24 mm. As a variation, one firm uses the square shape on the same film, picture size 24 mm. each way.

Amateurs and professionals, apart from schools, however, mainly employ the normal camera size, 36 mm. by 24 mm., i.e., two frames of a cine film.

The necessity for preserving colour films of this size from damage led to the use of glass slides 2in. square (the actual size of the glass is 49.3 mm.). Lantern plates of this size can readily be obtained, though they are only slightly cheaper than the full size, owing to the thin glass used, and to the handling costs, etc., being nearly as great. On these can be printed either optically or by contact, pictures up to about 40 mm. square.

Strip film reduces the cost of the commercially-produced lantern slide by 90 per cent, and weight and bulk by 99 per cent. With glass slides the saving is not nearly so great, but it is very considerable.

The Miniature Projector

It is useless for the experimenter to attempt to design or adapt his own apparatus unless he understands the principles of projection and the peculiar difficulties of the problem. Nor, until he has tried for himself, will he realise the reason for the cost and complication of the best projectors on the market.

The Illuminant

The ideal light source for use with a condenser would be a point source (did not Euclid say that a point had no magnitude whatever?) No filament lamp approaches this standard at all closely. The best thing is to employ a low voltage lamp, which can have a short thick filament. Lamps are now being produced with a so-called "solid source" in 12 volts up to 250 watts and in 24 volts up to 400 watts. However, 100 watts is a common size, and many film-strip projectors are in use which use only 24 or 36 watt automobile type bulbs, which suffice in a well-darkened room.

The current is usually supplied by a transformer. Although not usually provided, there should be extra tappings, or a resistance to provide both for a lower voltage to use when starting, and a higher voltage to allow the bulb slightly to be overrun when extra light is required.

The Heat Problem

The larger bulbs generate great heat; this problem is dealt with in two ways: ventilation and filtering. If ventilation to the lamphouse is inadequate, the bulb will get too hot, and its life will be reduced. In certain cases a fan is provided—an excellent scheme. But no fan can prevent the heat rays from being focused upon the film along with the light. Therefore, the best manufacturers fit a heat filter. A new British glass is claimed to absorb 80 per cent. of the heat, but less than 15 per cent. of the light.

Gathering in the Light

A mirror is a most important item, and the experimenter and constructor must on no account omit to fit one. The best are of silvered optically-worked glass, but metal ones are sometimes used. They have to withstand considerable heat, and must be capable of minute adjustment and firm fixation.

The condenser usually consists of two plano convex lenses fitted with their convex faces nearly touching (Fig. 1). Somewhat greater efficiency, however, may be obtained from various combinations of three lenses. In one system the lens nearest to the slide may be changed to suit the size of slide being shown. Triple condenser systems (Fig. 2) are, unfortunately, not generally on sale, but ordinary lenses are plentiful and not expensive. The cheaper ones are moulded, and quite effective. They are usually slightly greenish in tint, but this is of little importance. Better lenses are clear, and optically worked.

Light is scattered and lost whenever it enters and leaves a glass surface—this trouble is minimised by some manufacturers by "blooming" or coating with a fluoride. (Present price, 10s. per surface.)

The Lens

The best lenses are anastigmats made specially for projection, but there are many simpler lenses of the Achromat or Petzval types which pass a very good amount of light and give passable definition, especially in the centre. Therefore, one of these, if it gives a picture large enough, may prove quite suitable for a miniature projector. The usual aperture of projection lenses is between f/3 and f/4. The fact that a lens has a faster speed calculated as for camera use does not mean that it will be certain to pass more light when used for projection.

As for focal length (to determine approximate focal length of a lens, use as a burning glass, and measure the distance) 3ins. to 4ins. is the size normally fitted. Two-inch lenses may be used in a very small room or for projection *through* a translucent screen. For a small hall 6in. lenses may be fitted.

A fast camera lens will work more or less satisfactorily, but beware of heat damage.

Slideholders

Two-inch glass slides may be used in adapters, or holders of the usual type, but it is quite sufficient merely to push them through a suitably-grooved holder, either vertically or horizontally (Fig. 4). Light springs are necessary to ensure that the slide is held in correct focus.

Film-strip Holders

These are a greater problem, which increases with the heat of the lantern and the aperture of the lens. The picture is printed upon a strip of ordinary non-flam 35 mm. cine film, with the usual double sprockets, the "business" side being inside the curl. A few inches are provided at each end for threading purposes.

The small size films have all their pictures one way, so that the film merely travels downwards during projection, but 36 mm. by 24 mm. transparencies depend, of course, on which way the camera was held. To show this size, therefore, the holder must be made to rotate through 360 degrees; in some cases, the film-holder is attached to the front of the lantern—in others it forms a unit with the lens.

It will be realised that the film will soon be damaged by scratching unless great care is taken. The design should be such that neither side is touched while moving, except at the edges. In the better projectors a pressure glass or frame is automatically raised before the film is moved on to the next picture. In these, too, a sprocket is employed to engage with the holes in the film to move it, instead of merely winding it on to the take-up spool, a method which causes more wear and is inconvenient when it is desired to turn back.

Adapting Existing Apparatus

The first thing to do is to see if a suitable lens is available. A lens of 6in. focal length (see above) will just suffice in a hall or schoolroom, but not in the home. It is not practicable, in most cases, to obtain a larger picture by

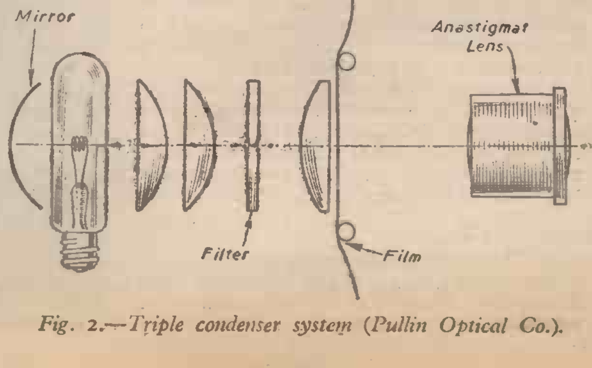


Fig. 2.—Triple condenser system (Pullin Optical Co.).

using a supplementary lens, but by all means experiment—the object lens from an opera glass is the sort of thing required.

Next, to hold the slide or film. Start with an ordinary slide masked down to 36 × 24mm., if you have no miniature transparencies. When satisfactory results have been achieved it will be time to construct a filmholder.

As it is now only necessary to illuminate such a small area, try adjusting the lamp and reflector to the best advantage, which may well double the intensity of the light. It is possible in some cases to secure good results by moving the slide forward, perhaps very considerably, into the cone of light.

It will be found that the lamp is usually some 6in. from the condenser, and that most of the light goes off in any direction but the useful one. This can only be improved by moving the lamp closer—which necessitates a condenser system of shorter focal length. For small slides this is now easily possible, and a new pair of lenses 2½in. or 3in. in diameter should be obtained and fitted in place of the large ones. The effect will be striking, as the lamp will now be placed much closer, and greatly improved illumination will result. Adjustment of all parts will be found much more critical, and careful experiment will achieve the best result. Here are two hints: (1) adjust the lamp before using the reflector at all; (2) place a piece of ground glass or paper in the position normally occupied by the lens (in focus) and secure images of the filament upon it, from both lamp and mirror.

In order to fit a film-strip holder to an ordinary lantern it may be necessary to remove the lens, together with its tube or bellows from the front of the body, and remount them on a new support. Exact directions cannot be given as types vary so much, but generally it will be necessary to extend the baseboard a few inches. No matter if there remains an open gap—modern lanterns constructed on the optical bench principle have no bellows and very little lens tube, and are very much cooler.

Film-strip Holder

This holder is built upon a strip of metal, preferably brass at least 1/16in. thick, 7½in. long and 3½in. wide, bent to angle shape, one part being 2in. inside the bend (Fig. 3).

Lay a length of film along the 2in. side and mark out the edges of the film and the extreme width of the picture.

Cut an aperture centrally 24mm. wide and 36mm. long unless only small size slides are to be shown, in which case 18mm. will do. A tension file will be found useful in cutting the hole.

Five spindles 2in. long and ⅛in. diameter are now fastened into position, either by threading or by soldering.

In order that the picture side of the film may not touch, two thin strips of brass are made to reach nearly up to the lines already drawn to denote the picture width. Fastened by the same screws are two narrower pieces which nearly reach the lines showing the width of the film. That is, the bearers will be 25mm. apart and the guides 36mm. part.

The pressure plate is of any suitable metal, but not too heavy. It has an aperture to match that in the frame, and is held in position by two arms. These arms are fastened to the pressure plate at their lower ends by small bolts; play is not necessary, but they may need adjustment. Their upper ends are fastened to a length of tubing which fits over the rod. A coil spring is fitted as shown. It is desirable to fit two narrow strips of metal to the back of the pressure plate to hold the film by the edges. The whole track of the film is thoroughly smoothed and polished.

The take-up spool is of wood or metal not less than ¾in in diameter. The end of the film is tucked under a semicircular clip fastened to the middle of the spool, which carries a wheel or disc 1¼in. in diameter at its end. A simple ratchet is useful.

The film is loaded from the side, by merely raising the pressure plate.

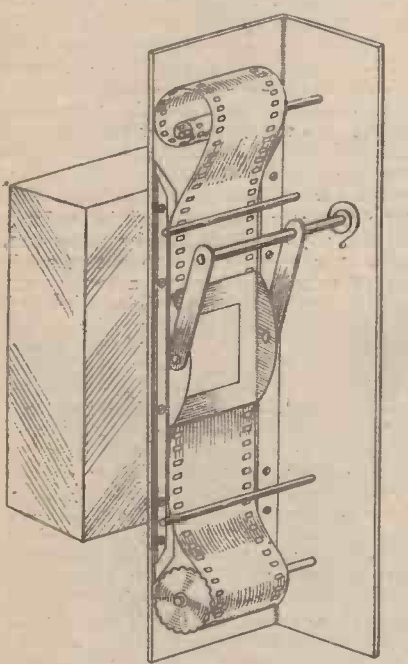
The rotating device, if required, can be added and placed between the holder and the lantern (Fig. 5).

A disc 2½in. in diameter, having an aperture 40 × 32 mm. cut in it, is mounted in a ring 3½in. external diameter and 2½in. internal diameter to fit the disc.

It is best turned in brass or light alloy ⅛ or 3/16 in. thick, but plywood is fairly satisfactory, and a ready-made substitute can be found in the upper part and lid of a golden syrup or similar tin.

It will be seen that the filmstrip holder is spaced about ¼in. from the disc. This is partly to allow clearance for the clips which retain it in place and partly to provide ventilation.

The same holes and bolts which fasten the film bearers and guides serve to hold the rotating disc to the holder.



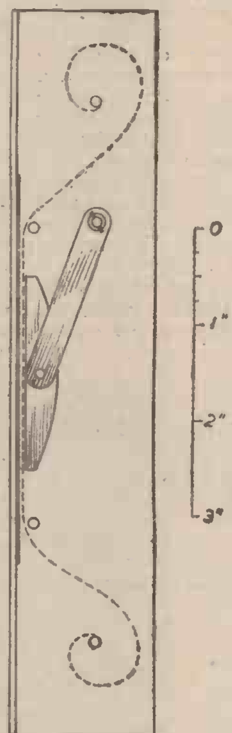


Fig. 3.—General arrangement and side view of a simple film-strip holder.

Addresses

Visual Information Service, 168a, Battersea Bridge Road, S.W.11 and Newton and Co., Ltd., 72, Wigmore Street, W.1, supply filmstrips on travel, religious and general educational subjects. Usually there are 30 or 40 pictures on a strip, and the price works out at from 1d. to 3d. per picture. These firms make strips to customers' order at 3½d. to 6d. per picture, and also supply projectors.

The following make miniature projectors as well:

G. B. Equipments, Ltd., Wardour Street, W.1.

Aldis, Ltd., Birmingham.

Pullin Optical Co., Ltd., Great West Road, Brentford, Middlesex.

Common Ground, Ltd., Sydney Place, S.W.7.

The following supply optical goods, new and secondhand:

Broadhurst Clarkson and Co., Ltd., 63, Farringdon Road, E.C.1.

Misc. Trading Co., 135, High Holborn, W.C.1.

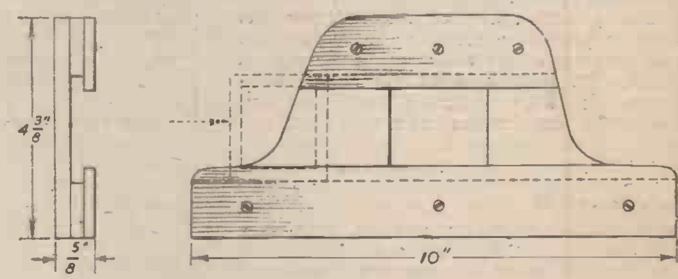


Fig. 4.—Push-through holder for miniature glass slides, to replace full-size carrier.

These firms make special lenses for projection:

Dallmeyer, Ltd., Willesden, N.W.10.

Aldis, Ltd., Birmingham.

Pullin Optical Co., Ltd., Great West Road, Brentford, Middlesex.

The following firms supply projection bulbs:

Siemens, Ltd., Upper Thames Street, E.C.4.

General Electric Co., Kingsway, W.C.2.

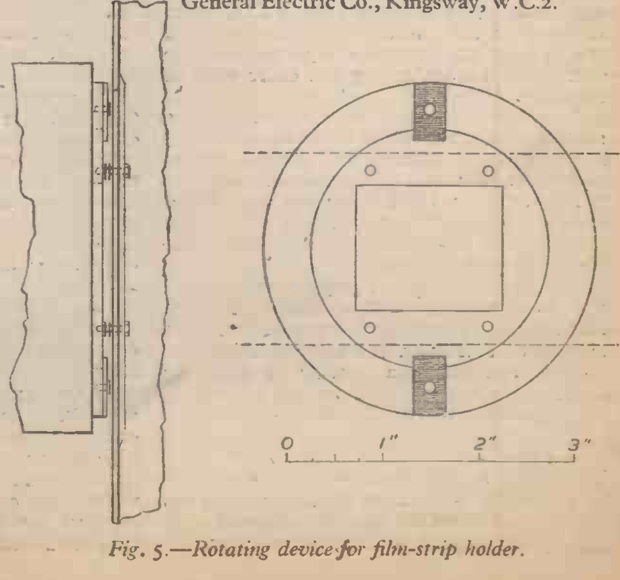


Fig. 5.—Rotating device for film-strip holder.

Inventions of Interest

Bullet-resisting Clothing

THE evolution of armour for the body has not yet culminated in an absolutely bullet-proof covering, but considerable progress has been made in the direction of shielding the wearer from bullets, shrapnel and splinters caused by firearms and explosions.

An inventor has been impressed with the fact that such a covering has not always been convenient to remove. The protecting garment has been heavy to draw upward. In the case of a wound, it might even have proved an obstruction to access to the injured part.

Accordingly, the inventor in question has designed a garment in which the front part and the back part are connected together in a detachable manner. He proposes the use of short lengths of manganese steel or other bullet-resisting material in plate form.

To Train Horse Riders

A SUPER-ROCKING-HORSE has entered the field. This equine wonder emanates from the brain of an American citizen who has applied for a patent in this country. The animal belongs to the family of mechanical exercising horses.

The principal aim of the inventor has been to produce a means whereby exercises may be taken which will simulate the various movements performed in the riding of a horse. It is so contrived that there can readily be imparted to one's arms, legs and torso the movements occasioned when one rides a horse at a walk, trot, canter or run.

This exercising horse is operated by muscular motion of the legs, arms and body rather than by mechanical means. Consequently, the rider can increase or decrease the speed of the action at will, and is not required to respond to movements caused by a motor or other mechanism such as is employed in previous types of exercising horses.

Safe for the Young

PRIMARILY the device is designed for children. And it is so contrived that it can be used by either adults or juveniles without danger.

Not only does the horse afford exercise to all the muscles of the body, but it gives the rider an opportunity of using his skill and judgment. The inventor affirms that, while it enables a child to develop those qualities, it also helps the youngster to co-ordinate the muscles of the arms, legs and other parts of the body.

Standing with each of his feet upon a stirrup block, the rider leans forward in a riding posture holding the handle-bars at the sides of the neck of the animal. He then moves or swings his body up and down, bending his knees and at the same time pushing and pulling the head of the horse backward and forward.

This action puts the stirrup springs and the horse's head into oscillating motion. As a result, the rider automatically moves himself up and down in a manner resembling that of one riding a trotting or galloping horse.

Fire Fighter

WHEN an aeroplane crashes, the usual sequel is that the ill-fated machine is rapidly enveloped in flames. To deal with such a catastrophe is one aim of a mobile fire-fighter which has recently made its debut.

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."

This contrivance consists of a vehicle driven by an internal combustion engine. It comprises a tank holding a sufficient supply of water, a pump of adequately large capacity and mechanism for using the propelling power of the vehicle to work the pump.

There is a hose connection to the pump to direct and deliver water, liquid chemicals or gases, separately or in conjunction, in large or small quantities from one or several points, quickly and with efficiency.

This fire-fighter can be moved speedily, owing to its having the requisite power and its centre of gravity positioned low on the chassis.

There is a bank of compressed gas cylinders for direct use in quenching particular types of fires.

The tank covers the greater portion of the floor of the chassis, and a foam generator feeds foam into the outlet from the force pump.

"Mind Your Bike"

THE bicycle thief is ever with us. To put an obstacle in the way of this culprit a cycle lock with new characteristics has been submitted to the British Patent Office.

In this instance the housing for the lock is brazed, or fixed in a similar manner, entirely within the top or bottom tube or tube liner where the tube enters the top or bottom head lug of the tube that contains the steering column. And the lock is of such a nature that it can be inserted in the down tube and then pressed laterally into the housing. There it is held by a spring plunger or other fastening device.

The lock bolt is spring pressed and enters a recess in the steering column or in a plate that is brazed or otherwise fixed to it.

The end of the bolt may bear against the wall of the steering column within the recess when in its locked position.

Bombs Dropped in Water

ALTHOUGH hostilities have ended, the supply of military inventions has not entirely ceased. Here is one which is the subject of a recently accepted application for a patent in this country.

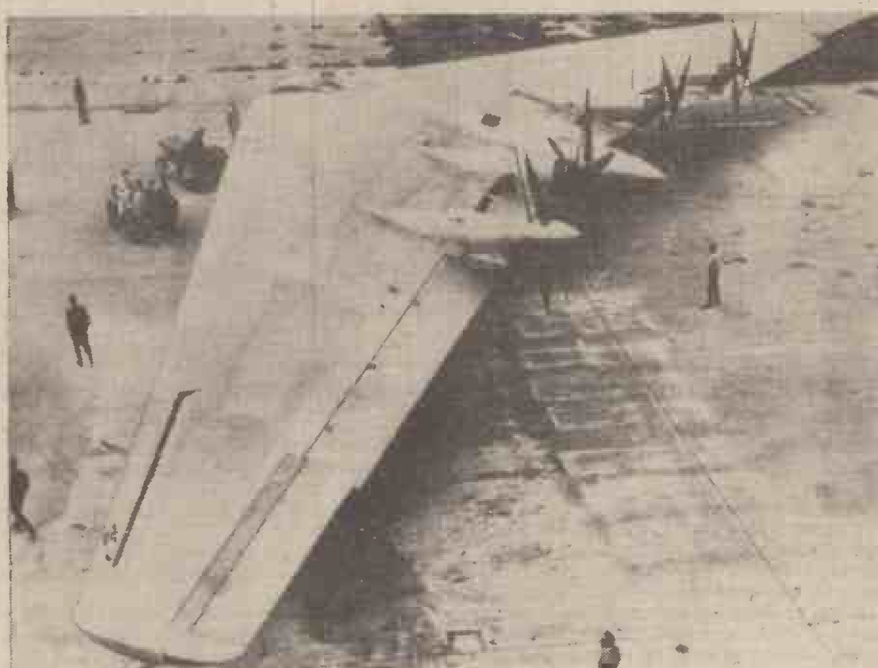
The device in question relates to bombs dropped into water and more particularly to floatable bombs which are required to explode when rising in the water at a short distance beneath the surface.

The inventor affirms that in order to minimise the errors in hits by under-water bombs it is advantageous to obtain a high terminal velocity in air and a low terminal velocity in water. Consequently, the depth to which the bomb sinks is limited and the time of immersion for a given upward velocity is reduced.

In addition, the low terminal velocity in water, by limiting the depth to which the bomb sinks, allows it to be used in rather shallow water.

The new device consists of an aerial bomb provided with a streamlined false nose covering the nose proper, which has a greater drag. The false nose serves to reduce drag while the bomb is falling through the air and to decrease the shock of impact.

The false nose, which may be made somewhat fragile, disintegrates under internal pressure after the nose of the bomb has entered the water. The nose proper increases drag and modifies the under-water travel of the bomb as required.



The giant Northrop Flying Wing XB-35 is wheeled to a runway for its first taxi-test in preparation for the initial test of flight, which took place in the United States recently.

The Annals of Electricity—10

Ampère's Advances in Electrical Science

IT was James Clerk Maxwell, himself a towering electrical genius of last century, who first described Ampère as "the Newton of Electricity," an appellation which is certainly as apt as it is a complimentary one. For just as Newton's investigations and calculations served to lay the foundations of physics and mechanics, so also did the researches of the ingenious Ampère, by their elucidation of the laws governing the action of electric currents, bring into being the practical science of electro-dynamics which deals with electricity acting as a motive force, a science which, indeed, culminated in the invention of the dynamo and the electric motor, and thereby introduced our present-day electrical age.

Yet, curiously enough, electricity was only a sideline with Ampère. His interest covered almost the whole gamut of the sciences. He was a botanist, a mathematician, a physicist, a devoted student of natural history, a chemist, an astronomer, a classical linguist, to mention only a few of the subjects in which Ampère made himself prominent. Nevertheless, if Ampère had not turned his attention to electricity we should never have heard of him in the ordinary way of things. The "amp.," that conveniently abbreviated designation of the unit of electrical quantity, which is Ampère's most lasting memorial, would never have come into existence.

André Marie Ampère lived a crowded life. Invariably he had half a dozen irons in the fire at any one time, so that it is impossible for us at this period of paper scarcity to trace out his career in any detail. He was born in Lyons, in the south of France, on January 22nd, 1775, the only son of one Jean Jacques Ampère, a well-known merchant of that town. Jean Jacques had been in a prosperous way of business, and soon after his son's birth he retired from active trade and settled down as a country gentleman in a village not far away.

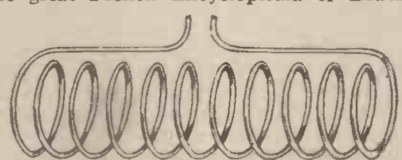
An Infant Mathematician

André Marie, the future electrician, turned out to be an almost uncannily precocious youngster. His innate mathematical ability showed itself the earliest. When he was barely seven years of age he was doing long calculations with kidney beans or pebbles, and, having acquired the ability to read, his first choice of books took the form of treatises on algebra. When he was twelve he was battling with Euler's and Bernouilli's mathematical works on the differential calculus, treatises which were written in Latin, which language he mastered especially for the purpose of comprehending these two great masters.

There was no regular schooling for Ampère in those days. He seems to have learned what he liked, being aided in the process by his father and by the kindly Abbé Dubarron, the learned librarian of the

André Marie Ampère.

College of Lyons. If was Ampère's wont in after life to remark that at the age of eighteen he knew about as much mathematics as there was to learn, whilst it is a fact that at about this age he had read through and apparently thoroughly digested the great French Encyclopædia of Diderot



A wire helix or "solenoid" which under the influence of an electric current behaves like a magnet.

and D'Alembert, a colossal compilation running into 20 folio volumes. This great treatise on universal knowledge Ampère devoured from the beginning to the end. Years afterwards, indeed, he gave proof of his knowledge of its contents by reciting the substance of articles chosen at random from it.

Victim of the Guillotine

In the midst of his placid and, perhaps, somewhat pathological intellectualism a storm broke with elemental fury into Ampère's life. It was the world-shaking storm of the French Revolution. It was an upheaval which carried away his father, Jean Jacques Ampère, to the then almost continuously operating guillotine of the Revolutionary Government in Paris, for Ampère *père* had, in his retirement, been a *juge de paix*—in other words, a magistrate—and, as such, a member of the much-hated "aristocrats."

The tragic fate of his kindly father brought a great sorrow into young Ampère's life. He endeavoured to drown it by assiduous study. He went for long excursions and botanising expeditions, and it was on one of these excursions that he met his first wife, Julie Carron. After their engagement Ampère became a private tutor in Lyons, and not very long after his marriage he obtained a lectureship in chemistry and physics in a French county school. After a year or two Ampère was able to return to Lyons, having obtained (in 1803) the professorship of mathematics and astronomy in the newly founded Lyceum in that city.

Less than a year afterwards his wife died. He then gave up his professorship at Lyons and sought refuge from his sorrows in Paris, obtaining there a post of tutor in the Polytechnic School.

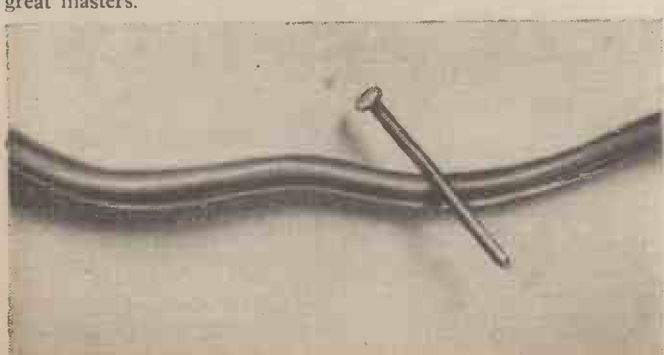
After a little while things improved for Ampère. He settled down to his studies again, devoting much time to mathematics and building up his scientific reputation by the publication of original papers. In 1806 he was appointed secretary of the French Bureau of Arts and Sciences. And in that year, also, he married again.

A couple of years went by, after which he became an "Inspector-general" to the University of Paris. In the following year (1809) Ampère was nominated to the Professorship of Analytical Calculus and Mechanics in the Polytechnic School at Paris.

The Top of the Ladder

Ampère had now climbed almost to the top of the academical ladder. He remained in Paris for almost the rest of his life. All his researches, electrical and otherwise, were carried out under the roof of the great Polytechnic in Paris, and in the famed French Institute in that city.

From these seats of original learning Ampère published a large variety of scientific papers on mathematics, physics, botany, natural history, chemistry and mechanics. The subject of electricity happened to be just one of the many studies which he "took up," as it were, almost automatically. It was a study which appealed particularly



A needle or a nail placed across a wire carrying a current becomes magnetised.

Residual magnetic influence in a nail which has been electro-magnetised, is sufficient to exert its effect upon a compass needle.

to the brain of Ampère on account of its need for mathematical treatment. Hence it was that his interest in electricity and magnetism, and, afterwards in electro-magnetism, was mainly of a mathematical nature.

Let it be said at once that André Marie Ampère was no painstaking, practical genius in the electrical art as was, for example, our own renowned Michael Faraday. Indeed, Ampère failed to make any really first-class electrical discovery. Yet it was he who, by systematising and explaining the discoveries of others, particularly the discovery of electro-magnetism which was made by Oersted in 1820, put electrical science on its feet and made it possible for future workers to have a clear understanding of the subject in which they were engaged. The great Faraday, among many other original workers, was indebted to the more theoretically minded Ampère for much of the groundwork on which he based his magnificent discoveries.

It was Oersted's discovery of electro-magnetism in 1820 which seems to have impelled Ampère in his Parisian laboratories to concentrate his attentions on electrical work. Within a week of Oersted's announcement of his discovery, Ampère had worked out an almost complete exposition of Oersted's electro-magnetic effect, and had demonstrated that all magnetic effects could be produced by the electric current alone. Such a result of high-pressure work on the part of a single individual is almost incredible, but dates are dates, and anyone who cares to examine the publication dates of Oersted's and Ampère's original papers will be amply convinced of this fact.

Ampère's Rule

Ampère gave a definite rule for finding the direction in which a compass needle turns under the influence of an electric current, this effect constituting Oersted's original discovery of electro-magnetism.

Said Ampère: "Picture a little manikin swimming with the current while facing the compass needle. The north pole of the needle will then be turned to his left, while the south pole of the needle will be turned to his right."

This imaginary "bonhomme d'Ampère," as others quickly dubbed the electrical swimmer, has from Ampère's time been paraded in nearly all electrical textbooks as an aid to the student in determining the movement of the magnetic needle in relation to the direction of the electrical current, or, conversely, as a rule for ascertaining the direction of the current from the observation of the movement of the needle.

Ampère did more than this, however. He was the first to show that if electric currents flow through two adjacent parallel wires, the wires will tend to attract each other when their respective currents flow in the same direction, but that the wires will tend to repel each other when their respective currents flow in opposite directions. He showed that this force of attraction or repulsion is directly proportional to the intensity or strength of the currents and inversely proportional to the square of the distance between the wires.

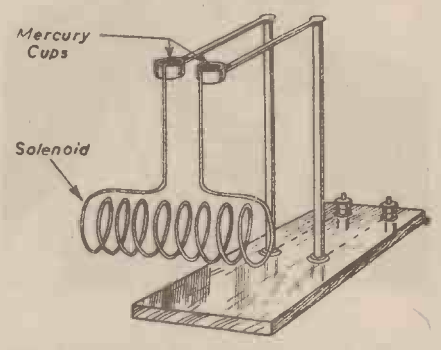
Perhaps it was this particular discovery which James Clerk Maxwell had in mind when he first called Ampère the "Newton of Electricity," for, the reader will remember, it was the great Sir Isaac Newton who first announced a similar law with respect to the force of gravitation.

Discovery of the Solenoid

It was Ampère who introduced the electrical "solenoid" and, afterwards, the electro-magnet.

It is very interesting to trace the course by which these two discoveries came about, since, unlike not a few other discoveries, they were by no means creations of chance.

Ampère, in thinking out an explanation of the electro-magnetic effect observed by Oersted, postulated a theory which endeavoured to account for the phenomenon of magnetism by supposing that the magnetic effect of, say, an ordinary bar magnet is due to a tiny electric current which continually circulates around each individual molecule of iron in the magnet. In the non-magnetic state these supposed molecular currents circulate around the molecules in varying directions, but when the bar is magnetised the currents, according to Ampère's reasoning, must circulate in one direction only. So that, in effect, the sum of these minute circulatory currents would be equivalent to that of a larger single current moving in a series of circles.



Showing Ampère's method of suspending a freely-movable solenoid from mercury cups in order to demonstrate the solenoid's behaviour as a magnet when a current is passed through it.

Ampère's theory of magnetism was wrong, but it led to surprising consequences, practical as well as theoretical. It resulted in Ampère's trying out the effect of a single electric current flowing in a circulatory manner through a helix of wire. And, just as Ampère expected, under these conditions, the helix behaved, when freely suspended or mounted, just as if it were a bar magnet, the helix taking up a horizontal position north and south just as a bar magnet would do when freely mounted.

Ampère's electrical helix came to be known as a "solenoid," the word being derived from the Greek and meaning "tubular." Solenoids attract and repel each other, as Ampère discovered, according to their polarities just as ordinary magnets do. Indeed, as Ampère remarked, they are to be regarded as "skeleton magnets," or, as we might say to-day, synthetic or artificial magnets. And just as a bar magnet will communicate its magnetism to a non-magnetic iron bar, so, too, will a solenoid impart its magnetism to a metal rod or bar which is placed within it, but out of any direct electrical contact with its coils.

The Electro-magnet

Here, of course, we have the electro-magnet, the parent of countless electrical devices. Whether the first electro-magnet was made by Ampère or by his brilliant contemporary François Arago, a French physicist and astronomer, seems to be doubtful. It was certainly Arago (not Ampère, as has sometimes been stated) who found that a conductor carrying a current would feebly attract and magnetise a needle or a nail placed across it, but it was Ampère who ascertained that the needle or nail might, under these conditions, sometimes become sufficiently magnetised to exert an influence on a suspended compass needle in just the same way as an ordinary magnet is able to attract or repel the pole of a compass needle.

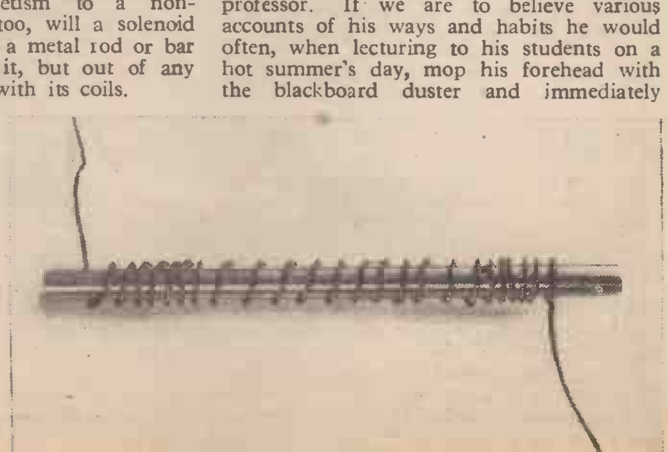
It is fairly certain, however, that to Ampère goes the priority of reasoning that a coiled wire ought to intensify this effect, and of thus bringing into practical possibility not only the solenoid but also its direct outcome, the electro-magnet.

Based upon the idea of the electro-magnet, Ampère put forward the notion of an electric telegraph. But he was not practically minded enough to get anywhere with this project. For instance, the telegraph which he proposed was to be based upon the deflection of a magnetic needle by a wire coil carrying a current, but there were to be as many needles, coils and connecting wires as there are letters in the alphabet. And since, also, the chemical battery was the only source of the electric current in those days, very great battery power would have been necessary for the operation of such a telegraph over any reasonable distance. Hence the whole notion of the telegraph as projected by Ampère was dropped in favour of more practical schemes which were not very long in forthcoming. All the same, since Ampère's telegraph plan was announced in a paper read by him before the French Academy of Sciences on October 2nd, 1820, its projector must, in fairness, be numbered among the few claimants for the honour of being designated "Father of the Electric Telegraph."

This was about as far as André Marie Ampère went in the science of electricity. He laid the foundations, cleared away a mass of former misconceptions, and indicated where others might build. But he took little, if any, part in the subsequent work of applying electrical science to practical ends.

Indeed, Ampère's life at this period seems to have become one entirely of routine. His salary was small and he had accustomed himself to living in what used to be termed "gentile poverty." In many respects, Ampère, during the height of his fame, seems to have been the typical personification of the legendary absent-minded professor. If we are to believe various accounts of his ways and habits he would often, when lecturing to his students on a hot summer's day, mop his forehead with the blackboard duster and immediately

Illustrating the outcome of Ampère's solenoid—the electro-magnet, comprising merely an iron bar placed within a solenoid.



afterwards proceed to wipe out the blackboard figures with his silk handkerchief.

Ampère's *Essai*

Almost his last creative work was Ampère's *Essai sür la Philosophie des Sciences*, a work which he did not live to complete but which was afterwards published in its incomplete form in 1838. Ampère's last *Essai* attempts to present the whole range of science and natural knowledge to the student. It begins by dividing science into two large categories, material science and the science of mind or thought. Each of these two divisions was subdivided, and by this means more than a hundred branches of natural science were obtained.

Some of Ampère's names for his arbitrary science divisions sound fantastic to our ears. Who has ever heard of the sciences of "terpnognosy," "technesthetics," "coenolbology," and "cybernetics," to mention but a few of the strange names in Ampère's last *Essai*?

The *Essai* is, indeed, a work of a lifetime's intensive learning, and a tremendous tribute to the ingenuity of its author, but, all the same, it is unbalanced, impracticable, unfinished, and, as such, has been forgotten for three generations.

As he grew older Ampère's health became feebler, and the time eventually came when he had to leave Paris and to go south in search of relief from his chronic chest trouble. He went to Marseilles hoping that the gentle breezes of the Mediterranean would restore him at least partially. But he had no sooner got there than he was seized with a brain-fever. It was his last illness, from which he died on June 10th, 1836.

The scientific world regretted Ampère's passing. Although retiring, nervous, shy, and impracticable, Ampère had made a great impression, through his original work, upon contemporary scientists and philosophers. They acknowledged his originality, if somewhat belatedly, and they raised monuments to him.

But the greatest monument of all came in 1881 when the International Congress of Electricians met in Paris and agreed to designate by the term "ampere" the unit of electrical quantity, thereby translating into living language the memory of a man who had done so much to establish the foundations of electrical science.

The Netherlands Railways One Year After the Liberation

Only half a year after the total destruction of the Oosterbeek railway bridge, near Arnhem, the first train passed over the emergency bridge.

FOR seven long months, from September 17th, 1944, to May 5th, 1945, the greatest part of the railway system and industry of Holland lay paralysed. Stations and yards, roadbeds, signal-boxes and bridges, everywhere lifeless and deserted, fell easy prey to the fury of the enemy, whose rage at approaching defeat was vented on the first-class equipment and installations of the Netherlands Railways. This destruction, carried out with typical German thoroughness, transformed the Netherlands Railways into little more than a mass of wreckage, so that on the day of liberation it seemed that its restoration might well be despaired of.

Certainly the restoration has been no simple task; primarily because the most indispensable materials have been unavailable. But regardless of this the railway personnel set to work with all their might and soon the first trains were running again in Holland. To begin with they carried food and displaced persons coming home, but before very long a passenger service was possible.

Now a year has gone by. A year of great effort on the part of everyone connected with the railway, from high to low. A year in which almost insurmountable obstacles had to be overcome; in which problems hitherto unknown were solved by most original methods. But all these difficulties have been, as far as possible, overcome. The means were found, by improvisation or experiment—while never for one minute forgetting that safety is the most important consideration—and bit by bit, mile by mile, bridge by bridge, the rebuilding of the railway went on.

Reconstruction Plans

It is still going on, at full speed. The reconstruction is to only a small degree complete. But this seems to be an appropriate time, just exactly a year since the reconstruction could be begun, to look back and see what has been accomplished during this period. This can be most clearly shown with the aid of a few figures.

In September, 1944, the Netherlands Railways operated 1,974 miles of railroad, of which by May, 1945, 1,221 miles, or 62 per cent., were destroyed or torn up. Now, a year later, 1,800 miles of line, or 91 per cent., are back in use. In September, 1944, there were 354 miles of electric line. Of this 315 miles, or 92 per cent., were destroyed or rendered useless. Now 115 miles are back in service.

Once there were 21 railway bridges over the great rivers. Sixteen of them, or 76 per cent., were blown up or obstructed. Thanks to

The bridges of Holland, with its numerous rivers and canals, are of supreme importance. Everybody in Holland knows this, and so did the Germans, and they destroyed 70 per cent. of the railway bridges.

tremendous efforts and the great help given by our Allies, 12 of the bridges, or 57 per cent., are open to traffic again. In total, 220 railway bridges were blown up or damaged. At present 191 of these are open to traffic again.

There is one more set of figures that gives a clear picture of the achievements of this year; this shows the distances travelled by train. In September, 1944, 38,562 miles were run by passenger train and 24,375 miles by freight. On May 5th, 1945, the total—thanks to the restoration of one line in the south of the country—amounted to 1,183 miles and 1,313 miles respectively. Now, one year afterwards, the distances travelled are: 29,493 miles by passenger train and 20,625 miles by freight, that is 68 per cent. and 85 per cent. of the former totals.

Shortage of Materials

The greatest difficulty facing this work of reconstruction is the general world-wide shortage of materials. This also accounts for the less rosy picture given by some other figures. In September, 1944, there were altogether 163,000 seats in the passenger cars of the Netherlands Railways. Of these no fewer than 156,000, or 96 per cent., are a total loss, as the Germans removed or destroyed a huge number of passenger trains. On top of this, the workshops, where much repair work might be done, were plundered and wrecked so that only a limited amount of work can be done in them even now. Thus it is that the Netherlands Railways still only have some 45,560 passenger seats, or 28 per cent. of the original total.

Finally, some figures on the rolling stock of the Netherlands Railways. Naturally, the greater part and the best part of this is stolen and gone. The 137 streamlined electric cars that the Netherlands Railways still owned in September, 1944, were all removed or destroyed, as were the 57 Diesel-electric and 25 Diesel cars, which were once the pride of the Netherlands Railways. Most of this stock was removed eastwards and what has returned —and it is by a long way not all—is in a miserable condition. However, it has been possible, even in the sadly wrecked workshops, to repair some of these cars so that there are at present 31 streamlined electric, 14 Diesel-electric and 10 Diesel cars back in service.

Steam Engines

The Germans attached great importance to steam engines, which they showed by making off with or destroying 722, or 84 per cent., of the total of 866 belonging to the Netherlands Railways. Some 400 of these were located in Germany and have been brought home. But that hardly means that they are fit for use; some of them will never run again and their only value is that they can give material for the reconstruction of others. However, a certain number can certainly be repaired, which work is being carried out, with the valuable co-operation of private firms as well, at the Netherlands Railways workshops at Tilburg. At present there are 326 locomotives running, which is 37 per cent. of the number in use in 1944, and this includes 15 new Swedish and 19 not new but perfectly serviceable Swiss engines.

This question of locomotives poses a considerable problem in reorganisation of the service of the Netherlands Railways. For, though it is true that the railways also have the use of 294 engines hired from England, these are not in good repair and, despite the fact that private firms are joining in the repair work, it is hardly possible at one and the same time to rebuild the damaged engines and keep those now in use in repair. The result of this situation is that the supply of locomotives remains limited, while the work of reconstruction cannot expand.

Shortage of Cars

An additional difficulty is the shortage of cars for steam-powered engines. Before the strike there were 1,498 cars, of which 1,406, that is 94 per cent. of the total, are gone. At present the Netherlands Railways have no more than 466, or 31 per cent., cars which, in addition to the 232 loaned from abroad, is still too few. It is for this reason that the Netherlands Railways have been forced to use freight and baggage cars for its passenger service.

But that all of these difficulties will be overcome, there is no question.

Scientific Facts

By Prof. A. M. LOW

Air Is Mighty Hard

I HAVE often explained that hardness depends entirely on speed and that if you slap your hand on a basin of water it will sting because the water is hard at high speeds. You can assure yourself and your friends by demonstrating the hardness, as it were, of air at high speeds, or at least the pressure of air in the atmosphere against which a car has to push its way.

On a smooth table, hanging over one edge, place a thin board about 18in. long by 10in. wide. Open a newspaper and put two or three sheets over the half of the board which rests upon the table. You have positively "nailed" the board to the table and if you give the overhanging part a really hard blow with your fist you will find that nothing happens.

It is a matter of time, because the paper prevents the air getting under the board during the period of your blow. Press slowly with your little finger on the overhanging part and up she comes without a tremor.

Any pilot will tell you that to open your mouth at 200 m.p.h. in an open 'plane would be very stupid and if you try to hold out your hand from an aeroplane cockpit the air at high speeds is so hard that it knocks it back as if it had been hit by a brick.

I once saw air escaping from a pressure chamber at about 5,000lb. per square inch. Hammers and spanners and half bricks bounced on the stream exactly like the ping-pong balls which dance on a thin water jet at a shooting gallery. So you must think of this factor of speed. Engineers always do. When gas has to travel fast in a pipe they calculate the bends as if they were dealing with treacle and not air. Air in inlet pipes compresses, gets hot and bounces about like a lot of springs. The watching eye of a high-speed cinema has got to have a butterfly on the wheel effect, the picture itself travelling with everything that moves.

You Can See By It

WHEN writing about light I think I did not make it clear that what you and I call light is only one form of an etherial oscillation. It mildly resembles wireless waves except that its frequency is vastly higher. Grey light from the sky is a combination of all the spectrum colours and if you paint a white disc about 3in. diameter with segments of each of these rainbow colours and then spin it like a top you will soon find that the colours blend into white. There are many other kinds of light, each different from its neighbour. There is the cathode-ray which makes some of the platinum compounds fluoresce, a property very useful to makers of television screens. X-rays are also light, but have quite different properties, and are capable of penetrating apparently opaque substances owing to their very short wave-length with which the particles of normally solid matter are liable to interfere. If you had eyes which were sensitive to X-rays you would be able to see through walls; if you had eyes like a microscope you would see the air full of living creatures, and if it did not happen that the sun's rays were composed mainly of these spectrum colours you would never have taken white to be plain and not coloured. If the sun's rays had been green your relative eye sensibility would have been different for you are a creature of evolution in nature's plan. You would have looked at a pair of bright red pants and remarked "what a pity they are not coloured." While white would, no doubt, have seemed most glaring and out of place. Heat is merely a slightly different form of light with a longer wavelength. It can be focused as in the normal electric fire, and its rays can be bent like those of light by using the proper material. In the early days of infra-red photography when it was first discovered that photographs could be taken through cloud the first experiments were made with lenses constructed of rock salt because this substance did not cut out the heat rays. There is no real difficulty in taking a photograph inside a dark room by the light of a kettle of hot water.

At the other end of the stick we have ultra-violet light, which is invisible, and which does not pass through lenses containing lead. That is, of course, why special glass has to be employed if the full benefit of the sun's rays is to come into your house. In this world we know very little about light, but we do know that it is a somewhat material thing, and I quite think that when atomic power has been further investigated and we have found how to change matter into energy quite easily, we shall be able to write knowledgeably about the weight of light. For light has weight, and actually hits us all the time. It has been calculated that if a half-penny was raised to the temperature of the inside of the sun the actual weight of light proceeding from it would knock down everyone to a radius of over five miles. Obviously, it would frizzle them up first, but in these war-like days that is probably not so interesting.

Floating Metal

DURING the war, and at the height of London's bombing, I was engaged on toying with explosives in an area round which burning houses enabled the reading of a newspaper in the middle of the night to be comfortably practicable. So you will understand that the anti-aircraft defences were of some interest to me.

A friend came along with the suggestion that if we could fill small cylinders a few feet long and a few inches in diameter with hydrogen, releasing them in millions, they would prove definitely unpleasant to enemy pilots.

He did not realise, of course, that to achieve such an object the aluminium would have to be so thin that it could never be used in practice.

Yet one can understand that without a little arithmetic he could easily go wrong, for the gasbag of the original Zeppelin was constructed entirely from sheets of aluminium. The volume of gas contained in this way was far greater in proportion to its weight than could ever be arranged with small containers.

No aluminium could be made sufficiently thin to render the use of hydrogen-filled walking sticks of any purpose although I should mention that metals can be so thin that light is often transmissible. The resulting colours and interference with light waves which result are surprisingly beautiful.

Radar Aids the Weather Forecaster

A Brief Outline of the Developments Made in this Important Branch of Science

By E. L. WILLEY,

IT has been found that radar of the shorter wavelengths can see areas of rain, falling snow, and certain types of cloud that are dangerous to 'planes, in addition to detecting targets such as ships and aircraft.

The echo obtained from these weather phenomena is easily distinguishable, being spread out over the radar screen, consequent upon the large area covered by the " target," whereas the echoes obtained from ships and aircraft are very precise.

By watching the motion of these weather echoes across the screen the speed with which a rain belt, or a thunderstorm, is moving can be accurately calculated; so that from the information of its exact position given by the radar, it is possible to forecast to within time limits of two or three minutes when the rain will reach a given place.

Furthermore the brightness of the echo indicates the intensity of the rain, thus the weather forecaster is able to say whether approaching rain is becoming lighter or heavier.

Advanced Technique

With the type of radar set at present in use for this work, one is able to watch the weather over the area within a hundred miles radius of the set. As a rain belt rarely moves across the land, or sea, with a speed of more than 20 m.p.h., use of radar to forecast its arrival should enable nearly five hours' accurate warning to be given. Unfortunately thunderstorms are a somewhat different proposition, as they generally develop rapidly, and the radar operator will see the echo of the storm suddenly appear on the screen as the thundercloud reaches an optimum state in its development. It is, however, found possible to give a 15 minutes' warning of the approach of a thunderstorm.

As may be imagined, the use of this technique in weather forecasting is a great advance on previous methods, when the time limits of predicting the arrival of a belt of rain were within the regions of an hour, and as far as thunderstorms were concerned it was only possible to state that they could be expected over a large area, and no warning at all could be given to the places subjected to a downpour.

Besides seeing rain, radar can detect falling snow. This gives a less intense or bright echo than a steady fall of rain so that there is a danger that by merely using radar observations it may be difficult or impossible to distinguish between light rain and heavy snow. This, however, is no great problem as the weather forecaster can state definitely from the information normally available to him which of rain or snow is to be expected.

An interesting phenomena is that melting snow gives a far brighter echo on the radar screen than the rain which it eventually becomes. Meteorologists believe that in this country all rain commences to fall as snow, so that by directing a radar beam up into falling rain, a very bright echo will be obtained from the melting snow flakes at the freezing level of the atmosphere; thus enabling the height of the level to be measured. This provides a valuable aid to meteorologists, as a knowledge of the height of the freezing level is of vital importance when forecasting icing conditions for aircraft—a matter of grave concern to pilots.

Another danger to aircraft is the type of cloud in which there are large vertical upcurrents. These currents frequently attain velocities of over 20 m.p.h., so that the strongest aircraft is soon broken up if it happens to enter one of these clouds. Fortunately such clouds may be detected by radar, so that the pilot of an aircraft need have no fear of such clouds in the dark, if his craft is equipped with suitable radar.

The radio sonde meteorological balloon ready for release. A small parachute is tied below the balloon which expands as it rises into the rarefied upper air. In the stratosphere, at a height of ten miles or more, the balloon bursts, and the apparatus floats down on the parachute.

Value to Industry

It thus appears certain that the use of radar for watching the weather will prove of immense value to industry, commerce, and shipping. Power supplies may be put out of action over a wide area by a heavy thunderstorm, a failure which can be averted if the power company has a 15 minutes' warning of the deluge.

Radar in aircraft may be used to warn the pilot of dangerous clouds and areas of bad weather that lay on the course of the aircraft, and the weather information obtained from a set at an airport can be used to guide incoming aircraft so that they avoid areas of bad weather and dangerous clouds. Also the accurate forecasts possible as to the weather conditions at the airport will prove of invaluable assistance to the flying control authorities in planning the various alterations to flying schedules which the weather makes necessary.

In the tropics the impossibility of accurately tracking typhoons has seriously impaired the accurate forecasting of their movements, a difficulty which the use of radar will to a considerable extent obviate.

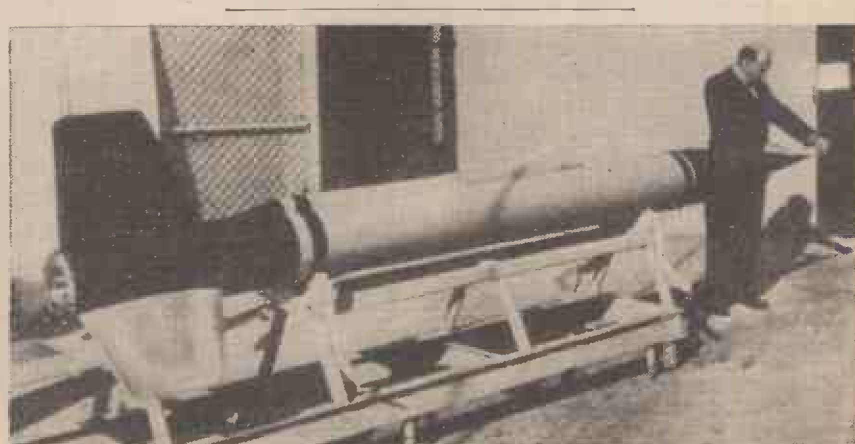
The weather forecaster at sea will find radar an invaluable assistant. Even in peacetime, weather observations over the sea are sparse, a fact which makes forecasting at sea a difficult task. Now with the aid of radar, the sea-going meteorologist is able to watch the weather for a hundred miles round his ship and as a result is able to forecast with the same facility as his colleague ashore.

Wind Speeds

An important feature of a weather forecast is the speed and direction of the wind up to heights of 10,000 to 15,000 ft. A knowledge of these is essential for the navigation of aircraft, and in wartime for accurate gunnery. The meteorologist normally finds these winds by observing at given time intervals the bearing and elevation of a hydrogen-filled balloon, rising at a predetermined rate of ascent. Then by the use of simple trigonometry he calculates the wind speeds and directions at the various heights. The presence of low cloud, in which the balloon soon becomes lost, more often than not brings such observations to a premature end. A rubber meteorological balloon, in itself, gives no echo on a radar set, but now a number of types of radar targets for attachment to these balloons have been developed, so that they can be tracked by radar throughout the course of their ascent.

As a result the winds at high levels may be found in good or bad weather, by night or by day.

All the developments outlined in this survey have been produced as a weapon in time of war, but now we may look forward to the use of radar in weather forecasting as an invaluable help in time of peace.



At Pasadena, California, Glena Bassett examines the ionisphere rocket, developed by the California Institute of Technology, that set an American altitude record of 230,000ft. in a recent test.

THE WORLD OF MODELS

By "MOTILUS"

A Realistic Model Railway, and a Gloucester Man's Model Ship Built from Matches

THE model railway which forms the basis of this article is the property of an architect, Mr. H. Linley Bown, of Grain Beck, Killinghall, near Harrogate. It is seldom that such a complete and detailed layout comes up for sale, particularly at a time when model railways are still at a premium, but the circumstances of war have taken away the boy for whom the railway was built and it is natural that his father will not now have the same interest in their mutual hobby.

Electrically Operated

Mr. Bown tells me it is getting on for 20 years since the first electric railway was purchased for his son. It was an electric train of German make, purchased as a birthday present, and it worked direct from the mains supply through a resistance coil and carbon lamps. But after he had suffered one or two shocks whilst operating this layout, Mr. Linley Bown decided it was not very safe for the lad to work himself and the idea came to him to build a model railway, using scale model track, rectifier and control, together with locomotives, rolling stock and all general equipment.

Being an architect it was not difficult for him to draw out a detailed plan of his layout and he sent this to Bassett-Lowke, Ltd., asking them to supply all the materials required. Apart from getting a joiner to make the table, Mr. Bown built the entire railway himself and did all the wiring for power and lighting with the exception of the connection from main supply to rectifier and the fixing of main switch and fuses. He did, however, have occasional help from an electrician for connecting up to control and the electro-mechanical point operating device.

At the week-ends and in his spare time he worked away at the layout, and it took him about 18 months to build. The cutting and threading of the point rodding and connecting to the bell cranks for operating points and signals took perhaps the longest, especially getting the adjustment to give the necessary throw for points, but railways had always been of great interest to him, and ever since he was a boy he had had the desire to construct a working layout.

The gauge of the railway is the standard gauge "O" (1¼in.), and the total length of the main double line track is 34ft. There are also five sidings accounting for another 25ft., making a total of nearly 60ft. in all. The main supply of electricity is 230 volts A.C., transformed through a rectifier and reduced to 6-8 volts D.C. A vertical pattern control switch is used for starting, stopping and reversing, and this is also fitted with terminals for use with two road railways.

Two views of Mr. Linley Bown's model railway. (Above) Rugby Station in the foreground. (Left) The main line and goods sidings. York station is seen in the background.

Locomotive Stud

There is an interesting locomotive stud—a *Princess Elizabeth* passenger locomotive, a standard tank locomotive, the famous L.N.E.R. *Flying Scotsman*, and three 2-6-0 types, G.W.R., L.M.S. and L.N.E.R.—and his rolling stock includes three passenger coaches electrically lit and one mail van with pick-up apparatus. His goods rolling stock is all in wood and comprises brake vans, covered wagons, open wagons, timber, brick

A close-up view of York Station.

Passenger and goods trains passing through York station.

and Colas wagons, and these are all fitted with automatic couplings, with a device for fly-shunting in addition.

The track is laid in scale model permanent way and has two signal boxes, each of which contains six lever frames operating the signals and the points. Both the stations are lighted by electricity and, in addition, there is one set of electro-mechanically operated points. Other items in the layout are two engine sheds, a turntable, a goods depot, a coal office, a platelayers' hut, a water tower and a loading gauge. Mr. Bown has not attempted to make elaborate scenery but has obtained an excellent effect by cut-out silhouettes of impressionistic style round the walls. Realism is also achieved by the ample attention to detail in the platform accessories —the numerous model railway station staff, the pillar boxes, trolleys, seats, bookstalls, telegraph posts and wires, and electric light standards on sidings make the railway live. The track is all ballasted, and the embankment is carried out in plaster of paris, coloured up and with trees and shrubs fixed in, even the addition of swans and a bridge to lend an out-of-the-ordinary touch.

Mr. Bown's boy joined the Forces in 1939 and did not come back, but he has never regretted the work he put into this railway. His son spent nearly all his spare time in running it, setting himself problems of shunting and assembly of goods trains, time-tables for his passenger trains and in demonstrating to his friends, and during the war years Mr. Bown himself has given displays to the children in the village and to friends and their sons, to whom the railway must have given in all hundreds of hours of enjoyment.

To run two trains, work the signals and points and do any shunting required, demands concentration to avoid accidents and in Mr. Bown's opinion helps to train a boy to think quickly, and the assembly of goods trains in a pre-arranged order entails study and calculation, helping to inculcate a sense of responsibility and carefulness in the budding model engineer.

Here is an opportunity for someone else's son. If the railway has not been disposed of by the time this article appears in print, Mr. Bown would be willing to sell it complete, but the would-be purchaser must give an undertaking to arrange for dismantling and transport. The table on which the railway is built is made up in four sections and could be taken apart without removing the permanent way, stations, tunnels, sheds, etc., as the lines, point rodding, wiring and so forth could be disconnected at the ends of each section.

Model Cargo Liner

Now from model railways to boats. I have recently come across a very interesting model cargo liner built by Mr. William Brain, of Gloucester. It is 5ft. 9in. long by 10in. wide, and is estimated to contain nearly 33,000 matches.

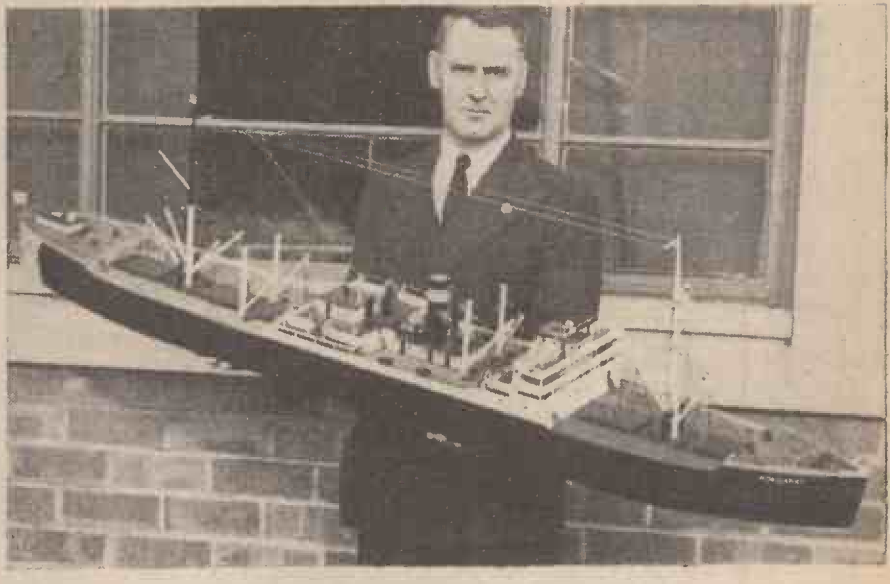
Prior to 1941, Mr. Brain, who is now employed by the L.M.S. Railway Company, had been connected with the sea for over 30 years and had served in the Merchant Navy. His hobby of ships dates from the time he was at sea and he has constructed numerous other models. His latest model was built by arrangement with the L.M.S. Home Guard, and waste matches have been sent to him from the goods station, while neighbours have also helped to keep him supplied.

Working on this model in his spare time, Mr. Brain has taken about three months to build the ship, which weighs 12lb. 2oz. He used ordinary glue to stick the matches together and then painted the finished model.

His latest effort is to build a model of the L.M.S. Railway Company's motor vessel *Princess Victoria*, which when completed will be given to the Railway Servants Orphanage.

Model Making in Switzerland

The writer has recently returned from a visit to Switzerland for the first time since the Swiss National exhibition of 1939, and will have a mass of interesting information on the progress of model-making in Switzerland during the last seven years for our next issue.



Mr. William Brain and his model cargo liner.

Pegasus Engines in B.O.A.C. Flying-boats

THE B.O.A.C. Hythe-class flying-boat Hudson took off from Poole Harbour, Dorset, on the morning of Sunday, May 12th, to re-open the Empire flying-boat route to Sydney, suspended during the war. Fitted to the Hudson, as to all other aircraft of the Hythe class, are Bristol Pegasus 38 engines, developing 1,030 b.h.p. at take-off and driving de Havilland three-blade airscrews.

The Pegasus has had one of the longest and most remarkable records in the whole of aero-engine history. First produced in 1932, the Pegasus initially developed 570 b.h.p. To-day it gives over 1,000 b.h.p for the same capacity. Four world height records were captured by Pegasus-engined aircraft in the years before the war. The first was in 1932, when a Pegasus-engined Vickers Vespa reached 43,976ft. The second and fourth flights, in 1936, and 1937, were made by Squadron Leader F. R. D. Swain and Flight Lieutenant M. J. Adam respectively in Bristol 138A monoplanes in which the Pegasus engines was fitted with a two-stage supercharger. Adam's flight recaptured the record for Britain after it had been won by Italy—with a Pegasus-engined Caproni aircraft.

In 1938 Pegasus engines gained another honour when they powered the Vickers Wellesley aircraft of the R.A.F. Long Range Development Flight, which beat the world's long-distance non-stop flight record.

That the Pegasus was not merely an engine fitted for special record-breaking operations has been proved by its reliable and efficient service in military aircraft during the war and in civil aircraft both before and after the war. With this engine, the Hythe-class flying-boats operate at 170 m.p.h. T.A.S. on 60 per cent. of take-off power.

Now the Pegasus is back on its pre-war job, for it was with Pegasus-engined flying-boats that the service to Sydney was inaugurated and maintained before the war.

QUERIES and ENQUIRIES

A stamped addressed envelope, three penny stamps, and the query coupon from the current issue, which appears on back of 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.

Gold-plating Bath

I WISH to set up a small electro-gilding bath for gilding some small articles.

Please let me have the formula for making the gold solution (1 pint). Also the voltage to use and current density per sq. ft. of surface.—N. Tibbitts (Gloucester).

THE simplest and the best way for any inexperienced person to set up a gold-plating bath is to purchase ready made a quantity of gold-plating salts from a firm of specialists in plating materials, such as Messrs. Wm. Canning and Co., Ltd., Great Hampton Street, Birmingham.

If you wish to make your own solution, proceed as follows:

Dissolve a quantity of fine gold (i.e., pure gold) in a mixture of 3 parts hydrochloric acid and 1 part nitric acid. After the gold has dissolved, evaporate the solution to dryness. Then dissolve the residue in a little distilled water and add to the resulting solution strong ammonia drop by drop until there is no further precipitate.

The precipitate so obtained consists of gold fulminate. It is quite safe as long as it is wet or moist, but in the dry state it is a *highly dangerous detonating substance*. Hence, you must never allow it to become dry.

Make up the following bath:

Potassium cyanide	..	10 grams.
Sodium carbonate	..	15 grams.
Water	..	500 ccs.

This solution should have about 2 grams of the gold fulminate dissolved in it, although the exact quantity of the fulminate is immaterial. Use an E.M.F. of three-quarters of a volt and use the bath at a temperature of 60 deg. C. to get a full gold colouration. At lower temperatures the gold is deposited in a paler shade.

As an anode, you can use a piece of pure gold wire or, alternatively, a length of platinum wire. If you use the platinum anode you will have to make additions of gold fulminate to the bath from time to time in order to make up for its loss in strength, the platinum anode not dissolving in the bath.

It is, however, our opinion that, unless you are practised in the art of gold-plating, you would be well advised to buy your gold salts ready made.

"Paste" Stones and Jewellery

CAN you please tell me how paste stones and jewellery are made?—K. Beall (Sutton).

THE term "paste" used in connection with jewellery refers to varieties of glass which are coloured by admixture of traces of certain metals. These special glasses have a brilliant appearance, in consequence of which they serve extensively as gem stones.

Here, for instance, is a "paste" for making imitation diamonds:

Pure white sand, 100 parts (by weight); lead oxide, 35 parts; potash, 25 parts; borax, 10 parts; manganese dioxide, 5 parts. The ingredients are very finely powdered and then heated in a furnace to white heat, at which temperature they fuse and form a variety of glass which is afterwards made into "paste" or imitation diamonds.

Electric Arc Furnace: 1in. Spark Coil

CAN you advise me concerning the voltages necessary for an electric muffle and an electric arc furnace. I wish to run them off A.C. mains, so could you please specify what kind of a transformer and also any other requirements that I shall need? Where can I obtain the parts for the furnaces?

I am in the process of making an induction coil to produce a spark of at least 1in. from 12 volts. Could you give me particulars of length, etc., of the wires for both primary and secondary coils?—B. A. Rimmer (Catterick).

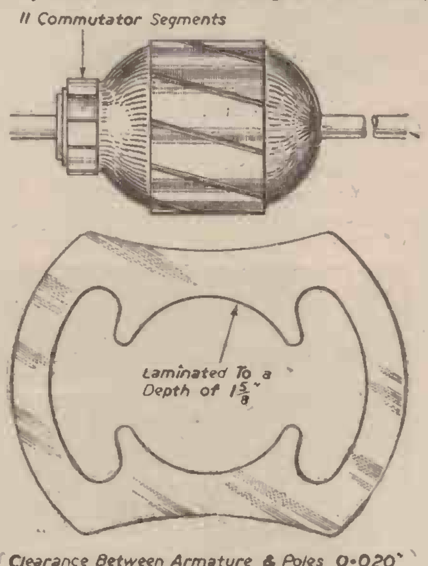
AN electric arc furnace can be supplied through a single-phase air-cooled transformer from the A.C. mains. For ½in. carbons you could use a transformer having an output of about 20 amps. at 55 volts (1.1 kVA.). A choke coil or series resistance should be connected between the secondary of the transformer and the electrode.

You may be able to obtain suitable muffles from The Thermal Syndicate, Ltd., Wallsend, Northumberland; and Newtempheit insulating material from Newalls Insulation Co., Broxbournbury, Broxbourne.

For a 1in. spark coil fed from about 12 volts D.C. you could use a core built of 22 s.w.g. annealed charcoal iron wires built up to 1in. diameter by 9½in. long. The coil bobbin could be 8½in. long between cheeks of 2⅜in. diameter. The primary could have two layers of 18 s.w.g. D.S.C. wire, and the secondary 1½lb. of 38 s.w.g. D.S.C. The secondary layers should be about a half shorter than the primary layers. When winding the secondary the wire should be passed through a bath of hot paraffin wax, the surplus wax being wiped off with a piece of old linen whilst feeding the wire on to the bobbin. A layer of thin paper should be wound between each of the secondary layers. The complete coil should be well basted with hot wax. A condenser should be connected across the make-and-break contacts. This could be made with 100 sheets of tinfoil, 7in. by 5in., interleaved with sheets of waxed paper 8in. by 6in.

Field Winding for a Small Motor

I HAVE a small electric motor (voltage 230-250), the armature and field stamping of which are shown in the accompanying diagrams. I intend to use it for driving a cinema projector, or small emery wheel. The field windings are burnt out,



Armature and field stamping for a small electric motor. (G. Webb.)

and I shall be glad if you will inform me how many turns and what gauge of wire to use for rewinding the field coils.—G. Webb (Woodley).

IN view of the fact that the number of turns and size of wire on the armature are unknown, it is only possible for us to give you an approximate specification for field windings. We suggest you wind each field pole with 450 turns of 28 s.w.g. enamelled wire, the two field coils being connected in series with each other, so the poles have opposite magnetic polarity and in series with the armature.

The speed of the motor will vary considerably with the load, which makes the machine not very suitable for driving an emery wheel, as the motor may run very fast when unloaded. A switch should, therefore, be fitted near the motor so this can readily be switched off at the end of the cutting period.

Solid Mercury

I REQUIRE some solid mercury for experimental purposes. By what simple method would you suggest I freeze the metal?—O. Davies (Treorchy).

MERCURY freezes at a temperature of −39 deg. C. (−38.85 deg. C., to be exact), so that you will have to cool the metal down to about −40 deg. C. or more before you can obtain it in solid form.

A mixture of 2 parts of crystallised calcium chloride and 1 part of powdered ice will lower the temperature to about −40 deg. C., so that this freezing-mixture will—theoretically—suffice. Yet, practically, it is not efficient. Your best plan is to use either "Dricold," which is solidified carbon-dioxide gas and which is (normally) obtainable from Imperial Chemical Industries, Millbank, London, S.W.1, or, better still, by the use of liquid air, which is a commercial, transportable commodity obtainable from The British Oxygen Co., Ltd., Wembley (through one of its nearest local branches). A quart of liquid air (costing about 6s.) would freeze pounds of metallic mercury and keep it in solid condition for days without in any way affecting it chemically.

Oil Stain

I DESIRE to make up small quantities of oil-stain for use on woodwork, and should be pleased to receive your guidance as to the formula and manufacturers of the materials required.—V. D. Armstrong (Birmingham).

ALL you need for your purpose if a supply of linseed oil and a quantity of oil-soluble dye, both of which commodities can be obtained from any large paint stores. Alternatively, the oil-soluble dyes can be obtained from any chemical manufacturer or wholesaler, such as Messrs. Philip Harris & Co., Ltd., of Birmingham, or Messrs. A. Boake, Roberts & Co., Ltd., Stratford, London, E.15.

Dissolve about 10 parts of dye in 90 parts of linseed oil so as to give a 10 per cent. solution of dye in oil. If darker or lighter shades are required, vary these proportions accordingly.

The stain is merely rubbed or brushed on to the woodwork and subsequently allowed to "dry in."

Magnifying Power of Telescope

COULD you please let me know whether there is any method of determining the magnification power of a refracting telescope without special apparatus, and, if so, what it is?

I am also mystified by the markings on binoculars such as, for example, 6×30, and would be much obliged if you would explain this also.—S. Hadden (Nottingham).

THE magnifying power of a telescope is governed by the focal length of the object glass and by the magnifying power of the eyepiece. The longer the focal length of the object glass and the greater the eyepiece power, the greater will be the magnification of the instrument as a whole.

To determine the focal length of the object glass, remove it from the barrel of the telescope and hold it in the sun's rays so that an image of the sun is thrown on to a sheet of white paper. Move the glass backwards and forwards in front of the paper. At one position of the glass, the circle of light (i.e., the sun's image) thrown on the paper will be the sharpest. Measure, now, the distance from the centre of the object glass to the paper. This will give you the focal length of the lens. The focal length of the eyepiece can be estimated in the same manner, but the eyepiece focus or focal length will be in inches, whereas that of the object glass will usually be in feet.

Strictly speaking, the business of the object glass is not to magnify. It is merely to form an image of the object looked at, this image then being magnified by the eyepiece glass. Hence, the greater the focal length of the object glass and the greater the magnification of the eyepiece, the greater will be the degree of magnification of the telescope system as a whole.

The same principle applies to binoculars. The smaller numeral refers to the object glass magnification, the larger numeral referring to the diameter (in millimetres) of the object glasses. The greater the object glass diameter, the more light it admits and the more brilliant is the image. The greater the eyepiece magnification the greater is the apparent nearness of the object looked at.

The Composition of Alabaster

I WISH to know if alabaster is a composition substance, and whether or not it is a patented formulæ? Also, how is it made and coloured?—A. Charlton (York).

ALABASTER is not an artificially made substance. It is a naturally occurring mineral. It is a soft, semi-translucent material composed of calcium sulphate with a little calcium carbonate, together with a little iron, which gives it veins of yellow and brown and sometimes red. It used to be mined chiefly in Italy.

A so-called imitation of alabaster is said to be made by colouring plaster of Paris with a little ochre, but this material is brittle and not satisfactory. There is, in fact, no satisfactory imitation of the real material.

Water Analysis

CAN you tell me whether there is a chemical formulæ whereby one is able to determine the purity of water so that it may be safe for drinking purposes? I wish to experiment with several samples of water, and to find out what foreign matter or pollution they contain.—G. Tanner (London, S.W.).

THERE is no simple chemical or chemical formulæ which will enable you to determine the purity of water for drinking purposes.

Water analysis is, at the simplest, a complicated matter, even when non-drinking waters are concerned. When drinking waters are involved, not only chemical analysis, but also bacteriological examination is essential, since a water may be fairly pure chemically but contaminated bacteriologically, and vice versa.

What you require is a good modern book on water examination and water testing, such as one of the following:

W. P. Mason: Examination of Water: Chemical and Bacteriological (18s. net); J. C. Thresh and J. F. Beal: Simple Method of Water Analysis (3s. net).

We believe, also, that Sofnol, Ltd., Greenwich, issue a useful booklet on water-testing, and we think that they would let you have a free copy if you would write to them on this matter. Otherwise, your only mode of becoming expert in water examination is to study a good textbook and to make experiments as you progress in the subject. A good working knowledge of normal chemistry is, of course, also essential.

Welding Glasses

WOULD you please let me know the best way to keep welding glasses clear in hot weather? Also, I would like to know what colour of glass is best for these glasses or goggles when used for light work, such as the mudwings of motor-cars.—J. G. Huggins (Enniskillen).

MAKE up a stiff paste by squeezing together shredded soap and glycerine. Smear a thin film of this over the glasses. It will help to keep them free from moisture condensation.

A dark green or greenish-blue glass is probably the best for the work you name, although the pure blue glasses supplied with many welding outfits are quite suitable. Light blue glasses and those which are merely tinted should not, of course, be used, since they do not keep back the intensely powerful rays which are injurious to the eyes.

Aquarium Water Testing

COULD you give me any information on aquarium pH or hydrogen ion water testing sets; if they could be made, or where I could buy one?—J. Thompson (Southfields).

AQUARIUM water pH testing sets comprise a series of tubes containing coloured liquids, each liquid having a definite pH value (or hydrogen ion concentration). A few drops of the water to be tested are placed in an empty tube of similar size to the specimen tubes and a drop of coloured "indicating" liquid is added to the water under test. The resulting colouration is then compared with the series of specimen tubes and the precise pH value is thus readily estimated by this comparative method.

These pH value testing sets for aquarium water can be obtained through any of the big London dealers in aquarium supplies and requisites, or, direct, from The British Drughouses, Ltd., Graham Street, City Road, London, N.1.

Renovating a Chipped Bath

THE enamel on my bath has chipped away exposing large black patches. I should like to re-enamel it, and shall be glad if you could provide me with a simple formula and method. If this is not possible, what other action can I take to make it fit for use?—J. Marco (Leicester).

YOU do not say whether your bath is one of the porcelain enamel type or whether it is merely an iron bath which has been given one or two coats of a white enamel paint. In the latter case, the remedy is simple, consisting merely of smoothing the sides of the defective area and in re-painting the bath.

If, however, the bath is a "porcelain" one, that is to say if it has an iron base which has been vitreous enamelled, there is, unfortunately, no remedy for the trouble which you yourself can apply. The vitreous enamelling of the bath is effected by painting the bath with a special enamel and by afterwards subjecting it to white heat in a specially-designed furnace whereby the constituents of the enamel melt and fuse together to form a glass-like surface which is rendered opaque and coloured by the white pigment in the enamel. You cannot possibly imitate this process yourself even on the smallest scale, and it would be an exceedingly expensive job to have the bath re-enamelled by the vitreous enamelling process. Thus, so far as we can see, the only move which you can make is to buy from your local paint store a small quantity of some really good white enamel paint, and, after smoothing down the edges of the defective area of the bath, to apply several coats of the white enamel paint, thereby gradually building up an enduring white coating over the underlying black patches. This treatment, to a large extent, will hide the disfigurement, but, naturally enough, the enamel paint will not be anything like as enduring as the normal vitreous or "burnt-on" enamel of the bath. But in this matter, it is, we are afraid, a case of Hobson's choice.

Etching on Celluloid

I SHALL be glad of any information of methods of etching on celluloid. It is required to form clear lines which will be filled with a suitable black. Can you suggest such a black?—T. A. Locke (Newquay).

THERE is no satisfactory chemical method of etching on celluloid. Liquids which attack celluloid, such as acetone-amyl acetate mixtures not only dissolve the celluloid exposed to their action but they also soften the surrounding parts. Hence, by treating the celluloid with such liquids you would not get clear lines.

Celluloid can, of course, be embossed by means of heated stamps and its surface may also be lined by means of an electro-engraving stylus. For filling the lines, use a stiff black ink made by working lampblack into beeswax which has been softened by a mixture with raw linseed oil.

For actual surface writing on celluloid in black, use the following ink:

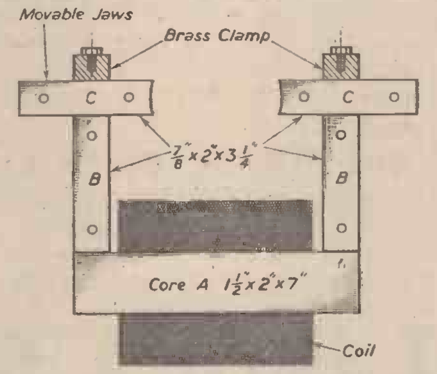
A.	Tannic acid	5 grams.
	Acetone	25 c.cs.
B.	Ferric chloride	5 grams.
	Acetone	25 c.cs.

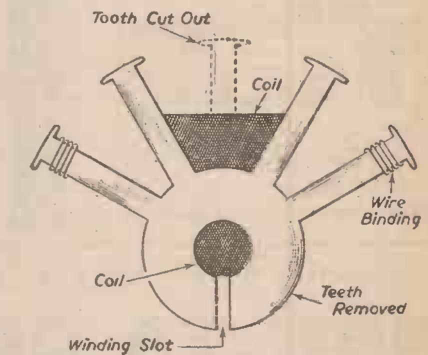
Mix A and B together to produce the black ink, and store it in a bottle provided with a well-fitting stopper. This ink attacks celluloid, and probably it might be of some use for your especial purpose.

Windings for a "Growler"

I ENCLOSE a drawing (Fig. 1) of an assembled "Growler" which is used for testing small D.C. armatures for short-circuits. From the dimensions given, can you tell me how many turns I shall have to put on the coil and also the size of the wire I must use? The apparatus is to be used on a 230 volt, 50 cycle circuit.

I also wish to use a similar piece of apparatus for testing small 3-phase stators (core diameter: 2¼in.; core length: 2¼in.) for short-circuits. Can you please advise me on the design of such a "Growler"? The apparatus will be used on the same circuit.—W. Taylor (Ripley).





Figs. 1 and 2.—A "Growler" assembly and diagram indicating modification to armature stampings.

WE suggest you wind the coil of your "Growler" with 1,500 turns of 18 s.w.g. d.c.c. wire.

A small testing appliance for the stator windings could be made from armature stampings built up to 2¼in. long. The diameter of the stampings should be such that, when modified as in the sketch (Fig. 2), they will enter the stator bore. Certain teeth should be cut out of the stampings as indicated and a radial slot made to allow of winding. The coil should be wound with 2,000 turns of the largest size of s.s.c. enamelled wire which can be accommodated.

Increasing Speed of Small Motor

I HAVE obtained a ⅛ h.p. electric motor which I wish to use for dental work. It is 230/250 volts, worked off the A.C. mains. Would it be possible to make this into a three-speed machine without causing a serious drop in power?—W. G. Avery (Witham).

IF the motor is an induction motor, having a squirrel cage rotor, it is very doubtful if it could be rewound as a three-speed machine without involving a considerable loss of power. To advise fully on this point we should like to know the inside and outside diameters of the stator laminated core, together with its length and the number and dimensions of the stator slots. Would it be essential for the motor to be self starting or could it be started by hand?

If the motor is a series or universal motor, having the armature winding in series with the field winding, the speed could be reduced by means of a series resistance. The safe full load torque would be approximately constant, so the safe full load horse power would be practically proportional to the speed. It may also be possible to increase the speed somewhat by means of a diverter resistance connected across the field coils, in this case the full load torque would fall with increased speed, the horse power being practically unchanged by diverter control. We may be able to suggest suitable resistances for such a motor if you will let us know the present speed on full load, the speeds required, and preferably the voltage drop across the field coils on full load. Resistance control will result in rather a big variation of motor speed on a varying load.

Removing Stove Enamel

I WISH to construct a tank for the purpose of removing paint, particularly stove enamel from bicycles. Would you please oblige by giving details of: 1. Composition of bath; 2. Formula of liquid.—G. C. Rink (Birkenhead).

REAL stove enamels are very difficult to remove. The cheapest medium for dealing with such enamels is a strong, hot solution of soda ash or caustic soda.

Alternatively, the following composition has been recommended for removing enamels:

Benzene	50 parts (by weight)
Methylated spirit	25 " "
Acetone	10 " "
Nitric acid	10 " "
Turkey Red Oil	5 " "
Beeswax	1 " "

A simpler solution of this type can be made by dissolving 30 parts of paraffin wax in 500 parts of benzene and then adding 500 parts of acetone. This is very highly inflammable. It is best brushed on to the enamel, allowed to remain on for five minutes or so, and then scraped off.

Any kind of metal or earthenware tank is suitable for containing this latter solution, but the caustic soda solution previously mentioned and the one containing nitric acid must be stored in a glass vessel. For this purpose, old glass accumulator cases are admirable.

It is not usually necessary for the enamelled parts to be immersed in the liquid. It is sufficient to brush the liquid over the parts, but in all cases, the parts will need a final scraping or rubbing down to remove the softened enamel.

Staining Ivory

WOULD you kindly let me know what technique to adopt to stain ivory in such a manner as to allow the "grain" to show—the colour required is any shade of red?—P. H. Kirk (Kettering).

VERY gently simmer the ivory in water for one to two hours so as to soften the outer skin of the material and to allow better penetration of the dye. Then plunge the article into a hot and rather concentrated solution of the dye containing a little Glauber's salt and some soap, both of which latter materials serve to promote evenness of dyeing. A suitable dyebath would be:

Dye powder	8-10 grams.
Glauber's salt (Sodium sulphate)	3 grams.
Soap	1 gram
Water	100 c.cs.

The dye liquor should be hot (nearly boiling), and the ivory article should be immersed in it for about 30 to 45 minutes, a little water being added to the bath from time to time in order to make up for evaporation losses.

Rinse the ivory in warm water, then dry it in hot sawdust, and give it a finishing treatment by rubbing it over with a cloth charged with a little raw linseed oil.

If darker shades are required, increase the quantity of dye in the bath.

Any water-soluble aniline dye will serve for this purpose.

Spirit stains (which dissolve in methylated spirit) may also be used, the stain solution being brushed on with a camel hair brush. In this instance, although the dyeing is easier, patchy results are likely to accrue, together with poor penetration of the dye. Furthermore, such colours tend to fade in strong light, and they can often be washed off with soap and water.

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

The Revised Highway Code

THE Minister of Transport has submitted to Parliament for approval a revised edition of the Highway Code, and this must be approved by both Houses of Parliament before it becomes effective. As, however, the present Government has announced that any opposition from the House of Lords will be countered by the creation of Labour peers to outvote them, presumably the revised Highway Code merely needs the approval of the House of Commons. Such is the position created by the new democracy.

The Highway Code is a code of direction, lacking the power of an Act of Parliament, and prepared by the Minister of Transport in accordance with Section 45 of the Road Traffic Act, 1930. It really is a Code of Conduct for the guidance of all road users, and a contravention of the provisions of the Code is not in itself an offence, but may be taken into account in proceedings in the Courts.

Cyclists and Motorists

THE Code is largely directed to cyclists and motorists, and only in a minor capacity to pedestrians. The only offence which a pedestrian can commit on the highway is that of obstruction, and although, as every cyclist and motorist knows, pedestrians are grave offenders in this and other respects, less than a dozen cases a year are brought against this largest section of road users. As Governments during past years have made up their minds that our traffic problems can be solved by regulations and prosecutions, this is somewhat surprising.

We are told that the new Code has been prepared in the light of experience and on the advice of experts, and the Minister acknowledges the valuable work done by all concerned in the drafting of the documents.

The existing provisions with regard to individual precepts have been reproduced almost without exception in the new edition. In addition, certain new precepts have been added, of which the following are the most important :

Paragraph 7.—Watch the children.

Accidents to small children are terribly frequent.

Paragraph 8.—If you are a parent or guardian teach your own children to cross the road safely and set them an example by your own road conduct. Do not let your children play in the street. Children under seven should be accompanied by an older person when using busy roads.

Paragraph 12.—Wait until a bus or tram has stopped at a recognised stopping place before you get on or off.

The section entitled "Hints to Cyclists" is useful, and is intended to aid the pedal cyclist in the safe use of his machine.

Braking Chart

A BRAKING chart printed on the inside of the back cover brings home to motor drivers the fact that a motor vehicle cannot be brought to a stop in the short distance which many experienced drivers think possible, although what this phrase is intended to convey is not clear. Certainly, it will make experienced motorists smile, and even inexperienced motorists know that the stopping distance depends upon the efficiency of the brakes, the speed of the vehicle, the condition of the tyres and the condition of the road surface. Every householder in the country is to receive a copy of the revised Code and it will be delivered free of charge by the Post Office.

Driving Tests

A COPY will also be issued to all new applicants for driving licences. When driving tests, which have been generally discontinued during the war, are reinstituted during the next few months, candidates will have to submit to a searching examination of their knowledge of the Code.

The ultimate object is to make the Code a treaty of good manners between all road users. The original Highway Code was first published in April, 1931, and it was revised in May, 1935. A further revision contemplated in 1939 was abandoned on the outbreak of war.

A great deal will have to be done by the authorities before the Code itself can be implemented by road users. Many of the accidents are caused by the so-called safety measures introduced to prevent accidents.

Obstruction

OBSTRUCTION, due to the excessive use of traffic lights and the all too numerous road islands and pedestrian crossings, is a prolific cause of accidents. Now that the various experiments have been tried and have failed they should be abolished and the roads kept clear for vehicular traffic.

We do not subscribe to the view of the Ministry of Transport and the police that our roads should be handed over to public service vehicles. Many people have to use their vehicles in connection with their work, and it is the duty of the authorities to provide adequate parking places for them—cycles and motor vehicles.

Bus Stopping Places

THE fixing of bus stopping places, fixed some years ago by a committee appointed by the Ministry of Transport is in need of serious overhaul and readjustment. We also think that the principle of paying policemen 3s. an hour overtime when they appear in Court is a direct invitation to the bringing of frivolous charges against road users.

Visit of Australian Cyclists

THE National Secretary of the New South Wales Pedal Cyclists' Association and Australian Cycling Association wrote a letter on April 25th to the editor of an English periodical who had criticised the proposed visit to this country of two Australian riders who were to compete in B.L.R.C. events.

Here is the reply :

"I have your letter of 25th April, 1946, and have observed your comments on the item regarding a proposed visit to Britain this season by Australian cyclists to compete in events organised by the British League of Racing Cyclists, a comparatively small British breakaway body. The information regarding the difficulties of a visit from Australia to Britain for cycling purposes was obtained from a reliable source. You do not provide any evidence whatever that any of the statements in the item are in error, and before making any further reference I would, of course, require more details from your organisation. Could you answer the following questions, as this might help ?

"Is the A.C.A. sending riders to Britain for B.L.R.C. events this season ? If so, have passages been booked and all the necessary permits secured ?

"What British events will your riders be entering ?

"How long will they stay in Britain ?

"Are they aware that the B.L.R.C. is not affiliated to the U.C.A., and that its efforts are regarded with disfavour by the majority of organised British cyclists ?

"Does the A.C.A. allow its amateur riders to accept money prizes ?

"How many members has the A.C.A. ?

"On the answer to these questions depends whether I agree or otherwise with your view that 'the whole paragraph is a gross misstatement of facts.'"

The answer, of course, is that the two Australian riders have arrived, and have competed. Mr. P. Small, the National Secretary, in a message of greeting to the B.R.L.C., said :

"The Australian Cycling Association is very proud to know that it has fulfilled its promise to the British League of Racing Cyclists.

"Alfred R. Strom delivers this message to you personally.

"You invited two Australian riders, and—despite most trying conditions—we have sent two. May all the luck of the gods go with them. We feel that they will be in good hands."

Now that the Brighton-Glasgow race is over, our contemporary will have had his various questions answered by the event itself. The letter which he wrote to the New South Wales Pedal Cyclists' Association evidently discloses a doubt as to whether two Australian cyclists were to be sent to this country to compete in the events. We therefore gladly give publicity to the above correspondence, since it is unlikely it will be published in any other journal, and it is only fair that the facts should be known.

We leave our readers to judge the charge of "gross misstatement of facts." This journal fairly represents all sides of a question.

"Raise the Standard"

By R. L. JEFFERSON

MOST cyclists who have reached middle age must have noticed the gradual decline in the standard of cyclists on the road; over the past few years the conduct of a section of clubmen in tea-rooms and inns is nothing short of monstrous.

Many of these people belong to what were once famous clubs, but, unfortunately, a lot of these have degenerated into nothing more or less than sections of the largest of all clubs, "The Kerbstone Wheelers."

Surely we have enough "cyclists" riding and wobbling all over the road complete with feeding-bottles, ice-cream jackets, etc., without adding to the number. At one time members of old-established clubs prided themselves on their conduct and did all they could to uphold the name of the greatest of all sports; those who did not behave in a civilised manner were removed, as indeed they should be.

If we want to keep our place on the road we must conduct ourselves as civilised and responsible members of the community. We don't need to look upon every motorist as a deadly enemy to be inconvenienced if at all possible; such a policy is foolish for several reasons. Even if we do succeed in holding up a motorist for a few minutes, what do you think his feelings will be when he meets the next cyclist, who may be a good roadman, and yet get cut closely because of the stupid conduct of some fool who should not be on the road at all. There are some dyed-in-the-wool people in our ranks who say cyclists are always right and motorists wrong; that's rather foolish, to put it mildly. There are good and bad in all walks of life; generally speaking they are mostly good.

If, for instance, you see an opportunity of giving a motorist a signal which will help him, you will invariably find that he will give you a wave of the hand, and as he goes on his way he will be thinking that some of us are at least civilised. We want more of the spirit of give and take in our daily lives, and, above all, on the road.

Roadside Manners

Twenty or more years ago no cyclist in trouble by the roadside had long to wait before a fellow wheelman came to his assistance; nowadays, if they notice him at all, it's only to shout some ribald remark at him and pass on their way. I suppose it's the spirit of the age in which we live that causes such conduct as this. Surely life is more pleasant if we try to help one another. After all, courtesy costs nothing.

I know quite a few cyclists who are middle aged and have dropped out of club life. These chaps are not snobs, but they just can't stand the element typical of club life to-day; the clubmen who infest the depôts and shops of lightweight makers are boring and overbearing in their manner, and strut about like peacocks on the strength of a weekly "25." Longer distances to them are "hard work." After they have done a few "25s" and failed in a "50" or so they pack up the game, having got all they could out of it and, of course, putting nothing back. The percentage of chaps who try to help youngsters to become real roadmen after they themselves have finished is lamentably small.

My own entry into serious cycling was caused by puncturing on the Hogsback at night. I was making a very ineffective repair when along came a couple of clubmen who soon did the job, and we rode on together, doing bit and bit till we reached London. From then on I began to realise that there was more in this game than just pushing the pedals round. There is a history of nearly 150 years to this game of cycling; let's all try to live up to the ideals that were established by older and wiser generations of wheelmen, and also try to be a little more humble. There is no need to feel smart because you've done 13 seconds for a 220 at "The Hill"; Jimmy did better than that in 1893 on a 64 gear. Think that over. Johnson did under 12 seconds for a 220 at Antwerp in 1920; his wheelbase was 42in., and he sat 6in. behind the bracket, his head angle being 68 deg. It seems rather remarkable to me that those who talk of modern super cycles being faster and quicker steering still don't go as fast as Bailey, Johnson, Ryan, etc., of 20 or more years ago on the *same* track. The fact is that the older generation had the ability to train and live right. They lived, breathed and oozed cycling, and that's what any racing man has got to do if he wants to get his wheel in front of any foreigner at the world's championship.

Attracting the Public

Let us realise that we have a long way to go to raise the standard of cycling so as to attract the public. At present the man in the street regards cyclists as a noisy, vulgar mob. Can we deny that some of us are guilty? Don't forget that the hooligans on wheels are always noticed; the quiet chap isn't. If you have a few hooligans in your club, try to educate them; point out what fools and traitors they are. If they don't see reason, get rid of them; they will only serve to bring discredit on your club. Don't try to be the lord of all creation when you're out on your iron; remember if it hadn't been for men like Macmillan you would probably not be cycling at all.

Ours is the greatest of all games. We have the modern magic carpet to travel on, to enlarge our horizons, to give us memories that one can't read in a book or buy in a shop. Let us not abuse our privileges, but show by our conduct that ours is the greatest of all games. We will get recruits to our ranks who will get others. that is our plain duty as decent cyclists.

A National Sport!

I for one want to live long enough to see cycling become a national sport in the sense that football and cricket are. This can come about if we wish it, but we've got to improve a lot. We've got to be less selfish, less noisy, and those who race have got to take it far more seriously. Also we have to eradicate the paid amateur and give an equal chance to the youngster who can't afford decent equipment. If a man is known to be in receipt of equipment or money from a maker, *ipso facto* make him a pro or bar him from competing with amateurs. It's all very well paying lip service to pure amateurism and wilfully closing our eyes to things which we all know are going on.

So for the sake of the game let's make 1946 the first year of a great revival of cycling, and a reawakening of interest by the man in the street. By our conduct we shall be judged. It's up to us all to prove our worth and earn our good name.

Paragrams

Bicycle for Two—Sometimes

AN Italian cyclist has evolved a special kind of tandem, the rear portion of which can be quickly unfastened so that the tandem forms two separate cycles. The unfortunate part of it is that after the separation there are only two wheels for two cycles, so it is not wise for the riders of the tandem to disagree while out on a run or one of them will have to walk back home.

Kettering Celebration

MR. TREVOR KILMISTER, of Birch Road, Kettering, captain of Kettering Friendly Cycling Club, celebrated his coming of age by inviting the members of the Club, with other friends and relatives, to a tea and entertainment at Kettering Central Hall. Mr. Kilmister was presented by the Club members with a leather writing case.

Proposed Damming of Loweswater

A STORM of controversy is likely to be caused by the recent proposal that Loweswater shall be dammed, and the waters of Mosedale Beck impounded.

What effect the damming of Loweswater would have on its scenic value is hard to gauge. The lake is dependent for its attractiveness on the views over Crummock and Buttermere, its sister lakes, and of the mountains grouped around the three waters.

The engineers describe as "most attractive" a scheme for impounding the waters of the Mosedale Beck, "particularly if other authorities joined in and reaped the benefits themselves." Mosedale is the narrow valley between the fell of Melbreak dominating the east side of Crummock and Hencomb. Here a wayfarer on his way from Loweswater to Ennerdale may see, as probably nowhere else in the Lake District, the rarest birds of the mountain ranges, the peregrine and the merlin, not to mention the raven and the buzzard.

Conferences of the local authorities have already taken place, and they are agreed that the implementation of the County Council's report on the subject must remain a matter for the local authorities concerned.

Clock From Cycle Parts

MESSRS. H. UPPADINE AND SON, cycle manufacturers, Balby, near Doncaster, have constructed what is probably a unique clock. The whole of the clock is constructed of cycle parts and is driven by a weight. The face is a specially made 60-toothed chain wheel, the hands are cycle cranks, and the movement is built up from gearwheels and chain.

Seventy Years a Cyclist

MR. W. H. WOOD, of Gainsborough, Lincs, who has been a cyclist for 70 years, and a chorister at his church for 60 years, celebrated his golden wedding recently by cycling to church to sing in the choir.

The Fines Fly Too

THE difficulty experienced in obtaining payment of fines imposed on airmen, most of whom are caught cycling without lights, was referred to by the clerk to Kettering magistrates when two airmen asked for time to pay. He said: "Many airmen have been fined at this court and then they move to another station. Pursuing them, we discover they have again moved and finally, before we catch up with them and the fines can be paid, they have gone overseas."

One of the Centres

THE old milestone in Long Street, Atherstone, Warwickshire, one of the several places claimed to be the centre of England, has been cleaned after being smeared with tar during the days of possible invasion. In addition to the well-known inscription showing 100 miles to London, 100 miles to Lincoln and 100 miles to Liverpool, the cleaning has revealed further lettering, which reads: "Litchfield 15, Lutterworth 17¾ and London 100."

Tough

CHARLIE WILLOUGHBY, 70-year-old Lincolnshire farm-worker, who still cycles a dozen miles or more when he wants a drink of beer, wears a pair of velvet fustian trousers which first came out of the tailor's shop 107 years ago. The trousers are old-fashioned in cut but show few signs of wear, in spite of Charlie having worn them for 41 years after the original owner ceased to have any need of trousers.

International T.T. in the Isle of Man

REFERRING to the illustration on page 82 of the August issue, the caption stated in error that the riders were taking the hairpin bend at Governors Bridge, Douglas. It is, of course, the famous Hairpin Bend at Ramsey.

Around the Wheelworld

By ICARUS

The B.L.R.C. Brighton-Glasgow Race

AS one would naturally expect with an organisation like the B.L.R.C., the Brighton-Glasgow race was a well-organised affair, and was carried through without hitch, without accident, without incident, without police opposition, but with police co-operation and collaboration, and as usual with B.L.R.C. events it was well supported by the national press, and by editors whose minds are not still buried in the past or who are advised by those with minds similarly interred.

I understand from one of the official mouthpieces of the Minister of Transport that he does not like this form of racing, and therefore would like it abolished. As the B.L.R.C. massed start races are run in strict accord with the law (indeed, the B.L.R.C. would welcome police action against any of its members who broke the law; they would themselves take action against the rider), the League is not concerned with the likes or dislikes of Ministers. Only an Act of Parliament can set this form of racing aside, but with it would go time trials and road records. The fact that the N.C.U. and the R.T.T.C. and the R.R.A. and the C.T.C. do not like this form of racing either is not an indication of national cycling opinion, as is evidenced from the vast numbers who take an interest in it, and turn up to witness the various stages of it.

Sir Stafford Cripps, I am given to understand, does not like meat, alcohol or tobacco, and if every citizen were to kow-tow to the likes and dislikes of various Cabinet Ministers life would indeed be intolerable. I, for one, am going to enjoy my cigarette and my rump steak (when I can get it) and my modicum of alcohol (also when I can get it), and I presume that cyclists of a similar mind are going to have their massed start racing.

Because one or two of the faint-hearts have rejoined the N.C.U., some of the more pontifical of the cycling scribes seem to think that 1946 will hear the Swan Song of the League. I can assure them that they will hear their own Swan Song first.

Terrific congestion is caused by the Lord Mayor's Show and the Boat Race, for example, but no one suggests that they should be abolished. The League events can be of equal national importance, and I am glad to think that the B.L.R.C. refuses to be brow-beaten by the so-called national bodies.

B.L.R.C. versus N.C.U.

IN a journal appropriately entitled, *Challenge* the B.L.R.C. and the N.C.U. present their cases in parallel form. No disinterested party free from bias or blinded by hero-worship can fail to recognise that the N.C.U. lost its case. The B.L.R.C. case is well known, and so I merely quote from the N.C.U. case as stated by the national secretary of the body.

"The public authorities . . . lost no time in making up their minds that the King's highway could not be used as a race track. . . . They were supported in this by a very large measure of public opinion." I should like to have evidence of this public opinion. Did not the national secretary here mean police opinion? As the N.C.U. at that time controlled all cycle sport it was the duty of that body to represent cycling opinion, not ill-informed public or police opinion anyway. The fact is that cyclists at the time were so annoyed with the N.C.U. that they broke away and formed rival bodies.

"A way was found (the time trial system) where speed tests can be indulged in without inconvenience to traffic or congestion of the highway generally."

The inference here is that massed start events as run by the B.L.R.C. are causing congestion and inconvenience to other traffic, when as the national secretary knows full well this is not the case, although it may have been in the days when the effete N.C.U. ran massed start racing.

The modern races are efficiently run, the courses are well marshalled, the police co-operate, and all of the evidence shows that there is an entire absence of congestion either at the start, during the course of the race, or at the finish.

The national secretary has to admit in the course of the article that "there was undoubtedly a strong feeling that time trials should be abolished, but the responsible Ministry, having examined the rules of time trials and seen the position, stated that so long as they were continued on those lines they saw no reason to interfere."

Why, therefore, did the N.C.U. ban time-trials and forbid its officials from taking part in them? As the N.C.U. was wrong about time trials there is good reason to suppose that its judgment is equally unsound on massed start, a point which "the responsible Ministry" would do well to remember. In other words, the Ministry can safely ignore the opinions of the N.C.U., for fifty years of road sport have proved how wrong they were in throwing it overboard and causing the creation of other bodies such as the B.L.R.C., the R.T.T.C., and the R.R.A.

The C.T.C. I dismiss as a body of little importance as far as sport is concerned. It knows little, if anything, about it, and is mainly concerned with cycle touring; although the Minister might bear in mind that some of its district associations have hard riders' sections whose events amount to massed start races. I believe that the C.T.C. can also erect "Dangerous Hill" signs, on hills which are by no means dangerous to-day.

The Minister is also informed that views of members of the C.T.C. on the subject of massed start racing are not necessarily the views of the C.T.C., which has not expressed an official point of view about it; nor is it competent or authorised to do so.

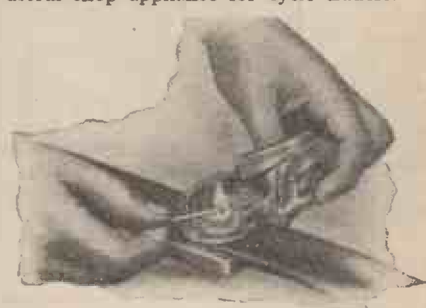
Cycle Tube Repairing by Vulcanisation

AN interesting outfit recently introduced by Mr. William Frost, the well-known pioneer of repairing vulcanisers in this country, is the "Autotherm" Cycle Tube Repairing Vulcaniser, which permanently seals and reinforces the damaged area of the tube, synthetic or natural rubber, by a reconstructive method which, in effect, duplicates the original manufacturing process at the point of repair.

The Autotherm Vulcaniser itself is a small but efficient vulcanising press, a substitute in miniature for the vulcanising presses used in rubber factories everywhere. It is handy and extremely simple to use, by the roadside or elsewhere, yet fulfils all the requirements of scientific repairing by vulcanisation. The outfit, which is sold at the extremely modest price of 7s. 6d., is complete in every particular, and includes an initial supply of repair-heat units (2 in 1) as well as other materials for a variety of jobs, such as hot-water bottles, football bladders, and other small rubber articles.

To many cyclists, the idea of repairing their tyres by vulcanising may be a novelty. It should be pointed out, however, that the compulsory use of synthetic rubber has reduced the reliability of patching and emphasised the value of vulcanising for permanent work. The Autotherm method is just as easy as patching, it is interesting and even fascinating to young cyclists, and can be carried out by anyone with complete success.

The Autotherm Vulcaniser has already been on the market long enough to prove itself as an indispensable outfit for cyclists, and a useful shop appliance for cycle traders.



The "Autotherm" cycle tube repairing vulcaniser in use.

If there is any difficulty in obtaining the Autotherm outfit, cyclists should send the name of their usual cycle dealer to William Frost Products, Ltd., Kautex Buildings, Elstree Way, Elstree, Herts.

The Trader Handbook

IN spite of paper restrictions, new features have been added to "The Trader Handbook" (motor, motor-cycle and cycle trades), the fortieth edition of which has just been issued by The Trader Publishing Co., Ltd., Dorset House, Stamford Street, London, S.E.1, at 7s. 6d., post free. The chief addition is a complete list of index marks or registration numbers allotted to motor vehicles by the Licensing Authorities in the United Kingdom from 1904 to February, 1946; with this list it is possible, with few exceptions, to ascertain the approximate age of any motor vehicle. Another new feature is a table of specification details of cars, commercial vehicles and motor-cycles put on the market in 1946. There is also a completely revised legal guide for traders, a "Buyer's Guide," and an alphabetical list of some thousands of branded goods used by the motor and cycle trader, and a directory of manufacturers, factors and wholesale suppliers to these industries. Much other useful technical and general trade information is included in the 312 pages of this handbook.

New Works Director

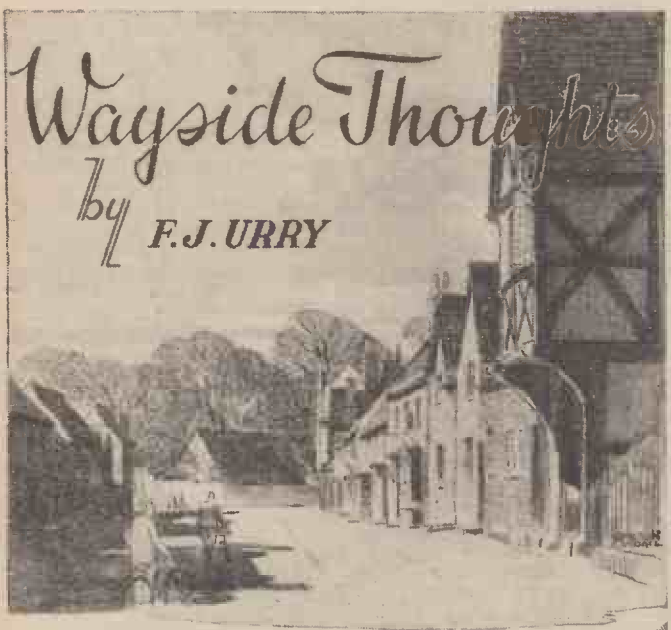
FOLLOWING the retirement of Mr. J. H. Furniss after many years service with the company, Mr. Walter F. Withers, A.M.I.A.E., has joined the Hercules Cycle and Motor Co., Ltd., as works director, in general control of the Rocky Lane and Manor Mills factories.

Mr. T. A. Yapp, M.B.E., will continue as works manager of Manor Mills Factory specifically, and Mr. P. J. Lester as works manager of Rocky Lane Factory.

Mr. Withers, who has had exceptionally wide engineering experience in Birmingham, was formerly works director of Wilmot-Breeden, Ltd., and his appointment to the Hercules Company is in line with their extensive post-war plans in relation to the development of cycles and three-speed hubs.

Wayside Thoughts

by F. J. URRY



Better Information

I AM convinced that what this pastime of ours needs is a better-informed public. I suppose the majority of people would say they know all about cycling having once ridden a bicycle, but in my opinion the first part of that sentence would be gross exaggeration, to say the least of it, for the majority of people are ignorant of cycling in its proper sense, and know far too little about the bicycle or the way to ride it, if their purpose is to wander freely and easily over this lovely land. It is astounding that such should be the case considering the bicycle has passed its century, and, really, I blame the makers and sellers of their machines for such a state of affairs. Observation alone would reveal this ignorance to any expert rider, but I am not relying on that only. Occasionally I consort with a crowd of people, young and not so young, who have formed social clubs for the purpose of decorating leisure, and they ask me to tell them about cycling, what I see in it, what I get from it, why I keep riding when I need not, and why I ride the type of machine they can examine. Such folk are a fair sample of that community seeking a way of life to give them joy in their leisure time; and I say from intimate knowledge that their ignorance of the pastime is colossal. And the fact that many of them use bicycles or have done so in their time merely exaggerates the state of such ignorance. I do not expect everyone to know cycling as intimately as I imagine I do, but I would expect such folk to understand how to buy best and how to use their purchase for that widening of physical and mental horizons that is at once a joy and adventure, an exercise in health and a pleasant attraction to anyone fond of the country and concerned to add variety to life.

A Wider Publicity

IT is difficult to put the story of cycling over to such people in a brief talk, difficult to break down the long standing prejudice that cycling is "hard work," and really a trifle *infra dig.* to folk with a gentle sense of their own importance. And curiously enough, most of them seem really interested in your story, and often a trifle covetous of the healthiness you display, and the enthusiasm that emanates from the impromptu sentences. The soil is right to receive the seeds of cycling propaganda, but the seeds are missing, or at least are only scattered in such haphazard ways as these indicated. Cycling was once the interest of the daily press, but where is it now? Yet there are more riders than ever, and all of them are readers to-day, and there would be far more potential cyclists if the good gospel of the pastime could but find a proper place in the pages devoted to the sports and pastimes. Maybe when paper restrictions are removed we shall see a change and cycling will find a place in the columns, for it deserves one, not merely for the numbers interested, but because it is perhaps the worthiest of all games to fill with joy the leisure hours of a great community. Indeed, if this lovely land of ours is to become a playground for holiday folk, an attraction to foreign guests, and a means of making Britain more than a name on a map—as our authorities appear to desire—cycling must play a major part in such a desirable development, for the simple reason that it is the cheapest, as well as the healthiest means of movement. Therefore, I say that we need to teach people how to ride and what to ride and why, for the joy of the game is bound up with the correct method of playing it, as is the fact with all games, and that especial development has been neglected for years. It is time we all awakened, for the conditions were never more favourable, and the industry never stronger to urge their interests in the manner of publicity for the benefit of the pastime. The technical press, the daily press and the B.B.C., such are the avenues, and if the industry is wise it will supplement these with its own Book of the Bicycle as a free gift, telling people the best way of using its products for the pursuit of freedom, health and happiness, by presenting every purchaser with a copy. Think what an attraction such a volume could be, an index to another life in paragraph and picture, a means whereby folk could begin to understand what cycling can mean to happiness—for no man can tell the whole story because its individual joy is beyond expression.

One Day Out

I CARRIED out my own precepts one golden Sunday some weeks ago, and it was indeed a glorious day. There were a couple of us, both well over sixty, and because we had not seen the Avon and Severn Valley from the ridge of Fish Hill above Broadway this year, we decided on that route by way of Bidford and the Roman Road to the foot of Saintbury Hill. We were in Bidford just on eleven o'clock for the usual cup of tea, and by that time the sun was really powerful and every trace of the overnight frost had disappeared. I looked out for violets, but apparently it was still a little too early for the hedgerow kind, though some of the cottage gardens showed peeps, with the white bell of the snowdrops in profusion. We took an easy turn along the Roman Road, for the grade runs slightly up and the wind came steadily into our laps, but just before one o'clock we were at the Tower on the edge of Fish Hill and looked at the dazzling picture of the vale, half hidden and half revealed in the haze of an azure day. Finding no solace of refreshment on the ridge we dropped into Broadway for a lunch of sorts and the cheery flicker of a fire, and soon after made quietly for home by way of Welford, Binton and Aston Cantlow. It was just glorious, the day and the easy loping speed—the wind was now abaft—and the happy talk of how often we would do this thing and fill some of our Sundays with content. We had tea in Henley-in-Arden, a mighty tea of toast and an egg and buttered scones, and in the gloaming drifted home the dozen miles to make up a run of well over seventy. In the quiet moments before bedtime I thought—as so often is the case in these latter days—how lucky I am to be able to do these things, to use so lovely a day for the joy of vision and burn the miles away with an easy energy that leaves me nothing more than happily tired at the end of them. That is what cycling can do for you right down the years if you will let it, and it is an abiding mystery to me that so comparatively few folk have discovered the fact.

And Stormy Times

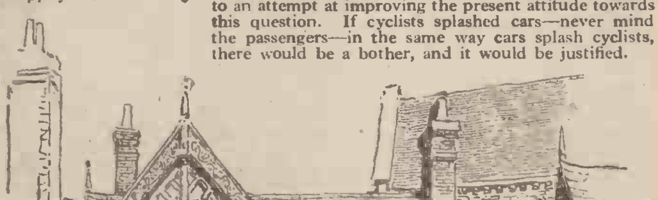
PRIOR to that ride I had an assignation on Saturday afternoon when a full-blooded south-wester drove a bigger volume of water at me since the year started. Fourteen miles would see me there, and an hour and a quarter of time. But I had not reckoned with the gale. It was low gear for choice on any rise, and a horizontal position to escape the wind and keep the rain from half blinding me. In an hour and a half I was there, ruffled, a trifle damp but very happy, and I think the latter condition was mainly due to that feeling of egotism we all experience on the completion of such a journey. You have done something and you are glad you were able. A roaring stove and a satisfying tea was the prelude to a couple of cheery hours with the lads and lassies, so that the struggle was worth the effort individually and collectively. With another early bird I left that comfortable hostel just on eight o'clock with the gale at its height driving the rain on hurrying, ghostly legs along the road, but now we were all travelling in the same direction. That was a great ride, following the flicker of the lamp's beams with the water running down the backs of our ears. We made home in an hour easily with no more dampness than the fringes of our hair. Yet weather of this kind seems to appall some people who positively shudder at riding in such conditions. Believe me, it is never so bad as it looks, and the only risk of real discomfort is the very remote one of sustaining a puncture or some mechanical trouble. If cycling was all fine weather, blue skies and fair winds it would lose much of its adventure, and for myself, I do not intend that it should.

No Immediate Hope

AH! me, I was told the other day by a big maker that any hope of switching over to new types of bicycle with better material and equipment was very doubtful as far as this season is concerned. The world's hunger for bicycles is so great that manufacturers cannot meet the demands, and all the available labour is concentrated on output, leaving little or nothing over to give attention to the first-class stuff or put into production all those improvements so glibly promised during the war. This man said quite frankly that the position is disappointing; he wanted to improve the breed, to get down to the type of machine which he knew was in demand in the home market; but the fact was that export must come before the highest quality, and export is the business on which he was concentrating. But I have reason to believe that we shall have good rubber tyres to buy in the not too-distant future, and this is a relief, for it will aid us to keep the old machine running with something left of its old liveliness. If we cannot feel any joy in the position it is at least something to know we are far better off than cyclists in any other country, not excluding U.S.A., where they have yet to learn what real cycling is. So it is a matter of saving your money for the moment, and "make do and mend" with the old model; the new one, when it is available will seem all the sweeter.

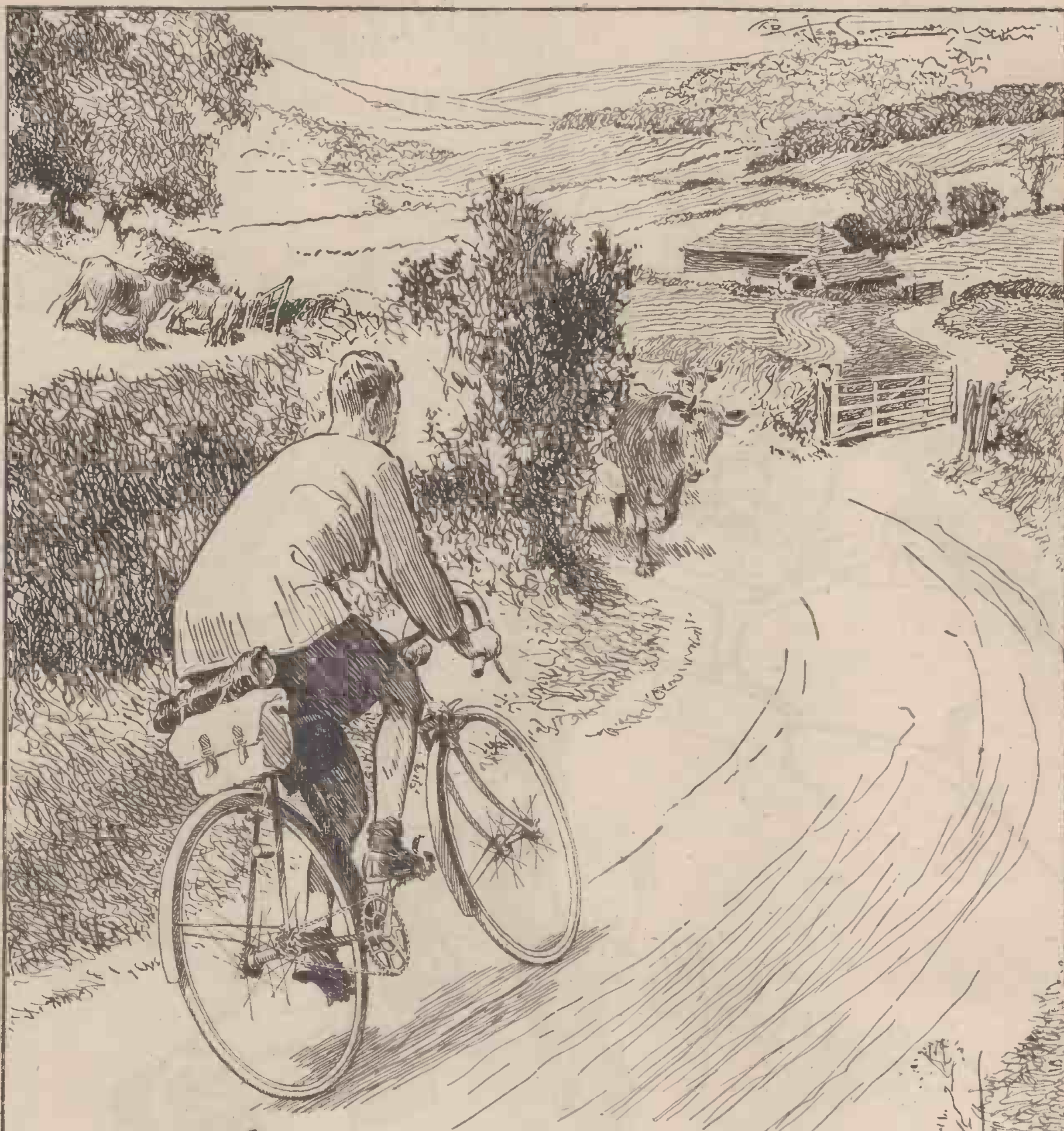
Prayer

THIS paragraph may not catch the eyes of my motoring friends, but if perchance it does drop into the consciousness of a few of them, I would ask them to listen to my prayer. On stormy days, when the wind howls down the street and the rain hits me obliquely in the diaphragm, some motorists pass me uncomfortably closely when there is no need for shaving tactics. They seem to forget my single track vehicle cannot be held on a dead true course when the gale comes howling round the corner at fifty an hour and a ballooning cape has to take the impact. It is merely asking another road user to show a sense of decency and good manners to the vulnerable traveller. The other desire I would like to see self-imposed by the motorist is a greater consideration for the discomfort imposed on pedestrians and cyclists when he fails to slacken speed passing or overtaking on a rain-flooded road. It is most unpleasant to be presented with a footful of dirty water, and I don't know what some of the ladies think when their garments are bespattered by the thoughtless action of an urgent driver. It is only during excessive storm times that I would like to see motoring consideration given to these matters, but, unfortunately, the majority of drivers are either ignorant of the discomfort and damage they fling at other people, or they just don't care. I prefer to believe the former, for human nature is mainly selfish because it is mainly thoughtless, and a word in season may lead to an attempt at improving the present attitude towards this question. If cyclists splashed cars—never mind the passengers—in the same way cars splash cyclists, there would be a bother, and it would be justified.



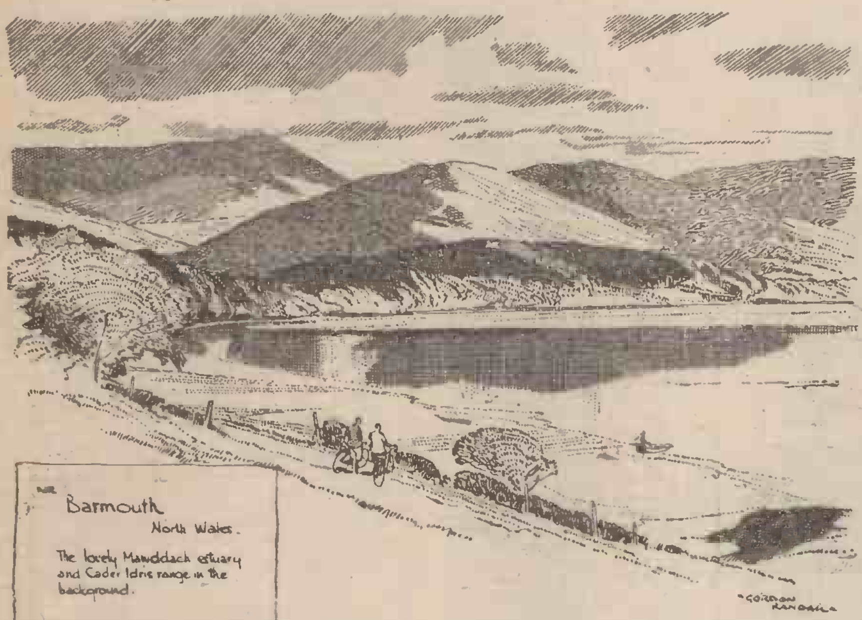
The historic Council House (1620) Shrewsbury

James II was the last of many royal visitors to stay in this fine building.



CYCLORAMA

By H. W. ELEY



Barmouth North Wales. The lovely Mawddach estuary and Cader Idris range in the background.

The Vexed Question of Bell-ringing

I DO not refer to the tuneful ringing of church bells, but to the "warning bells" of cyclists. Some riders have a passion for ringing their bells, and to my mind there is little or no use in the practice. I wonder how many riders have machines without bells? The number must be great, and I am not sure that it is not better to be minus a bell than to be addicted to the habit of constantly "tinkling." Personally, I have a bell on my machine but I very rarely use it, and do not find that it is often necessary to do so.

Gay Father Thames

THE other Saturday I spent some time at Marlow and recaptured something of the romance and charm of the Thames. It was a hot and sunny day; punts and boats and yachts were out in plenty, and swimmers dived from the bridge with skill and grace. And on the spacious lawns of the "Compleat Angler" folks sat and dozed, or drank tea, or gazed upon the water. All very peaceful and all very English, and I thoroughly enjoyed my visit. And riding in the Buckinghamshire country is always good . . . it is a county I love, particularly in the autumn, when the beeches are at their very loveliest, and one may ride through leafy lanes, communing with the spirits of Milton and Penn and gentle Cowper . . . all having strong links with Buckinghamshire.

Lure of the Night-ride

WHEN darkness falls, and the owls hoot in the spinney, and the moon casts a silvery radiance over the familiar countryside . . . then it is that I like to take out my bike and go for a spin. Night-time transforms the world, softening the lines and corners and imbuing objects with new beauty. And the long road is deserted . . . a ribbon beckoning on to romance and adventure. The little village which was so full of bustle and activity when we rode through it on that summer afternoon is now wrapped in sleep; the inn is shut; the grey old church looks almost eerie in the moonlight, and we are in a quiet and strangely beautiful world. I often wonder why more cyclists do not indulge in night-riding, for it is fascinating and most soothing to the nerves. Try a moonlight spin when you have had a particularly worrying day; it will do you more good than a bottle of medicine, and you will be surprised how different your familiar road can look when kissed by the moonbeams!

"See Britain by Cycle"

THE title is not mine . . . but that of a new and interesting series of advertisements issued by Dunlop and appearing in the cycling press. The series depicts various fascinating places it is possible to visit by cycle, and is finely illustrated by that good artist, John Pimlott. Canterbury, Corfe Castle, Ullswater, Snowdonia, Polperro, and Flatford Mill, and all the delightful scenes of the Stour and Constable country, all are featured in this series, and I have no doubt that many cyclists have cut out these advertisements and filed them for ready reference when touring. It is a truism that advertising can be educative and informative, and this series is pleasing proof of the fact.

Is it Really Necessary?

I REFER to the habit of calling a place where teas are served "Ye Olde Tea Shoppe." I hate the pseudo "old and arty," and it is strange that genuine old cottages should be marred by such cheap inscriptions. The country cottage where a cyclist may obtain tea and refreshment fills a great need, and its sign is ever welcome . . . but I do plead for the dropping of "Ye Olde"—to me it always makes the tea less drinkable, and whatever food is provided in these days of austerity, less palatable!

"A Cycling Adviser"

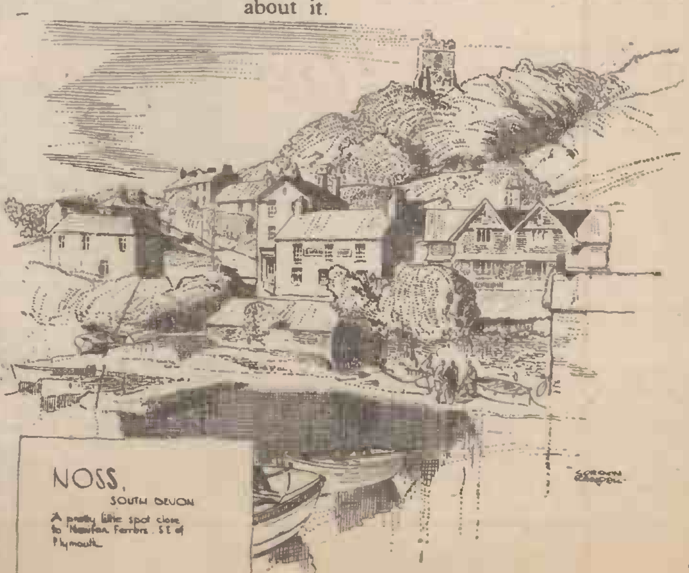
CLUB secretaries and members of clubs in Southern England are to have an expert adviser on tyre and rim equipment at their service. He is Mr. F. A. Borton, and he has excellent qualifications for his new appointment. He has been a keen cyclist for more than twenty years, and for eighteen years prior to the war he acted as secretary of Harrow Cycling Club. The Dunlop people have now appointed him to a special position to study and look after the needs of riders and give advice on their machine equipment and its use. Mr. Borton will be in close touch with light-weight cycle builders and assemblers. It is the sort of appointment I welcome, and many riders will, I know, be pleased at this extension of Dunlop service to the movement.

The Raleigh Handbook

MY good friend Fred Keller, the busy advertising manager of the Raleigh organisation, informs me that the first edition of the Raleigh Cyclists' Handbook, published early in the year, has been sold out and that a new edition is contemplated. I am not surprised at the success of the first edition, for the handbook was a model of all that such a publication should be: concise, easy to read, and of handy pocket size. I often wish that more cyclists would read some simple instructional manual about the care and upkeep of the cycle, for one still sees many cases of gross neglect and maltreatment.

The B.B.C. and the Cyclist

AN ardent rider was talking to me the other day and asked me why more talks were not given by the B.B.C. for the special benefit of cyclists. His contention was that the Corporation neglected the cyclist and the cycling fraternity. Is this true? I certainly cannot recall many talks devoted to our "game" . . . and one wonders why. What a mine of treasures exist in connection with the history of the cycle, the stories of famous cycling clubs, the feats of old-time riders, and the delights of cycle touring! The B.B.C. has, I realise, a mighty problem to cater for all tastes and all classes . . . but think of the millions of cyclists in this country! Maybe it is time that the "talks producers" did something about it.



NOSS, SOUTH DEVON. A pretty little spot close to Newton Ferrers S.E. of Plymouth

Lullington Church.
Sussex.
One of England's smallest churches. A lonely little building surrounded by trees off the main road from West Dean to Alfriston.
Only the chancel remains of the original building which was destroyed centuries ago by fire.

My Point of View

By "WAYFARER"

Good Habit

AN advertisement in the Personal column of *The Times* led off with the words: "Riding Habit . . . £22." The habit of riding (bicycles) is a very good one, which I possess. The price, however, is doubtful.

They Don't Try

WHEN I stopped for tea the other day, the caterer asked me how far I had come. The reply, "61 miles," brought the retort: "Coo! I'd be dead if I rode six miles!" Not literally, of course--but so many people could do so much more cycling if only they would try. You cannot excel at piano-playing, or climbing mountains, or knitting socks, or riding bicycles, without practice, backed by the will to conquer. There is so much fun, and so great a benefit, to be extracted from our recreation, that I wonder more folks do not make an effort to get "value for money." The reward is waiting for them—but it has to be earned.

Shut Up!

A MIDLAND daily newspaper recently reprinted a paragraph from an issue of 50 years ago concerning the stag-beetle's habit of flying about in the gloaming, and, "the cool of the day being also the hour of the bicyclist" (!), a warning was issued concerning "the peculiar danger" arising, one of these beetles having flown "straight into the mouth of an innocent cyclist." The majority of cyclists, it was suggested, ride with their mouths open. Just fancy that! It must have been a poor issue of the newspaper concerned if the foregoing were judged the most suitable paragraph for quotation half a century later! Still, the right plan for cyclists is to keep their mouths shut.

Rain Infrequency

OWING to the folding-up of the war job on which I have been engaged for the last six years I have just ceased to cycle to and from work. For most of the half-century (and more) during which I was in business the bicycle was my travel medium, and the point is mentioned at this juncture merely so that comment may be made on the use of the weather-protection I always carried. No record, of course, was kept, but, despite the notorious recklessness of our climate, the number of times I have had to make my daily journeys wearing a cape seems to be relatively low. It was felt, at times, that the number was far too high, especially when a stop had to be made *en route* in order to don my regalia (on such occasions I was pretty fluent on the subject!), but I am sure that statistics would reveal quite a small percentage of journeys under cover. Which is remarkable, considering the acknowledged instability of our climate.

Remedy

FROM this point it is an easy step to take in order to make reference to a problem which is at present troubling the transport authorities of the great city which I adorn with my presence. The difficulties attendant in the morning and evening peak hours are becoming more and more acute, and the powers-that-be seem to feel that, in the absence of more "staggering" on the part of business firms, there is bound to be some form of collapse of the existing arrangements. There is the further point that a considerable proportion of expensive trams and buses are used for only a short period daily, spending most of their time in garages, and leading a hectic life for an hour in the morning and an hour in the evening when everybody, with one accord, is intent on simultaneously travelling to or from his (or her) work. A remedy suggests itself to one who, as indicated, has for so many years supplied his own transport. If more and more people would make a point of cycling to and from their work how much better it would be for everybody concerned! The public transport situation would be eased, but, better still, the boys and girls would find it a great advantage to be riding to and fro. It is a healthy business, and convenient withal. The bicycle provides door-to-door transport, which is always ready, always available. No waiting — no crowding — no queues—no steamed windows—no breathing of the air with which, for the moment, other people have finished! Cycling to and from work has a great deal to commend it. It is worth trying.

Code Advice

I UNDERSTAND that the revised Highway Code contains the advice that dogs should be kept under control, whether on the road or in a vehicle. "Many a person," we are told, "has been killed or injured because the driver swerved to avoid a dog." Yes; and many a cyclist has sustained a nasty fall owing to the fact that dogs are allowed to roam the public highways just as they fancy. Some day, perhaps, there will be legislation on the point, carrying with it the implication that, broadly speaking, human life is of greater importance than the canine equivalent.

Radiant Memory

OF all the countless pictures which hang in the storehouse of my mind one of the most precious relates to the first of two days devoted to the traverse, some 23 years ago, of what is known as the Ring of Kerry—or the Grand Atlantic Coast Route. A pair of us, on our initial visit to Ireland, stayed for a couple of nights in Killarney, an action which prompted an Irish cycling journalist to voice the silly and somewhat spiteful remark that we "had done Killarney by candle-light." Then we set forth to ride from Killarney to Killarney by way of Kenmare, Sneem Waterville, Cahirciveen, Glenbeigh, and Killorglin, with a detour to Valencia Island, and the journey was a joyous one.

I had previously seen mountains, but never such mountains: never had I—never have I—been so impressed and inspired by the earth-lumps which entered into our vision. A matchless panorama fell to our lot. We saw something of the jungle of mountains which constitute the real Killarney, the town of that name being little more than a slum, dominated by a fine cathedral. We saw the mountains across the broad waters of the Kenmare River, and those across the broader waters of Dingle Bay. Sometimes these great uplands were in full view; sometimes they were partly concealed, partly revealed, by clouds which hurried over the scene. We saw, too, some of the "drowned mountains" lying off the west coast of Ireland—chunks which might easily have risen from dry land instead of from the bed of the ocean—and the sight was an impressive one.

No doubt we were both under the influence of the special glamour attaching to a first visit, causing us to view things through rose-tinted spectacles. No doubt, too, we were influenced by our remote location—by the fact that we were about as far from home as we could ever expect to be in these islands. Remoteness has always appealed to me as a cycle tourist; I always like to get a bit farther away—and still a bit farther.

Since those far-off days I have seen many uplands, including near and far views of Snowdon, Cader Idris, and Plynlimon. I have looked at Ireland from Scotland, and at Scotland from Ireland. I have viewed the 12 Bens of Connemara from the south side of Galway Bay, and the mountains of Killarney from the north side of the River Shannon, as well as from the Mallow road. I have ambled among the Wicklow Mountains; I have seen the Mountains of Mourne from the foot of Howth Head, 60 miles away. I know the backbone of England by sight, and have gazed at the Langdale Pikes. Pictures of the Coolins hang within my mental storehouse, and I have dwelt visually on the tumbled west of Scotland's mainland from vantage points in Skye. From various places my eye has ranged over the Inner and Outer Hebrides. But, if I have to award the first prize for beauty, combined with inspiration, then I award it in respect of those two August days in 1923 when I made the circuit of the Waterville Peninsula. A radiant memory, indeed!

The Magical Bicycle

I HAVE often spoken, with conviction, of the bicycle as a magical instrument of travel. Possibly, that almost supernatural characteristic of the two-wheeler is to be found, *in excelsis*, in the case of that small army of people, mostly women-folk, who have never mastered the art of balancing a bicycle, and who yet ride thousands of miles every year. The answer to this superficially insoluble problem is, of course, that such people occupy the back seat of tandems. They are all cyclists—but they cannot ride a bicycle! They are enthusiasts on cycling—but they must have company! Some of the keenest women cyclists I know are the people who, for one reason or another, would be completely at sea if they were asked to ride a single. Yet they account for thousands of miles every year, thanks to the magical bicycle.

Another aspect of the magic attaching to the bicycle has just come to my notice. A young relative of mine was recently found to be afflicted with contraction of the muscles, following child-birth. Her doctor—obviously a man of sound common sense—said that there was only one thing for it: she must resume her cycling. So the tandem, which had been put away for the time being, has been extracted from its lair, and husband and wife are enjoying themselves awheel in a quiet sort of way, and to the advantage of both parties.

Pernicious Doctrine

MY daily newspaper, in reporting on the recent Royal visit to Cheshire, spoke of "the towns of Northwich and Nantwich, where the streets are dangerously narrow." This is a pernicious and poisonous doctrine that a cramped space means danger. It does nothing of the sort. Of itself, a narrow street or bridge, or a steep hill, can never cause danger. It is the traffic which persistently ignores the obvious conditions that creates the danger.

Follow the Leader

I PAUSED, foot on ground, at the suburban road intersection, in order to let the cross traffic flow past. A stationary motor-car was on my right, and one or two others were panting behind me. When an opportunity came for me to negotiate the intersection in safety I took it. The motorist immediately behind me, unsighted by the still stationary car, decided to follow the leader. He overlooked that a cyclist can nip over a road very quickly, and he failed to appreciate the circumstance that No. 2 in a procession cannot of necessity do what No. 1 has achieved. A squealing of brakes prompted me to glance back when I reached the "still waters" of my desire, and I saw that two motor-cars—the one immediately behind me and another hurrying up the road at right-angles—had nearly kissed each other. This little incident has its lesson for cyclists. Don't cross the road if your vision is obstructed; don't assume that what was safe for the man ahead will be safe for you also.

"Shortening the Journey."

I CYCLED home one Sunday in the early summer with a man whom I do not often see and, when the parting of the ways came, he thanked me for my company which (he said) had had the effect of "shortening the journey." He did not quite mean that. As a general rule, we cyclists do not seek to abbreviate our rides, though there are exceptions to the rule. When we are "up against it" owing to difficult weather or geographical conditions, or if we are tired, company does seem to "shorten the journey," but, in the ordinary course of events, the presence of a genial companion adds to the pleasure of a ride and makes the time pass quickly.

Dividing the Distance

IT is very easy to be dogmatic on the question of dividing the distance which constitutes a day's ride, but the personal equation must always be borne in mind. I have often suggested that an easy way of viewing a jaunt of 100 miles is to split the distance into three equal parts, plus one. Thus, 33 miles in the morning, 33 in the afternoon, and 33 (or 34) in the evening, sound quite easy of achievement—as, indeed, they are. But this arbitrary division, all right on paper, is not of necessity the best in practice, and it is for the individual to ascertain how best he (or she) can dispose of a century of miles. At one time I, riding badly in the morning, would have transferred a block of the mileage to the evening when, normally, I am at my best—such best as it is! But nowadays the time makes little difference, and I employ no science in the dividing of my day's distance. I am a law to myself—which is another way of saying that the personal equation, all-important, is allowed to function. Thus, on one recent morning, I did 21 miles before lunch, while on the following morning I accounted for 34 miles. My usual evening mileage is in the neighbourhood of 25 miles. As an exception I rode 44 miles after tea on a recent day. There is no perfect, or universal, method of dividing one's daily mileage. The matter is always one for personal decision, regard being had for one's mood and for the conditions in which the journey is being done.

Observations

NOTICED during the recent (or, perhaps, still current) beer famine: (1) The sudden and complete unpopularity of motor-coaches, which do not seem to be wanted anywhere. (In one place, however, a slight variation was observed, the wording of the notice being: "No coaches except by appointment." Fancy a motor-coach having to make an appointment with a pub just as though it were a human being going to have a tooth out!) (2) One pub exhibited a notice: "No beer—only pop!" As Robb Wilton would say: "Well, of all the things!" Imagine how a consumer of alcohol would view the offer of a bottle of "pop"! (3) At a pub called "Ye Olde Half-waye House," a wag had adjusted the grim notice about the fluid famine so that it read: "Solde Oute." It was thus in keeping with "Ye Olde" tripe!

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