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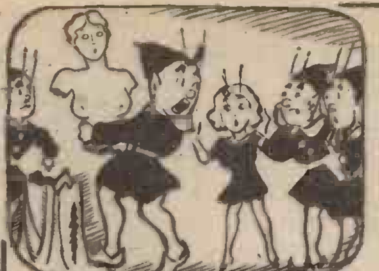

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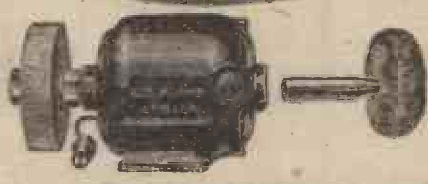

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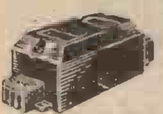

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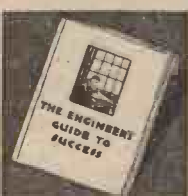

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PRACTICAL MECHANICS

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

Editor: F. J. CAMM

VOL. XI. AUGUST, 1944 No. 131

FAIR COMMENT—BY THE EDITOR

Experimental Engineering

AN association which deserves to be better known, especially by those lone hands who experiment and invent, is "The Society of Model and Experimental Engineers." This society, founded in 1898, has for its object the association and fellowship of those interested in light mechanical, electrical, model and experimental work.

Meetings are held at the Kingsway Hall, Kingsway, W.C.2, some of them being devoted to lectures and the reading of papers, frequently illustrated by lantern slides and films, or accompanied by demonstrations and experiments.

Other meetings are informal, when members bring up their work for exhibition and trial. The society owns a 1in. scale 6-coupled locomotive—the joint work of the members—and a multiple track for passenger carrying, with 14 gauges up to 5in. Stationary engines and other working models can be tested under steam from the society's boiler or run under air from the compressor.

Limited Outlook

If one may venture a small criticism, it is that the society attaches undue importance to the hobby of model locomotive construction, which by no stretch of the imagination can be called experimental engineering. With minor exceptions, it is a hobby pure and simple, and there are plenty of model locomotive clubs to cater for this very small section of the model-making public.

We should like to see the society take on a broader and more national outlook as do other societies. Fascinating though model making undoubtedly is, to concentrate too much on the model side may prevent the society from being taken as seriously as it deserves.

In these days of new materials, new industries, and new inventions, with the prospect of post-war advancement when wartime secrets are released, the time has come when the society should remodel its programme more in keeping with modern times.

All societies must change their programme with the changing times. They outgrow their original conceptions, and must advance. There is plenty of scope for this society to encourage inventors. Members not particularly skilful or lacking in equipment could have their experimental work conducted by members of the society. New ideas in machine tools and methods could be tried out, and in this way the society would fully justify its title.

Another small improvement which we think could be effected is in its title. The term "model" incorporated in the title of a society narrows its appeal, and may give a totally false impression of the excellent work which it undoubtedly does. There are many who do not like to be considered model engineers. It is realised that this society was founded at a time when model locomotive building was a popular hobby. It never, however, became a national hobby, for it was always too expensive. Moreover, it was not backed by a large industry, which, in itself, indicates the smallness of the movement. Model aircraft, on the other hand, has become a large national movement, but I do not see anything in the literature of the association which indicates that it encourages experiments with model aircraft. In view of the great developments now taking place, particularly with jet and rocket propulsion, the moment seems ripe for the society to broaden its outlook and to widen its ambit. Why not "The Society of Experimental Engineers"?

The literature would quite give the impression (an erroneous one) that the members are chiefly interested in model railways and locomotives.

Competitions

The society holds competitions at some of the meetings for trophies and other prizes, as well as social meetings and private sales of models, tools and materials. Visits are made in normal times to places of engineering and scientific interest. Here again the literature suggests a locomotive interest.

The membership to date is approaching 500, and this is altogether too small for a national society, and supports our criticism. The society has a commodious workshop and library at 20, Nassau Street, Mortimer Street, W.1, which is open normally Tuesday and Thursday evenings from 7 o'clock and on Saturdays from 5 o'clock. The workshop is equipped with a 6¼in. and 6in. lathe, a 24in. by 12in. planing machine, milling machine, drilling machine, 4½in. lathe, several 3½in. lathes, a watchmaker's lathe, several treadle lathes, hand drilling machine, sheet metal rolls and shears, vice benches, brazing hearth and forge, small tools and screwing tackle, etc. Dynamos and motors or any other electrical apparatus can be tested, and the boiler delivers a supply of steam.

Experienced members of the society acting as stewards are in attendance, and are ready to give advice and assistance to any member. Frequent demonstrations of various engineering processes are given. The society's journal, issued quarterly, is sent free to each member. The subscription for those living within 20 miles of Charing Cross is 25s. a year; those outside this radius but within 50 miles, 12s. 6d. a year, and above that, 6s. per year.

Some of the new members elected recently have been recruited from engineering establishments on production work. Visitors are at all times welcome to inspect the workshop and library and to attend the monthly meetings held at Kingsway Hall.

Effect of Taxation on Car Design

IN view of the invitation of the Chancellor of the Exchequer in his Budget speech to the House of Commons, manufacturers through their trade association have reconsidered the points which they have already put forward. In the first place they draw attention to the consequences of the alteration in taxation on design and production. It may well take several years before a basic change in the design of a motor vehicle can be brought into production. Both the design itself and the evolution are costly, and still more so is the production expenditure involved in such items as dies, jigs, tools, machines, and general equipment.

An alteration in taxation which affects design is, therefore, an extremely serious matter, and it is of the greatest importance to the industry that such alteration should be of infrequent occurrence and very carefully considered from every point of view.

The future basic method of vehicle taxation should be such that under changing conditions of home and international demand, the manufacturer will be free to adapt his products to whatever those requirements may be, and should not be restricted by conditions only applicable to a particular year or decade. It is for this reason the manufacturers are opposed to taxation being graded otherwise than in small steps or categories. For many years past the design and capabilities of the British motor-car have been seriously handicapped by the R.A.C. formula, upon which taxation is based, and which does not take the stroke into account.

The manufacturers are unanimous in requesting that the method of taxation should be changed to one related to cubic capacity. The weight of the engine would be less, which is a factor of importance in export markets, where weight is the usual basis of import duty.

Jet Propelled Cars?

But are not car manufacturers ignoring the possibility of the jet propelled car? This has no moving parts and can be very cheaply made. A passing thought in connection with the reaction-propulsion unit is that it does not call for high octane fuel and does not require lubricating oil at all. This, perhaps, is a matter of concern to the oil companies, who largely rely upon the motor industry for their sales.

The Pilotless Aircraft

Technical Details of Germany's Latest Offensive Weapon

By F. J. CAMM

SEVERAL inaccurate and fanciful articles have appeared in the daily press purporting to give technical details of Germany's new pilotless aircraft, with which they are indiscriminately bombing certain parts of Southern England. In order that our readers, and particularly Northern readers, who have not seen one of these machines in the air, may have accurate knowledge of all of the details of this form of aircraft known to date, I have prepared the following notes and illustrations.

I can say at once these aircraft are not radio-controlled, nor do they make use of turbines. These flying bombs first fell in this country on Tuesday, June 13, 1944, and we have been enabled from the undamaged pieces which have come into our possession to piece together a complete machine, so that we know precisely how it works, its range, its weight, its concussive effect, the capacity of its tanks, its propulsive principles, its wing-loading, its speed, its physical characteristics, method of construction, and not the least important, its limitations.

It is not generally known that this type of machine was first developed by Melot, a French engineer of note, during the last war. It was subjected to tests under the surveillance of the French military authorities, but the experiments were not entirely successful, and the idea was shelved. It was impossible to arouse further enthusiasm for the idea when peace was signed, and there the matter rested so far as France was concerned.

The Germans, however, realising that the Luftwaffe was declining in quantity as well as in quality, about a year ago commenced experiments at the point where Melot left off. In passing, it may be stated that Hitler really expected this to be a blitzkrieg war. He expected it to be over before any other nation was ready, and so he had made no provision for a long war, nor for the elasticity or flexibility of design, particularly of aircraft, necessary to meet changing conditions imposed by a long war.

The entry of America into the war provided us with a vast arsenal from which we could replenish our stocks of war materials and build up an air force which has blown the German air force out of the skies.

The German engineers, crying "Ichabod," perceived in the flying bomb a means of carrying out so-called "reprisals" on England, and of reviving the flagging German morale at a time when the Berliners were pressing the German High Command to "bomb London."

It is not a German invention, but a Teutonic adaptation. The Germans are adept at adapting the ideas of others. Within the space of a year they have perfected the device and demonstrated the practicability of reaction propulsion.

Types and Specification

There are several types of these pilotless aircraft in use by the Germans, and the cardinal difference is in the wing platform. One type, however, seems to be more favoured by the Germans than the others, if we are to judge by the quantities of them which they are using. This type has a square wing form with an aspect ratio of 5-1. The main details of the specification are given on the next page.

It will be seen from the very high petrol consumption that the machine is of low thermal efficiency, and evidence of this is provided by the fiery jet, about 14ft. long, which it emits in flight.

The Power Unit

The power unit is of amazing simplicity, and it has practically no moving parts. Mainly it consists of a Venturi tube, about 11ft. in length, with a maximum diameter of 2ft. A grille of lattice formation is fitted in the forward end, and this grille may be closed by a system of flap-valves, as shown in the diagram, permitting and excluding a flow of air into the unit.

No one has yet inspected or disclosed the method of launching, but presumably the machine is catapulted into the air, the catapult imparting a sufficient velocity to operate the power unit and to cause the shutter-valve to operate. When in motion air pressure lifts the spring steel shutter valve in the grid, thus permitting a flow of air into the unit. Fuel is injected at the same moment into this air stream, causing approximately 40 explosions a minute.

It is obvious that at each explosion the internal pressure, being greater than the external, will close the shutters and so seal the grid inlets, preventing forward emission of the exploded air-and-petrol-mixture.

As soon as the pressure in the combustion chamber diminishes by the escape of gas through the Venturi the pressure on the outer face of the grille exceeds that inside it, and so the spring shutters open, permitting further entry of air. This cycle, of course, is repeated until the fuel runs out.

The heater bars, which are used to provide continuous ignition and preheated to incandescence are streamlined to improve gas flow. Thus the unit is of the compressorless type, similar to those devised by Lorin in 1913, and Luduc in 1933.

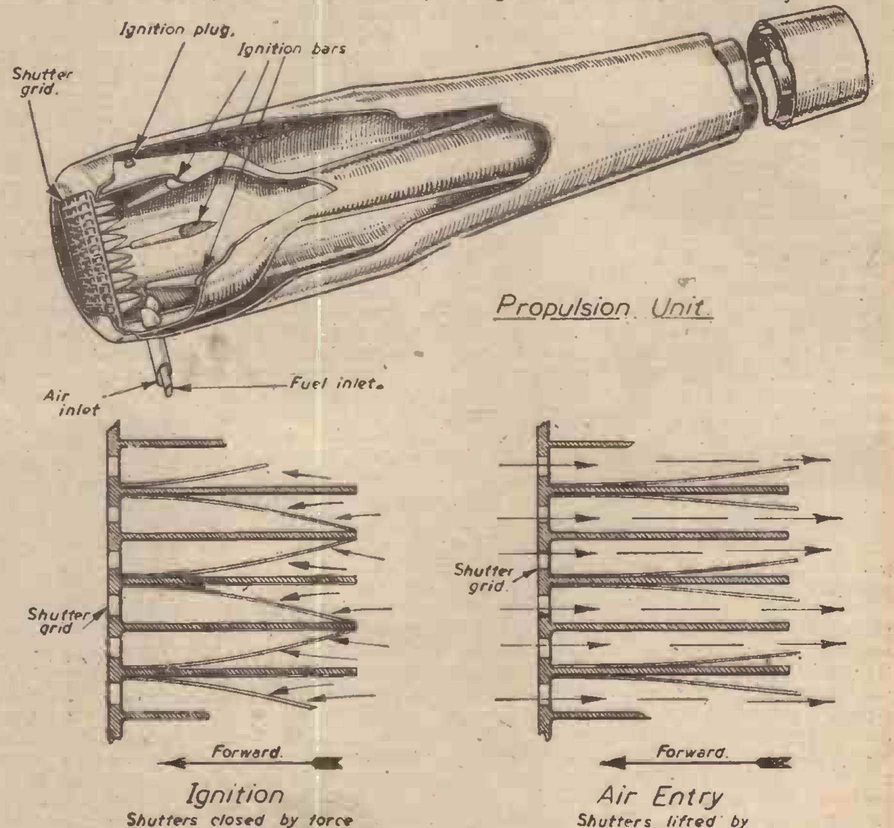
Steel Construction

The explosive is carried in the warhead, mounted in a thin casing in the front of the fuselage. The machine is built practically throughout of sheet steel of about 24 s.w.g. for the fuselage and wings, and 10 s.w.g. for the propulsion unit.

The bulkheads and ribs are of pressed steel, formed to shape and welded together. It is coloured with the usual type of German camouflage—dark green on top, and light blue underneath. It is operated by an automatic pilot set before the take-off, and once it has been launched the enemy has no control over its further movements.

It must not be presumed that the use of this new weapon came as a surprise to us. We knew they were planned for use on this country many months ago, in order to divert the Allied air forces from their attacks on German industry, communications, and transport. It was the main object of the attack by the R.A.F. on the experimental station at Peenemunde on August 17th, 1943, to destroy the plant.

I have no doubt that, as with all new weapons, we shall find the answer, as we have done with the magnetic mine and other "secret weapons." It must be remembered, too, that methods already in use are taking heavy toll of these missiles, only a few of which are getting through to their indiscriminate objectives. A large proportion of them are shot down into the sea or in open country. Our fastest fighter, the Tempest, has a speed in excess of the pilotless aircraft, and has chased and accounted for many hundreds of them already. Many minds are at work, and it is hardly necessary to remind readers that intelligence, inventiveness, and ability to circumvent are not indigenous to the soil of Germany.

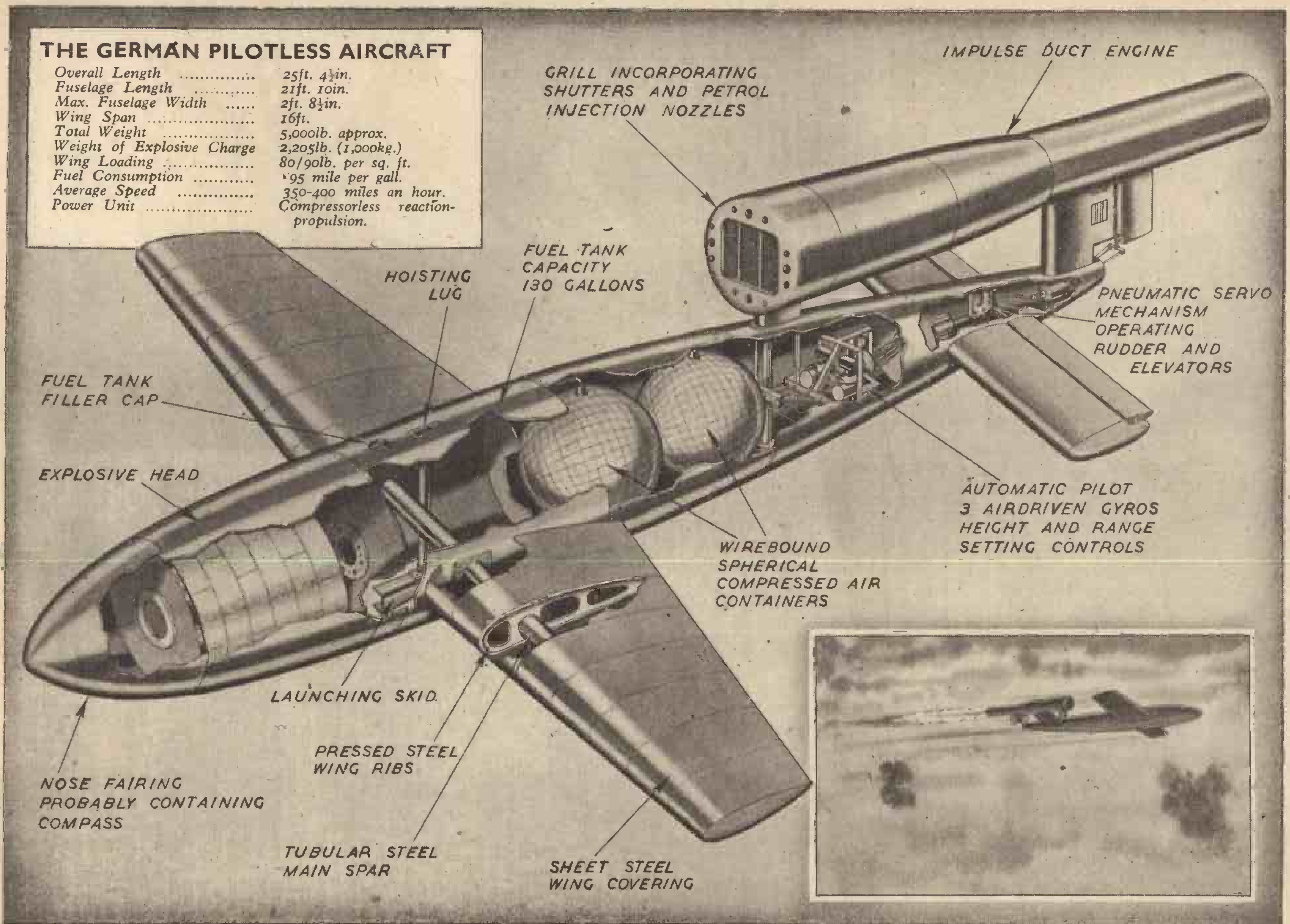


(*Original drawing copyright of "Practical Mechanics."*)

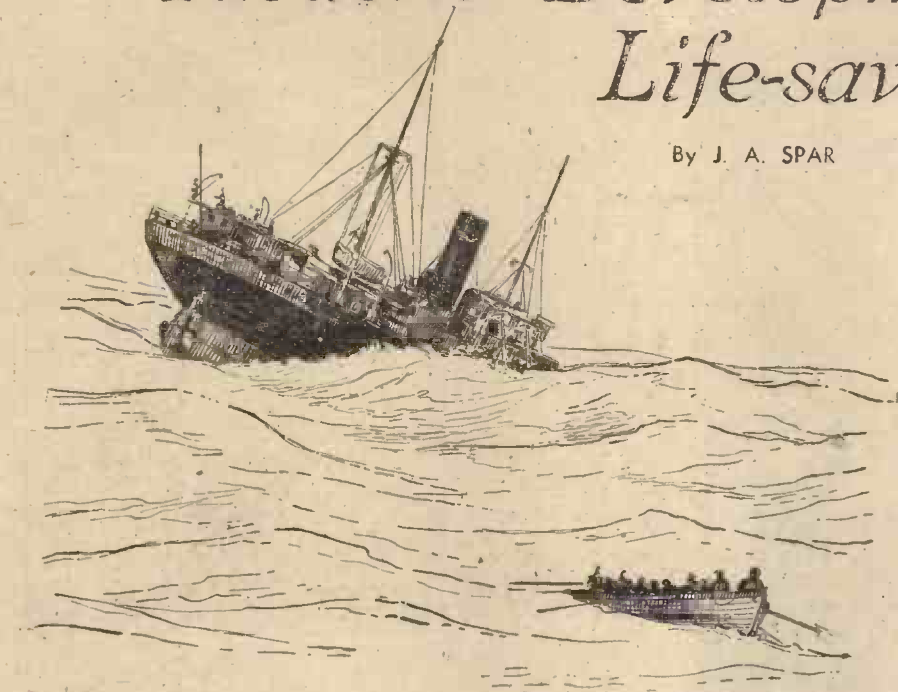
Sectional view and details of the propulsion unit.

THE GERMAN PILOTLESS AIRCRAFT

Overall Length	25ft. 4½in.
Fuselage Length	21ft. 10in.
Max. Fuselage Width	2ft. 8½in.
Wing Span	16ft.
Total Weight	5,000lb. approx.
Weight of Explosive Charge	2,205lb. (1,000kg.)
Wing Loading	80/90lb. per sq. ft.
Fuel Consumption	·95 mile per gall.
Average Speed	350-400 miles an hour.
Power Unit	Compressorless reaction-propulsion.



Modern Developments in Life-saving at Sea



By J. A. SPAR

THE Battle of the Atlantic has now reached a stage where Admiral Doenitz must lose more than one U-boat for each merchantman sent to the bottom. That is highly satisfactory, but we must not forget all those merchant officers and men who lost their lives in the earlier years of the war. But for far-reaching developments in the technique of saving life at sea, these losses must have been tragically heavier.

What the exact casualties are has not, for security reasons, been revealed. But we have been told by the Prime Minister that since the start of the war the proportion of merchant seamen lost, hailing from these islands alone, has been about one-fifth of the average number engaged in this service. On another occasion Mr. Churchill told the House that the losses of merchant officers and men have been in greater proportion than those even of the Royal Navy.

In the last war the Germans claimed to have sunk about 19,000,000 tons of shipping —the actual figure was nearer 12,000,000 tons. In that 1914-1918 war we lost 40,000 seamen. This time the war at sea has been incomparably fiercer—fought over a far vaster area of ocean with much more lethal weapons. And in this war the German sinking claims, grossly exaggerated, amount to no less than 34,000,000 tons.

Lord Leathers, the Minister of War Transport, has explained that casualties occur either as a direct result of enemy action or in attempting to get away from sinking vessels. Nevertheless, when cargo vessels are attacked and sunk, 87 out of every 100 of the men are saved. The loss of life in lifeboats and rafts is small, amounting to less than 2 per cent. of all the occupants. In other words, once a man is away from a sinking ship he is well on the way to safety.

First Line of Defence

The lifeboat is the merchant seaman's first line of defence. Realising this, the Ministry, the Admiralty and the entire shipping industry spared no pains to ensure that not a single life is lost which, by effort or foresight on the part of those responsible, might be saved. Crews must have all possible means of making a quick getaway from sinking ships. Once in the boats, everything must be done to minimise the hardships of lifeboat voyages, and the means of summoning rescue ships must be the best that service and practical experience can devise.

While speaking of lifeboat voyages, it may be mentioned in passing that nothing irritates shipwrecked officers and men so much as to read in the popular Press accounts of how they "drifted" for twenty, thirty or forty days, as the case may be. Far from drifting helplessly at the mercy of wind and sea, these lifeboats have been sailed long distances, sometimes over a thousand miles to make a landfall at the required point. Such feats are the results of accurate navigation and good seamanship, not of "drifting" at the mercy of Providence.

Many very sensible and practical suggestion are put forward to the Ministry for the safety of men in lifeboats. Many are adopted, but the question often resolves itself into whether it is possible to put a quart into a pint pot. The best use has to be made of the limited space available; in a boat which may have to carry 40 survivors, it is essential that not a single inch shall be wasted.

One very important new lifeboat device was the fitting of bilge rails and grab lines to which seamen could cling should the boat capsize and float bottom-up. These grab lines have fastened to them, by means of a line, containers filled with drinking water holding not less than two gallons, which are so placed in the boat that they fall clear if it capsizes. The men in the water can then haul it up.

The sails of lifeboats are now coloured bright red, experience having proved that this colour is visible at a greater distance than any other. At night the shipwrecked men are instructed to shine torches on these sails, so that the reflected light can guide rescuing craft. The effect is much the same as the red glow on the smoke of a locomotive when the firebox door is opened at night.

Essential Equipment

As part of its general equipment every lifeboat must carry an efficient compass in a binnacle with approved means of illumination. Experience showed that the old type of binnacle lamp was liable to be blown out in high winds, so arrangements were made to replace all lifeboat compasses with a new type in which the compass card and lubber line are permanently luminised. With the help of these luminised points and lubber lines it is now easy to see bearings without any other illumination at night.

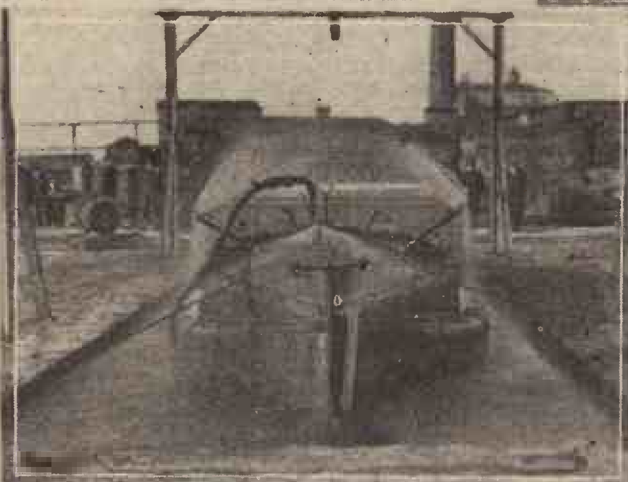
All lifeboats are now fitted with a canvas

Fig. 1.—" Skates " fitted to a lifeboat to nable it to slide safely down the side of a wrecked ship. (By courtesy of Schat Davits, Ltd.)

Tanker Lifeboat Under Fire Test

Lifeboat moored in the middle of a static water tank.

Sprayers in action actuated from manual pumps within the vessel.



Stern view of lifeboat, showing the complete drenching effect of the sprayers.

First fire test shows bows and stern enveloped in flames.

(Above) Second test showing the boat completely enveloped in flames. (Right) Occupants emerging from the lifeboat after the test.

The above illustrations show the converted steel lifeboat undergoing a severe fire test. The boat was manned by a volunteer crew during the test, who reported their reactions by means of telephone. Apart from slight blistering on certain parts of the hull, the vessel remained undamaged.

A test being made under shipwreck conditions with the Minimax Fresh Water Producer. (By courtesy of Minimax, Ltd., and The Sphere.)

hood and side screens all coloured yellow on bright orange, and large enough to shelter all the occupants of the boat. The landsman might think that the solution of protection from the weather could best be obtained by constructing an enclosed lifeboat, but seamen are unanimously against it. When you have to get into a lifeboat you have to move fast, so the open boat is the only practicable type for use in emergency.

Lifeboats have always carried a sea anchor—a contrivance like a large canvas jellybag or drogue, to enable them to heave-to and ride diagonally to heavy seas. They also have a small canvas bag stuffed with oakum which can be attached to the sea anchor. This is soaked in vegetable or animal oil and used to moderate heavy seas. A gallon of this oil is always carried.

There is a first-aid outfit, including Energy tablets and morphia, with full directions for using it. No merchant officer can qualify for his "ticket," or certificate of competency, until he holds a certificate from the St. John Ambulance Association Furthermore, he must from time to time take refresher courses and requalify.

Flares and Rockets

In addition to the dozen red flares which were always the rule, lifeboats now carry a torch for morse signalling, with two spare batteries and two spare bulbs. There must be at least six good-quality blankets in waterproof covers. A whistle is attached to the boat by a lanyard, as are two boat axes, one at the stem and the other at the stern. These axes are used for cutting clear if the lowering falls get foul.

There are six hand rockets in a waterproof case, matches, and an oil lamp. The old tin baler still remains, but it now takes second place to a manual pump for bilge pumping.

Four buoyant smoke signals, which can be thrown overboard, are another method of attracting attention, by giving off large volumes of orange-coloured smoke. In case the sails get ripped, or in order to make a canvas awning as protection against a tropical sun, lifeboats are provided with a sailmaker's palm and needle. A bunting flag, coloured yellow, 4ft. 6in. by 8ft., is attached to a light spar.

In a waterproof wallet is a set of charts covering the whole navigable globe, together with protractor, writing-paper, pencil and eraser.

When a ship is torpedoed, the surrounding sea is often covered with a thick film of fuel oil escaping from the tanks, and survivors often have to swim through it. To remove this oil from the face and body a supply of Turkey-red oil is carried.

The shipowners supply lime juice for the sick and injured, boiled sweets and chewing gum. There is fishing tackle with a variety of canned bait and spinners. This is doubly important since the recent discovery that any sea fish, if twisted firmly in a cloth, as one wrings out a towel, yields a quantity of wholesome drinking water which is not in the least salt. Shipwrecked men in this war have often managed to survive by catching and eating flying fish, which fly into the boat, attracted by the light of the lantern. In one boat they contrived to catch fish by rigging a small awning over the side and then grabbing with their hands the fish which came to lie in its shadow.

Rations

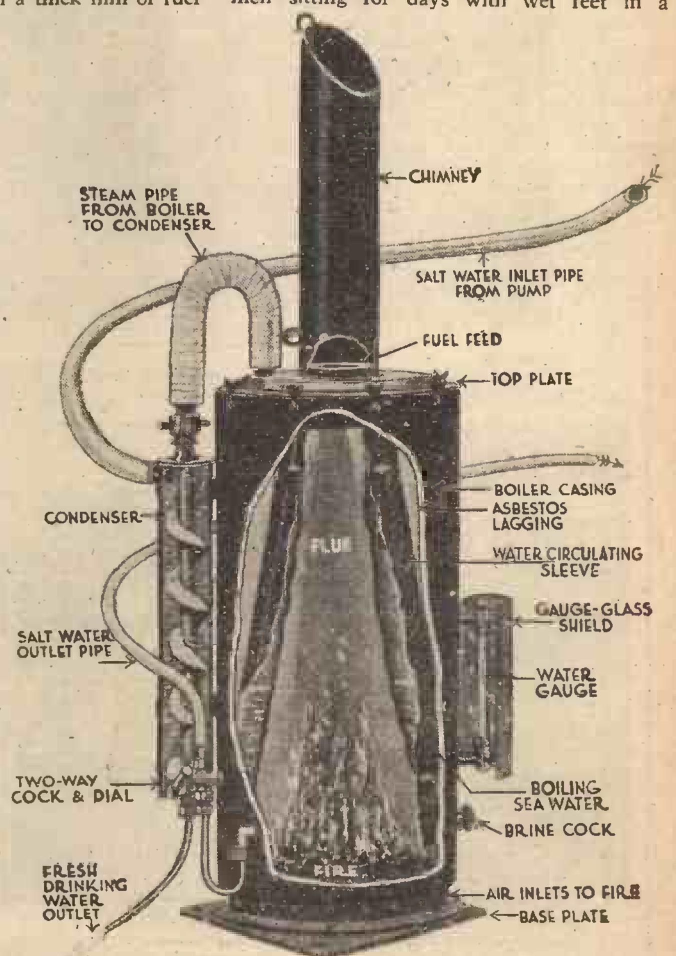
Here are the minimum rations which must be carried for each man:

112oz. of fresh water.
14oz. of biscuits.
14oz. of chocolate (specially prepared so as not to cause thirst).
14oz. of milk tablets.
14oz. of pemmican (a preparation of pounded meat and fat).

The drinking water is usually carried in small oval barrels called "barricoles," a Spanish word dating from the time of the buccaneers, and which the sailor invariably pronounces "breakers." There is a narrow dipper for issuing the water, and three rust-proof drinking vessels, one graduated in ½, 1 and 2 oz. Seamen usually keep in the lifeboats extra water in large pickle jars or any other suitable container.

The experience of several shipwrecked crews, who used the insides of cigarette-tin lids as heliographs to attract the attention of passing ship or aircraft, has led to the introduction of stainless steel signalling mirrors. These signals, used as a schoolboy uses a pocket mirror to dazzle a companion across a playing field, have been seen by rescuing ships as far away as nine miles. Signalling mirrors are particularly valuable when the sea is covered by a haze, in which case searching aircraft cannot see the boat. The reflected sun rays, directed towards the sound of the 'plane, can penetrate the haze. This, of course, does not apply to fog, but to heat hazes which are usually found in the tropics.

Boats are often damaged, either by torpedo or bomb explosions, or by catching on ragged obstructions when sliding down the side of a ship with an adverse list. Consequently a repair outfit is carried, with material for plugging holes and fitting tingles, as patches on the boat's side are called. This is most important, because men sitting for days with wet feet in a



Cut away view of the Minimax Fresh Water Producer for supplying fresh water to seamen adrift in an open boat. This apparatus burns any type of fuel, including pieces of wreckage, etc. (By courtesy of Minimax, Ltd.)

Seaman inspecting the life-light, which is carried in a special pocket in the life-jacket.

leaking boat find their feet swell into a state known as immersion foot if the temperature is below 60 degrees Fahrenheit. A gallon of special massage oil is provided to counteract this danger, which has many times been the means of avoiding a subsequent amputation.

When a ship is torpedoed, some or all of the boats on the attacked side are often rendered unusable by the explosion. The ship lists on her wounded side, so that the remaining boats have to be lowered down the opposite side, where, instead of being vertically dropped, they scrape down the side and, even if not seriously damaged, tend to capsize. To obviate this risk, lifeboats are now fitted with skates (page 368), which are like two bent skis or rockers on the inboard side. These skates are detached when the boat is safely waterborne.

Water Supply

The besetting fear of seamen adrift in an open boat is that their water supply may give out before help arrives. As a first step towards supplementing the water supply, lifeboats carry a rain-catcher made of finely woven cambric which can be spread out on stanchions so as to expose a large surface. The collected rainwater is led through a funnel into the barricoles or water tanks.

But in many latitudes rain may not occur for several months on end. Something more reliable must be found. Various suggestions on obtaining drinking water from seawater were examined, including various chemical reagents. Many of these suggestions came from the public, and all were carefully examined.

It soon became obvious that the solution was distillation. The problem was to design a still small enough to be carried, capable of producing an adequate amount of water and not requiring a bulky amount of fuel. The Department of Scientific and Industrial Research conducted experiments on behalf of the Ministry, seeking an apparatus which would yield water equivalent to several times the volume of the apparatus and fuel combined.

Necessity is the mother of invention. While various types of still were being designed, the chief engineer of a British ship constructed a still while actually in a lifeboat. The water supply was nearly exhausted when this officer succeeded in distilling salt water.

He used the cast-iron guard of a petrol tank as a fireplace, the petrol tank as a boiler, and the manual pump and copper piping of the engine for condensing. When tried out, it worked, over a gallon of water being obtained; then the operation had to be stopped owing to bad weather. Internal woodwork and kapok soaked in oil were used as fuel. When the weather eased up the operation was resumed, working from daylight to dark, during which time about five gallons of water were distilled and stored in the fresh-water tank. That lifeboat's voyage lasted 19 days. The chief engineer received the O.B.E. for his "outstanding qualities of courage and resource, his action contributing greatly to the preservation of those in the boat and his determination and cheerfulness helping greatly to maintain their spirits."

It is probable that the oil-soaked kapok was extracted from the buoyancy tanks,

The life-light floating at the end of its lanyard, leaving the user's hands free. (By courtesy of the G.E.C.)

which are now filled with buoyant material, so that, when perforated, they do not lose their lifting value.

Meanwhile several different efficient stills had been evolved, and it was made compulsory for every ocean-going ship's lifeboat to carry one. The Minimax K.M. still is capable of giving about half a gallon of fresh water for each hour it can be kept working. Thus, on a 14-days' voyage, operating 10 hours a day, it would produce about 70 gallons of water, which is roughly twice the minimum amount carried in a boat intended to hold 40 persons.

This still works with solid fuel and relies primarily on coal briquettes, which are easily stowed in odd corners of the lifeboat, eked out by any wood or waste material in the boat or picked out of the sea.

Another still, the Dirshel, which burns paraffin, was tested in a stiff breeze with a rough sea, the boat sailing at approximately 5½ knots, and gave no trouble whatever. All it needed was a man to bale seawater into the resrvoir at the rate of about 3 gallons an hour.

Other reliable stills, capable of standing a good deal of knocking about, have been invented, and it is not too much to say that the horrors of thirst have been removed from shipwrecked crews, not only for the duration of the war, but for ever.

A valuable feature of these stills is that they can be used for boiling water to make hot drinks and soup out of broken biscuit and pemmican. They can also be used for drying clothes.

The foregoing details of gear carried by lifeboats takes no account of things which have always been carried: complement of oars and spares, steering oars, rudder tiller, mast, buckets and the rest. When it is remembered that all this material is stowed in the boat before a single man gets into it, and that the boat must then accommodate about the equivalent of an ordinary country single-decker bus packed to standing room, it will be seen what ingenuity has been employed.

Radio Equipment

The wireless transmitting and receiving sets are not kept in the boats, but held in readiness in the chartroom, where there is less risk of damage. Two of the boats are fitted with masts for aerials, one on the port and one on the starboard side, and in suitable weather kites are used to get the longest aerial.

The transmitter is designed so that non-technical persons can get the best out of it merely by pressing a button or turning a handle. It will send out the distress signal automatically for a period of two minutes, and these signals can be repeated at suitable intervals until the accumulators become discharged. The later types of transmitters are fitted with an adaptor so that the electrical energy required can be produced from a hand-driven generator.

The lifeboat receiver, which embodies a frame aerial, has proved valuable for direction finding. The Admiralty and the G.P.O. have arranged for the transmission of time signals by a number of coast stations throughout the world. These are a great help in accurate navigation, for, reliable as the new pocket-sized lifeboat sextants have proved, the absence of a set of chronometers limits their use, and the time shown by the ordinary pocket or wrist watch is only approximate.

In addition to the material already kept in the lifeboat, each survivor, whether seaman or passenger, carries other safety devices about his person. There is, for example, the protective suit. This, the invention of Mr. T. E. Metcalfe, of the Ministry of War Transport, is waterproof and windproof and affords effective protection against water, cold, wind and tropical sun. Over 300,000 of these conspicuous yellow suits have already been issued. Mr. Metcalfe assigned the patent rights of his invention to the Ministry.

(To be continued.)

A sea anchor which is trailed at the stem of a lifeboat to enable it to ride diagonally to a heavy sea.

Principles and Design of Transformers—4

Auto-transformers and Transformer Loading

By J. L. WATTS

(*Continued from page 338, July issue.*)

WHEN it is desired to obtain a secondary voltage which does not differ very greatly from the primary voltage it is often most economical to use an auto-transformer in preference to the usual type of double-wound transformer. It is important that the output circuit of an auto-transformer be kept free from "earth" faults, as these may constitute a short circuit if the transformer is fed from the usual type of supply system, in which one point is connected to earth at the generating station. Since the auto-transformer is designed merely to subtract or add a small voltage to the supply voltage, the auto-transformer can have a lower capacity than a double-wound transformer having the same output.

The relationship between the frame or core k.V.A. and the k.V.A. transformed in the case of an auto-transformer is

$$\frac{\text{Frame k.V.A.}}{\text{k.V.A. transformed}} = 1 - \frac{\text{L.T. voltage}}{\text{H.T. voltage}}$$

so that, in the case of a transformer used to step down from 250 to 200 volts, Frame k.V.A. $= \left(\frac{1 - 200}{250}\right)$ times the k.V.A. transformed. In other words, the frame k.V.A. of the auto-transformer is only one-fifth the size of the equivalent double-wound transformer. The frame size necessary for a transformer can be considered, for purposes of comparison, as roughly proportional to the volt amps. of the primary plus the volt amps. of the secondary.

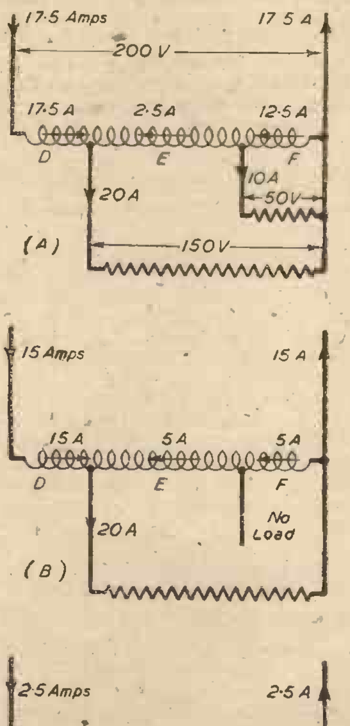


Fig. 1.—Current distribution in auto-transformer with various loadings.

Design of Auto-transformer

As an example we may take the case of a transformer which is supplied from 200 volt 50 cycle single phase mains to give outputs of 20 amps. at 150 volts (3,000 volt amps.) and 10 amps. at 50 volts (500 volt amps.). Neglecting losses, the secondary output of 3,500 volt amps. would require a primary input of 17.5 amps. at 200 volts. If we assume for the purpose of comparison that the transformer has one turn per volt the primary winding would require, if double wound, 200 turns capable of carrying 17.5 amps., that is, 3,500 amp. turns. The 150 volt secondary would require 3,000 amp. turns,

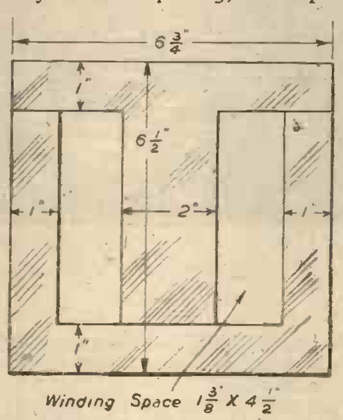


Fig. 2.—Dimensions of laminations for auto-transformer.

and the 50 volt secondary would require 500 amp. turns; giving a total of 7,000 amp. turns for the transformer.

When used as an auto-transformer it will be seen from Fig. 1 (A) that section D of the windings would require to carry 17.5 amps., section E 2.5 amps., and section F 12.5 amps., when both sections of the secondary circuit are fully loaded. In Fig. 1 (B) are shown the conditions when there is no load on the 50 volt circuit, and the secondary load of 20 amps. at 150 volts (3,000 volt amps.) would require a primary input of 15 amps. at 200 volts, if the losses are neglected. In Fig. 1 (C) are shown the conditions when there is no load on the 150 volt secondary circuit. From these diagrams it can be seen that the maximum load on section D of the windings is 17.5 amps. (875 volt amps.), on section E is 5 amps. (500 volt amps.), and on section F is 12.5 amps. (625 volt amps.), giving a total of 2,000 volt amps. for the transformer. If the transformer has one turn per volt it would require 2,000 amp. turns as compared with the 7,000 amp. turns for a double-wound transformer of the same output. This means that the core size of the auto-transformer need only be 0.285 of the size of a double-wound transformer.

On a 50 cycle supply a core having a net cross sectional area of 5 square inches could

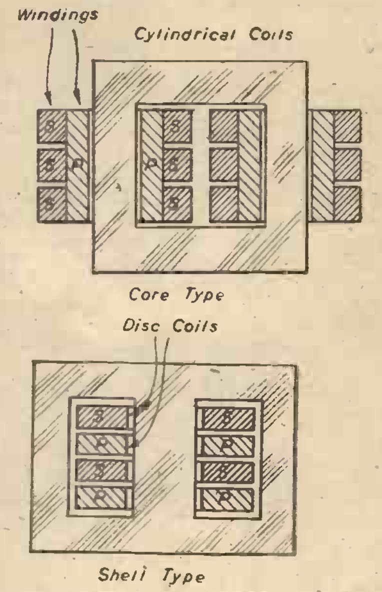


Fig. 3.—Types of transformer cores and windings.

be used. The turns per volt would then be $\frac{100{,}000{,}000}{4.44 \times \text{frequency} \times \text{total flux}}$, so that if a magnetic flux density of 65,000 lines per square inch is adopted the turns per volt $= \frac{100{,}000{,}000}{4.44 \times 50 \times 65{,}000 \times 5}$, which works out at 1.39. Section D would, therefore, need 70 turns. For sections E and F we may allow about 5 per cent. above the calculated number of turns to allow for volt drop on load, so that section E could have 147 turns and section D 75 turns.

Adopting a current density of 1,500 amps. per square inch cross-sectional area of conductor, the wire used for section D should have a cross-sectional area of 0.0116 square inch (10 s.w.g.), section E 0.0033 square inch (say 16 s.w.g.), and section F 0.00833 square inch (say 12 s.w.g.). Actually, since the efficiency of the transformer will probably be about 93 per cent., the cross-sectional area of the conductors should be about 1.08 of the area calculated to allow for the magnetising current. However, the extra area may be neglected in this instance, as the current density of 1,500 amps. per square inch is not an absolute limit. For section D we need 70 turns of 10 s.w.g.; if D.C.C. wire is used, this will occupy a space of 1.41 square inches. For section E 147 turns of 16 s.w.g. would occupy a space of 0.85 square inch, and for section F 75 turns of 12 s.w.g. would occupy 1.05 square inches, a total of 3.31 square inches. It is necessary to allow at least 25 per cent. extra space to cover insulation between layers and core and the space for bringing out the connections,

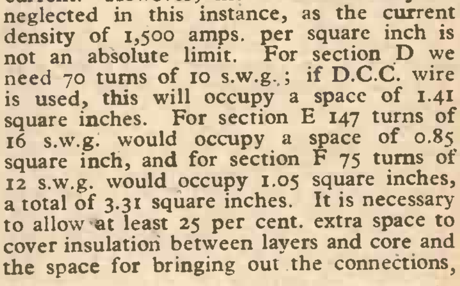


Fig. 4.—Equivalent circuit of a loaded transformer.

which brings the total area to 4.15 square inches. Stalloy stampings of the dimensions shown in Fig. 2 should provide adequate space and, allowing 10 per cent. over the calculated core section to cover insulation between the stampings, we find that the core should be built up to 2¾in. thick.

With this transformer it is suggested that cylindrical coils be used, although for larger shell type transformers the disc type of coils indicated in Fig. 3 are very convenient. It is usual to employ cylindrical coils for core type transformers, in which the coils are not surrounded by iron on both sides. Fig. 3 shows small spaces allowed between the sections of the coils to assist ventilation and cooling, as may be required on large transformers.

Equivalent Circuit of Transformer

When any type of transformer is connected to the supply mains it will take a small

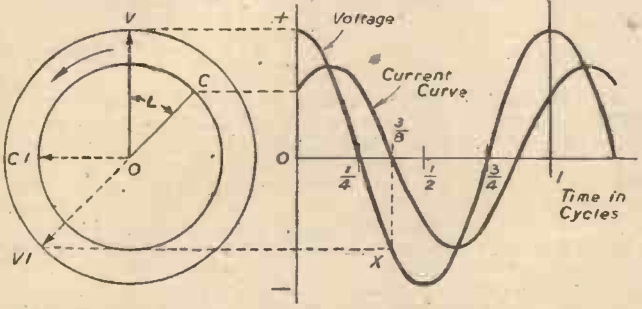


Fig. 5.—Voltage and current in A.C. circuit having a lagging power factor of 0.707.

magnetising current which is practically a quarter of a cycle out of phase with the supply voltage. There will also be slight eddy currents induced in the core, which acts somewhat as a secondary winding, and these will cause the primary winding to draw from the supply a small current which is in phase with the supply voltage. The combined current will flow through the primary winding against the resistance of the conductors and against the inductance or reactance resulting from the leakage magnetic flux round the turns. It is possible to draw an equivalent circuit to indicate the conditions existing in the transformer.

In Fig. 4 R_p represents the resistance of the primary windings, X_p represents the reactance of these windings, X_o represents an inductance corresponding to the transformer inductance on no load, and the resistance R_o will be equivalent to the circuit for eddy currents. The impedance Z of an A.C. circuit is equal to $\sqrt{R^2+(2\times3.142\times \text{frequency}\times L)^2}$, where R is the resistance and L the inductance in henries. The current flowing in such a circuit is equal to $\frac{\text{Volts}}{Z}$. We can now consider the effect of connecting the transformer secondary to a load circuit. In the diagram R'_2 and X'_2 represent the equivalent resistance and reactance of the secondary windings and are equal to the actual values in the secondary multiplied by k^2, where k is $\frac{\text{No. of primary turns}}{\text{No. of secondary turns}}$. R^1 and X^1 represent the equivalent resistance and reactance of the secondary load circuit supplied by the transformer, and are equal to the actual values multiplied by k^2. Such an equivalent circuit diagram could be used to calculate the primary current with various types of load. If the secondary windings or load circuit should become short circuited the value of primary current drawn from the mains will be equal to $\frac{\text{Volts}}{Z_E}$, where Z_E represents the total impedance of the transformer as obtained from Fig. 4. The reactance of the transformer windings is increased with increased separation of the primary and secondary, which will reduce the short circuit current.

Graphical Representation of Transformer Conditions

For those who are interested in the subject the vector method of solving transformer problems is very useful and provides a clear picture of what happens in the transformer. A vector can be drawn to represent each of the quantities involved, this line being considered to revolve about a fixed point at a speed which is equal to the supply frequency. For example, in Fig. 5 the line OV represents an A.C. voltage, the projection of this vector against a vertical axis will give the instantaneous value of the voltage. OV represents the maximum positive voltage as shown by the projected curve. Three eighths of a cycle later the vector will have revolved to the position OV_1 and will be negative, as indicated by the point X in the voltage curve. If we assume the current cycle is one eighth of a cycle behind the voltage (45 deg. lag) the vector OC will represent the current when the voltage is OV. Three eighths of a cycle later, when the voltage is represented by OV_1, the current will be represented by OC_1, and the instantaneous value will be zero, and so on.

Having illustrated the method, we can now proceed to apply this to a single phase transformer having a voltage ratio of 1 to 1. The line OM in Fig. 6 represents the magnetic flux passing through the transformer core and linked with the primary and secondary windings. The voltage induced in the windings by this changing flux will lag behind the flux cycle by 90 deg. or a quarter of a cycle, and can be represented by the vector OE_s drawn to a suitable scale. This represents the induced secondary voltage and also the back voltage induced in the primary. A voltage E_p must be supplied to the primary in opposition to the induced back voltage. The primary current of the transformer on no load is represented by the vector OC and lags by nearly 90 deg. behind the primary voltage.

Load Currents

Now we can consider the effect of connecting the secondary to a circuit composed purely of resistance, such as a batch of lamps. The vector OI_s represents the secondary current. Due to the resistance of the secondary windings there will be a volt drop in the windings which is equal to the product of secondary current and resistance of the secondary windings. It is important to note that this volt drop is in phase with the secondary current and can, therefore, be represented by the vector OD. There will also be a volt drop in the secondary due to the reactance of the secondary windings, and this will be equal to the product of the secondary current and the reactance due to the secondary leakage flux. It should be noted that the reactance volt drop is 90 deg. in advance of the current and can be represented by the vector OH. The total volt drop in the secondary winding is found by combining the two vectors, OD and OH, by means of a parallelogram of vectors, and is shown by OE. Now the secondary volt drop OE will reduce the secondary terminal voltage to a value lower than the induced voltage. Therefore by combining OE and OE_s by a parallelogram of vectors we obtain the secondary terminal voltage on this load, which is represented by the vector OV_s. It should be noted that, on the purely resistive load, the secondary terminal voltage will be in phase with the secondary current, and the power factor of the secondary load circuit will be unity.

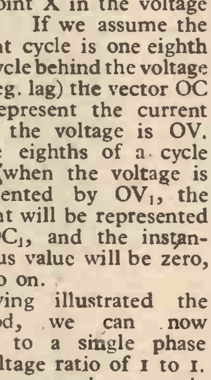


Fig. 6.—Vector diagram for transformer with secondary load at unity power factor.

Now the immediate effect of the load current flowing through the secondary windings will be to demagnetise the core and this will cause the primary to draw a current from the mains to restore the magnetism. This current will be exactly equal to the secondary current (in a 1 to 1 ratio transformer) and will be 180 deg. out of phase with the secondary voltage. It may be represented by the vector OG. Combining this vector with the vector OC (primary no load current) gives the total primary current on load, as indicated by the vector OI_p. There will be a volt drop OA, due to the resistance of the primary windings, and a volt drop OB, due to the leakage reactance of the primary windings. The total volt drop of the primary is represented by the vector combination OF. In order to maintain the initial induced voltage this volt drop must be added vectorially to the vector OE_p, and it is seen that the primary terminal voltage must be increased to OV_p to maintain the magnetic flux. It will be seen that the primary current lags by the angle θ behind the primary terminal voltage. The no load ratio of transformation of 1 to 1 falls to the ratio $\frac{OV_s}{OV_p}$, the volt drop being increased, and the ratio of transformation being reduced, by increased resistance of the windings and by increased leakage flux round the primary and secondary coils.

Inductive and Capacity Loads

If the transformer is connected to an

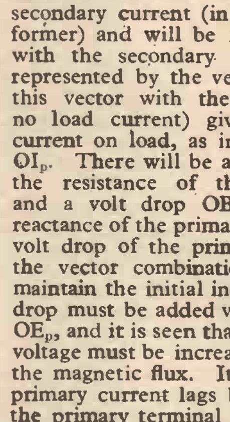


Fig. 7.—Vector diagram for transformer supplying inductive secondary load.

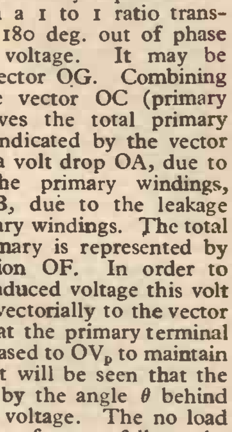


Fig. 8.—Vector diagram for transformer supplying capacity secondary load.

inductive secondary load circuit, such as a magnetic coil, the secondary current will lag by a considerable angle (such as θ_s) behind the secondary voltage. The conditions are now indicated in Fig. 7 and can be followed as for the resistive secondary load indicated in Fig. 6, the same notation being adopted. It should be noted that the angle of lag, θ_p, of the primary current OI_p behind the primary voltage OV_p is automatically increased. It is important to note that the volt drop is now greater than for the resistive load, and the ratio of transformation is reduced to a greater degree; this is due to the fact that the transformer windings have more reactance than resistance. It is, therefore, important to design the transformer to keep the reactance to a minimum for an inductive load. In most cases the primary voltage will be fixed so the primary volt drop will reduce the secondary terminal voltage below the value indicated by OV_s.

On the other hand if the secondary load circuit had a high capacity, such as a condenser, the conditions would be somewhat as indicated in Fig. 8. In this case the secondary current will actually be in advance of the secondary voltage. The same notation is adopted and it will be seen that this type of load causes the secondary terminal voltage to increase, and at the same time the ratio of transformation is increased.

The simplest way of dealing with a transformer which has a transformation ratio of more than one is to employ different scales for the primary and secondary values. For instance, if the secondary voltage is half the primary voltage, one inch on the primary voltage vector could represent 50 volts, and 25 volts for the secondary. One amp. primary current could be represented by the same length as two amps. secondary current. By this means all currents can be considered equally effective as regards magnetic effects, since the secondary currents are increased in practically the same ratio as the turns are reduced. If one inch represents 5 amps. primary current in a 1 to 2 step-down transformer, it could also represent 10 amps. secondary current. This will be quite in order since 10 amps. increase of secondary current will necessitate 5 amps. increase of primary current to restore the magnetising ampere turns, if the losses are neglected.

Rocket Propulsion

Further Notes on Its History and Development.

By K. W. GATLAND

(*Continued from page 332, July issue*)

IN 1812 an English Army Rocket Brigade was formed, which subsequently gained marked success at the siege of Leipsig in 1813, and also during the Battle of Waterloo, two years later.

After witnessing trials of Congreve rockets at London, in 1813, Austrian army officials succeeded in influencing the Austrian Government, who, a year or so later, established a sizable factory for the purpose of war-rocket manufacture at Weinerisch-Neustadt.

It is desirable to emphasise, before proceeding further, that the rockets developed up to this period were of very low thermal efficiency, decidedly unstable in flight, and, in consequence, inaccurate in trajectory. It was not until Congreve introduced fins, superseding the balancing "stick," that the rocket began to show any marked gain in technical advancement. However, the invention of this stabilising means cannot be actually credited to Congreve, as the idea was first given by Frezier, a French artillery engineer, in his technical book on armaments, published some years previous to the practical development, who also anticipated in the same work, a later refinement of Congreves, the "two charge rocket," to which reference will be made later.

Perhaps the most notable contribution to the science of rocketry, prior to the twentieth century, was the invention of the axially rotated rocket projectile. This rocket system, first developed in America in 1815, displaced both the balancing "stick" and the "fin," the exhaust apertures being spaced in a circle, and drilled offset to the line of thrust, instead of normal to it, as in the "stick" and "finned" principle. Needless to say, this refinement aroused much interest amongst rocket authorities throughout the world, and attention was focused towards its further development. In England Congreve developed many rockets of similar character to the American design, rotation being similarly imparted by virtue of offset thrust.

It was in the year 1826 that Congreve patented a method whereby a series of rocket cases were laid in line within a single containing tube, so that the charges became ignited successively, to thus obtain an increased duration of firing. This method, however, was first conceived by Frezier, as previously mentioned, and has since become known as the "step-rocket" principle.

Congreve was later knighted for his work in connection with English rocket artillery, and subsequently assumed the position of Controller of the Royal Laboratory, Woolwich.

At about the same period rockets of greater efficiency than those previously used in war were employed against the Turks by the Russians, who developed a battery launching system which fired several explosive rocket projectiles at one loading into the enemy lines in much the same way as the Russian rocket batteries operate to-day.

The Rocket Life-line

Although being employed for lighting and signalling purposes at sea, the rocket had found its greatest use in war, and the first evidence of its application actually being instrumental in saving life, instead of destroying it, was in 1826, when four rocket life-line stations were set up at various points on the Isle of Wight coast known to be most perilous to shipping. The rockets employed were designed by Dennett, of Newport. The rocket-line, however, had been first advocated by Trengouse in 1807, but, owing to the employment of the Manby life-line mortar system, which had then just come into extensive use at coastguard stations all round the British Isles, the true merits of the rocket for the purpose of life-saving were overlooked, and it was not until 1855 that the rocket finally came into its own, displacing the Manby mortar, the rockets used ranging in weight from ½lb. to 2lb. The advantages of the rocket over its contemporary are obvious. The rocket projector, for instance, is considerably more compact than the mortar apparatus and, in consequence, more portable. Still more important, the path of the line is traced out by the rocket exhaust—a great advantage, especially at night. Although it was not until 1870 that universal adoption was finally achieved, the rescue rocket since that time has been instrumental in saving over 14,000 lives. The 6lb. rockets of that period were capable of carrying a ½in. hemp line for distances of approximately 1,050ft.

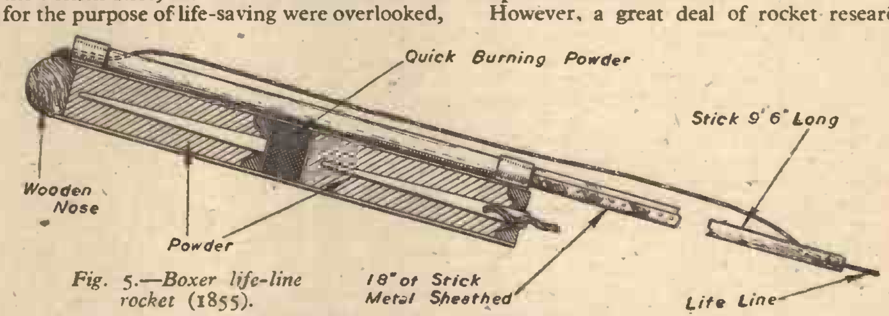


Fig. 5.—Boxer life-line rocket (1855).

In 1841, S. Golightly proposed a reaction propelled projectile intended to employ steam as the propellant. However, although his idea was correct in principle, the design was not technically sound, but, allowance being made for the period of invention, his scheme was, nevertheless, a remarkable one.

In the year 1844, William Hale designed and patented a rocket projectile stabilised by axial rotation, the exhaust apertures being practically tangential at the side of the case. The rotary stabilisation principle was further developed during the following years. Macintosh, in 1853, for instance, evolved a firing method in which the launching tube was initially rotated to impart rotation to the rocket prior to flight. A year later Court patented a design in which the exhaust impinged on small vanes inclined to the rocket axis. Fitzmarice, in the same year, developed the method of causing rotation by the action of air pressure on a "spiral" shaped head.

It was about the middle of the century that the rifled cannon came into use, due mainly to the endeavours of General Rodman and W. E. Woolbridge in America, and with its subsequent universal adoption, the war rocket quickly fell from favour.

Step-rocket Line Carrier

However, a great deal of rocket research continued, although mainly in connection with the rocket lifeline. In 1855, Col. Boxer, of the Royal Laboratory, Woolwich, further developed the "step-rocket" as a line-carrier (Fig. 5). This he evinced by placing two rocket charges in line within a single case. When ignited the first charge carried the projectile until its fuel was exhausted, at which stage it fired the second, and was blown off, the rocket thereby gaining additional impetus in flight, substantially improving the range.

A rocket-propelled airship was proposed in 1860 by Betty, an American engineer, but was not, however, proceeded with beyond the design stage.

In the year 1863 William Hale published a technical paper, "A Treatise on the Comparative Merits of a Rifled Gun and a Rotary Rocket," and a few years later further developed the axial rotation principle. Instead of offsetting the exhaust apertures as the Americans, Congreve, and he himself had done previously, Hale provided metal shields (Fig. 6) inclined over three escape holes drilled normal to the axis of the rocket, on to which the exhaust gases impinged, creating a rotary motion. With reference to the diagram, the screwed safety cap was fitted only for purposes of storage, in order that the rocket would explode should spontaneous combustion take place. These type projectiles were of two sizes, and named after their inventor—"Hales 9 and 24-pounders."

Misconceptions of Space-flight in Literature

Although Jules Verne, in his great work of fiction "From the Earth to the Moon," published in 1866, suggested rockets to retard the space-vessel depicted by providing reaction tubes at the nose of the craft, neither he, nor H. G. Wells in "The Shape of Things to Come" (published some years later) suggested the rocket means for propulsion—instead the impossible "space-gun" being employed for projecting the craft beyond the Earth's gravitational influence—in much the same way as a bullet fired from a gun.

were certainly revolutionary for their day of origin, they were naturally enough of little practical consequence at the time of their finding.

It is indeed surprising to find in a book, "Half Hours in Air and Sky," published by James Nisbet and Co., in 1899, the true principle of rocket motion defined, as follows:

"In the infancy of physical science it was hoped that some discovery should be made that would enable us . . . to pay a visit to our neighbour, the Moon. The only machine independent of the atmosphere, we can conceive of, would be one on the principle of the rocket. The rocket rises in the air, not from the resistance offered by the atmosphere on its fiery stream, but from internal reaction. The velocity would, indeed, be greater in a vacuum than in the atmosphere, and could we dispense with the comfort of breathing air, we might with such a machine transcend the boundaries of our globe and visit other orbs."

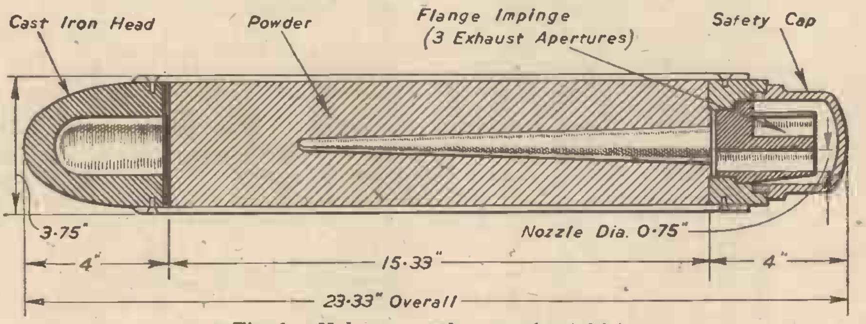


Fig. 6.—Hale 24 pound war rocket (1863).

The obvious fallacy of the "space-gun" principle is in the severe shock acceleration at take-off in order to attain an initial speed of 6.95 miles per second (release velocity), which beyond all measure of doubt would be instrumental in instantly crushing the occupants to death. Another obvious point is that friction caused by the rapid passage of the vessel through the atmosphere would be prohibitive. The rocket, on the other hand, would not need to develop such severe acceleration, due to the fact that a rocket vessel would carry its own propulsive means, the application of energy being spread over a considerable period, and acceleration built up gradually within bearable physical limits. The greatest velocity would be achieved far beyond the Earth's atmosphere belt, and, in consequence, the frictional effect would be by no means as severe. It is curious that having readily available the knowledge of elementary mechanics, these great writers of science-fiction did not realise the impracticability of their fictitious creations, for had they given the subject serious practical consideration prior to writing, the rocket means would have shown itself the only truly feasible method of achieving the conquest of space and, in consequence, further enhanced the value of their work.

The above comments of scientific literature have been included not so much for historical significance, but rather as a convenient point to clarify some of the early fallacies connected with the subject of space-flight, and interplanetary communication.

The First Rocket Aeroplane

A Russian, Niballchitch Kibaldchitch, in 1881, designed what might be termed the first reaction propelled aircraft. In actual fact, he recorded the basic design while imprisoned for being concerned with five others in the assassination of Czar Alexandra II, while awaiting the result of the trial, and the inevitable "Death Sentence." However, his drawings and manuscripts were not discovered until long after his death, actually in 1918, and although the ideas contained

When it is considered that even to-day the principle of rocket motion is constantly being misinterpreted, often by reputable engineers, the significance of this short paragraph written by an unknown author, is truly remarkable.

Experimental Work

Reverting to the rocket as a line carrier once more, a great deal of experimental work was conducted by various individuals in Britain towards the close of the nineteenth century, resulting in considerable improvement of this type of sea-rescue apparatus. Many of these developments were represented in trials of line-throwing appliances conducted by a sub-committee of the Advisory Committee of the Board of Trade, in which numerous forms of life-saving equipment were demonstrated. It is of interest to note that not only were various types of rocket-line apparatus tested, but in addition, line-throwing guns, drift buoys, kites and balloons. The most promising equipment proved to be a portable rocket apparatus designed by William Schermuly. This apparatus, consisting of a launching trough (into which the rocket carrier was placed), supported by a stand and fixed direct to a line-containing box, was initially tested under the auspices of the sub-committee in 1908 at Greenhithe, on board the "Warspite." The apparatus was set up on the rail of the ship, and fired, in the surprisingly short time of 2¼ minutes, contact being made with the shore some 200 yards distant, using a 2lb. rocket. Further Schermuly rocket line-carriers were tested in this and subsequent trials, later tests being conducted in October of the same year on the Tyne, when even better results were obtained in respect to setting up and firing, in one particular case, preparation taking only one minute, the 1lb. rocket employed bearing a line for 177 yards, a notable achievement for a light rocket. Another rocket of 6lb. set up and fired in 1½ minutes, successfully projected a line for 321 yards. The proved efficiency and extreme portability of the apparatus, which weighed complete only 40lb., were all the more notable in the fact that the tests were carried out single-handed. As the result of the 1908 trials, the Schermuly line-carrying apparatus was approved by the Board of Trade, and to-day, developments of this pioneer portable sea-rescue equipment constitute an important emergency item on all British and a very large number of foreign ships.

The Beginnings of Modern Research

The first to seriously suggest the rocket as a means for interplanetary communication would appear to be a Russian scientist, Konstantin E. Ziolkowsky. His first technical paper on the subject of rocket motion was published in the scientific journal, "Nautschnoje Obosrenije," in 1903, in which he pointed out the functioning principle of reaction, illustrating theoretically that a rocket could operate in vacuum.

In 1907, a French engineer, Esnault-Pelterie, commenced a mathematical investigation into the possibilities of space flight. The work was expanded in 1912, and later submitted to the Société Française de Physique.

Also in 1912 an American engineer, Dr. Robert Goddard, of Princeton University, after a considerable theoretical investigation of rocket motion commenced in 1909, successfully demonstrated that a rocket could function in space. This was arranged by firing a rocket charge within an evacuated glass tank, and the impulse measured, due care being taken at the same time that gaseous rebound did not affect the recording. The result indicated a slight increase in the thrust factor, in comparison with that obtained under normal atmospheric conditions. Thus it was finally proved that instead of being the medium which effects propulsion, the atmosphere actually has a "damping" effect, acting to lower the velocity of the exhaust efflux, thereby reducing efficiency. Much of

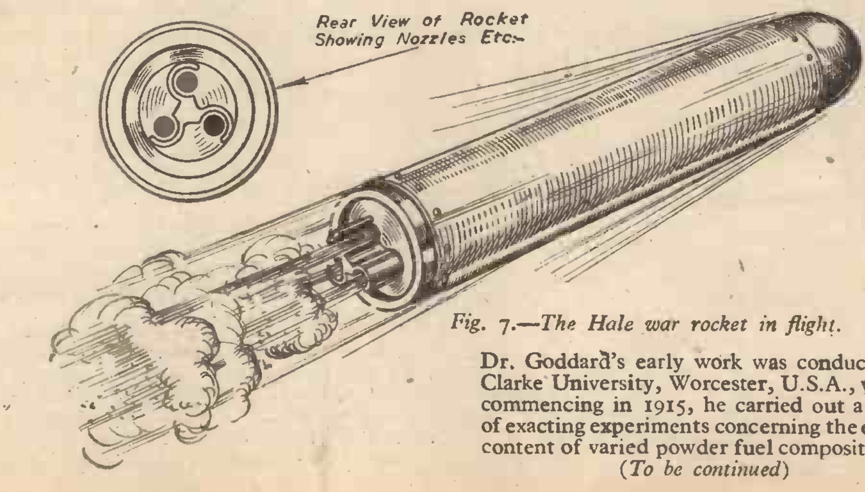


Fig. 7.—The Hale war rocket in flight.

Dr. Goddard's early work was conducted at Clarke University, Worcester, U.S.A., where, commencing in 1915, he carried out a series of exacting experiments concerning the energy content of varied powder fuel compositions.

(To be continued)

Engineer-built Houses of the Future—17

(Continued from page 305 June issue.)

Combined Pitched and Flat Roofs With Roof Gardens

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

THESE roofs, such as sketched in the first instalment of this series, are not only unique in house roof construction, but have combined æsthetic, structural, and utilitarian advantages that are well worth the attention of architects and structural designers. The pitched or sloping part can be so proportioned and covered as to provide a reasonable expanse of the traditional pitched roof which is liked by so many persons, and, by the limitation of such expanse, avoids that too top-heavy appearance associated with the ordinary type of tiled or slated roof. As an instance, the section of roof shown by Fig. 110 rises only about 6ft. above the top of the uppermost storey and yet with the overhanging eaves gives an expanse of pitched roof about 9ft. from eaves to top; with the ordinary pitched roof with an angle of about 40 degrees the ridge would be about 14ft. above the top of the storey. Structurally the combined pitched and flat roof is exceptionally simple, sound and strong, is a little more expensive than an all-flat roof, but is probably less costly than the traditional type of pitched roof with its large area of tiling or slating, and battens or boarding, rafters, purlins, struts, ceiling joists, binders, hangers and high chimney stacks, and gabled flank wall (if any) and gabled party wall (if the house is semi-detached). The roof as shown by Fig. 110 exerts practically no outward thrust on the external wall, whereas with the ordinary pitched roof the thrust is really great unless it is designed, framed, jointed and constructed with the utmost care—a care which was only very seldom exercised in pre-war house building. The comparatively small expanse of pitched roof will cause but little stresses on the building due to wind pressures; in fact, they can be ignored or almost so.

The utilitarian value of the combined pitched and flat roof can be considerable if a roof garden is required. The cubical contents within the pitched roof space is ample for the cold water cistern (unless it is located in the small stairwell leading to the roof where it would be easier to insulate it against damage by frost), and for useful storage spaces. The vertical cheeks to the pitched roof will act as a good guard, give privacy, and protect persons on the roof from wind from most quarters. Access to all parts of the flat roof and the pitched slope is easily attained for purposes of repairs and any renewals.

Combined Pre-building and Site Work

As a general rule it will be found that roofs of houses which come under the category of pre-built houses will require a little

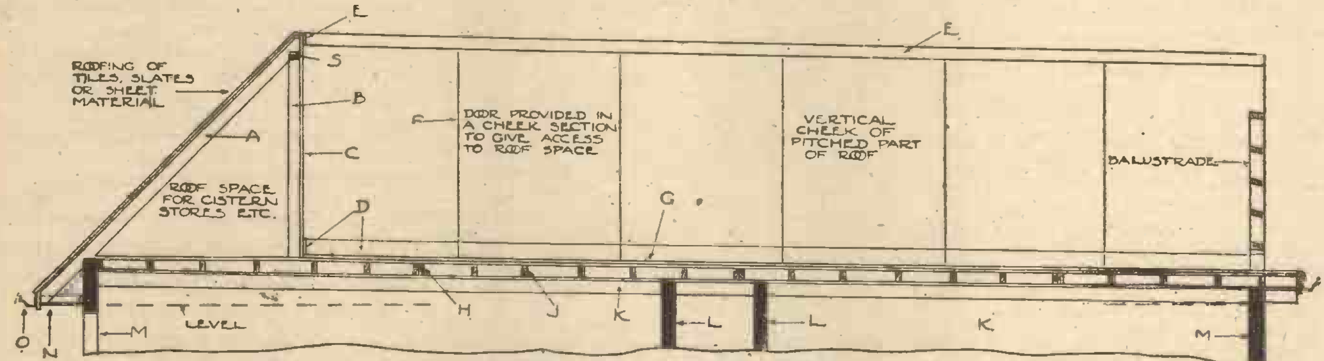


FIG 110 COMBINED PITCHED AND FLAT ROOF: SECTION FROM FRONT TO BACK EXTERNAL WALLS

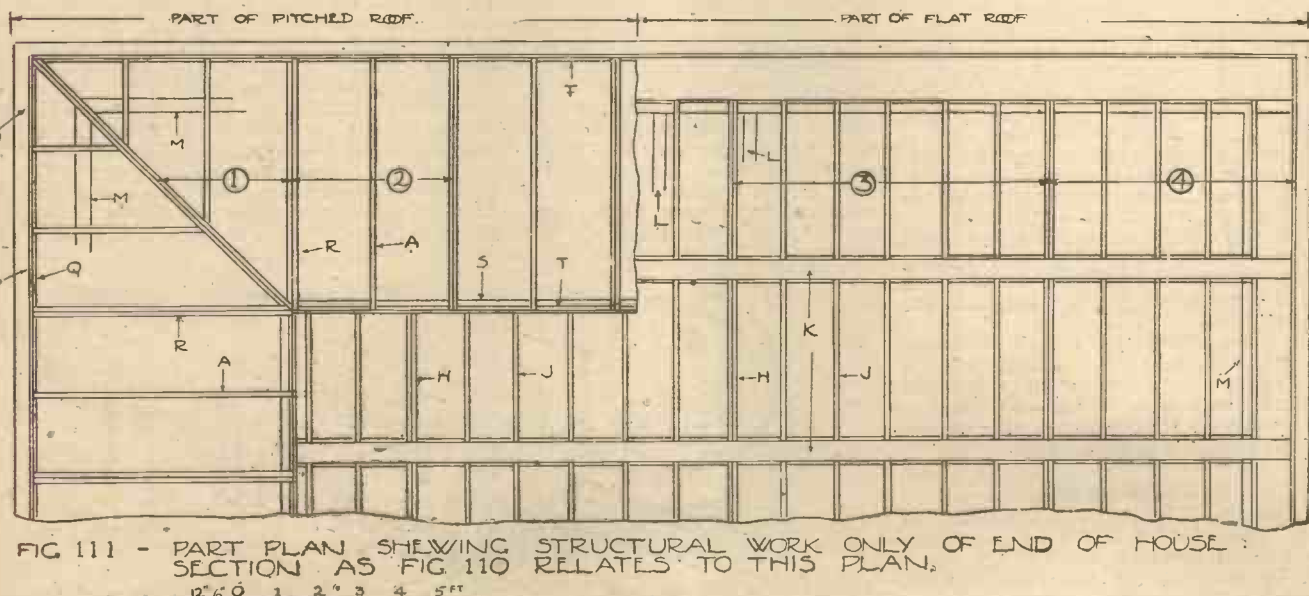


FIG 111 - PART PLAN SHEWING STRUCTURAL WORK ONLY OF END OF HOUSE: SECTION AS FIG 110 RELATES TO THIS PLAN.

Figs. 110 and 111.—(1) Hip unit. (2) Standard width pitched roof unit. (3) Standard width and length flat roof unit. (4) Flat roof filling-in unit. A—Rafters. B—Framing. C—Covering to vertical cheek. D—Skirting. E—Flashing. F—Joint in vertical cheek. G—Flat roofing. H—Double members at joint in flat roof units. J—Single member. K—Beam. L—Internal load-bearing partition. M—External pre-built wall. N—Overhanging eaves. O—Gutter. P—Fascia. Q—Edge or binding board. R—Double members at joint in roof unit. S—Plan of vertical cheek. T—Edge or binding board of roof unit.

greater percentage of site work than the other parts of the structure; this may not be true in the case of some of the simpler types of flat roofs, but it is true in others, and particularly where tiles or slates are used, and a flat roof must be made to withstand pedestrian traffic, and, of course, be perfectly watertight. But this site work can be limited to a reasonable extent if care be taken in designing and constructing the work. It should also not be overlooked that a certain good proportion of site work is an advantage, as it will help to balance the use of various materials and different kinds of labour, which is important in view of the national interests and the very considerable amount of building work which will be undertaken by engineers and builders. Such roofs as described in this article contain a high percentage of factory built units, which, with the various roofings, would be site-assembled and laid or fixed.

Structural Details

An examination if Figs. 110 and 111 will indicate that the flat roof portion and the floor and ceiling under the pitched roofs generally follow the principles and details of pre-built flat roofs with either steel, timber or built-up structural plywood beams and timber framed panelled units. The pitched roofs are, in effect, superimposed on the flat roof and act for the purposes previously described.

It is not essential to have any dimensional co-ordination between the flat and pitched roof units; it is better that there can be a freedom in the latter so as to enable any desired angle of pitch and length of slope to be used to suit individual tastes, subject, of course, to reasonable limitation of the number of standard units to suit pre-building systems.

Fig. 111 depicts part of the plan, showing a portion of each of the pitched and flat roofs. As a practical designing rule it will be found advisable to allow that standard width units should be used for the ordinary parts of the pitched roof, and standard triangular shaped units to the hips, and "filling-in" units of special size to make up at the ends of the roof. The same general principles should apply to the flat roof.

It will be noted that the flat roof is set out to a fall of about 2in. in 10ft., and that the ceiling is out of level to follow such fall. As explained in previous articles, this is an economical method of design and the slight lack of horizontality in the ceiling would be almost unnoticed except to very critical minds. Externally the fall would be also unnoticed, and the gutter along the flank wall would have a good fall without being specially laid to a fall as is customary with ordinary methods of construction.

The eaves construction as Fig. 110 is simple and is set economically to avoid any waste in the height of the building at the eaves; and, there is a good overhang.

The pitched roof may be covered with any of a rather great variety of roofing materials, such as the traditional roofing tiles or slates—the tiles including the ordinary 10½in. by 6½in. or 11in. by 7in. tiles, and various types of interlocking and pan tiles, etc. Asbestos-cement tiles or slates may be used, if desired, and there are the various kinds of superior felt and sheet roofings which can be considered; the sheet roofings being useful for pre-building and thereby limiting the amount of site-work. The vertical cheeks would, of course, be in pre-built structural units and covered with sheet material such as asbestos-cement, flat or corrugated sheets, felt on boarding, or a suitable kind of weather-resisting plywood. The joints between the units will present no difficulties, as they may be either filled, or have cover strips.

The roofing for the flat roof should be chosen with the greatest care, as, apart from its primary essential of providing a watertight surface, it must be capable of being durable under reasonable pedestrian traffic conditions; in other words, it must wear well. There are several traditional and modern materials which will comply with these essentials, amongst them being the following: Built-up felt roofing covered with tar-macadam or asphalt; built-up felt covered with non-slip paving tiles. All of these roofings make it easy to form proper watertight skirtings at the junction between the flat roof and vertical cheeks and at the eaves at the rear of the roof; the underlayers of felt may be turned up behind the skirtings or bottom of sheet material to the

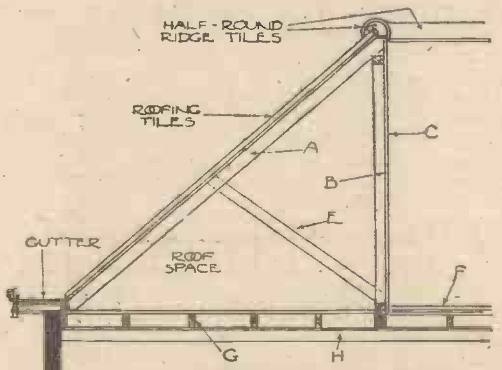


FIG. 112 - SECTION SHEWING HIDDEN EAVES GUTTER.

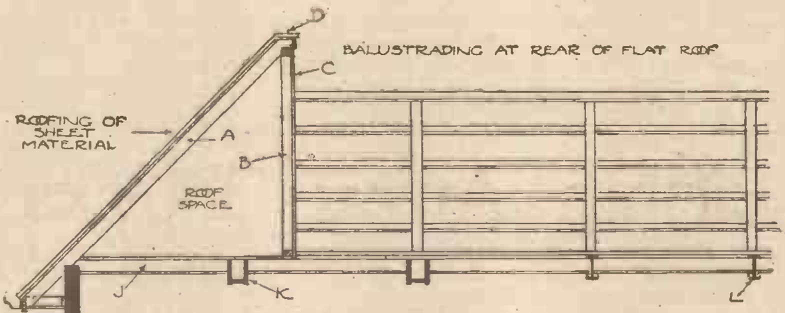


FIG. 113 - SECTION THROUGH PITCHED ROOF AT FLANK OF HOUSE.

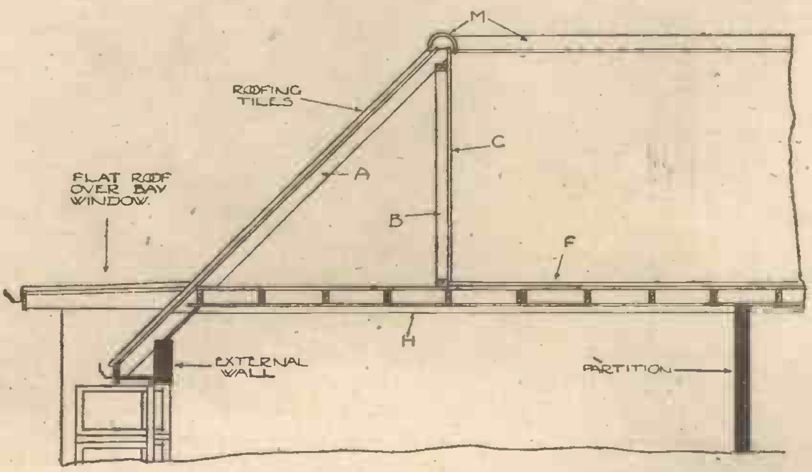


FIG. 114 - ALTERNATIVE METHOD OF CONSTRUCTING EAVES WITH ROOF EXTENDING A LITTLE INTO ROOM

12' 6 0 1 2 3 4 5 FT

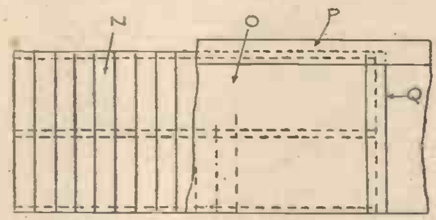


FIG. 115 - ROOF UNIT WITH SHEET ROOFING MATERIAL.

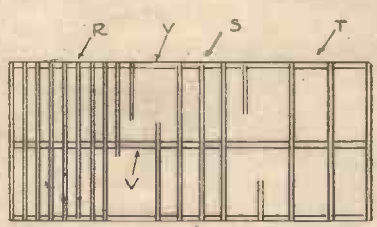


FIG. 116 - ROOF UNIT WITH BATTENS FOR TILES OR SLATES

Figs. 112 to 116.—A—Rafters. B—Framing. C—Covering to cheek. D—Felt covering. E—Strut. F—Flat roofing. G—Timber member. H—Beam. J—Unit. K—Built-up pre-built beam. L—Steel beam. M—Half round ridge tiles. N—Boarding. O—Sheet material. P—Side cover strip. Q—End cover strip. R—Battens for ordinary roofing tiles. S—Battens for slates. T—Battens for interlocking roofing tiles. V—Unit structural members.

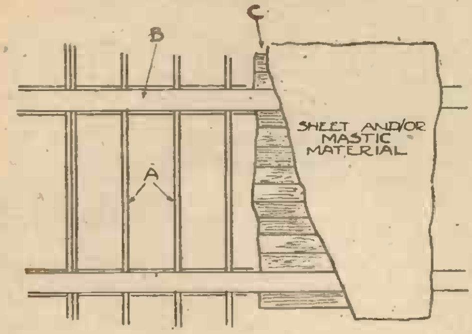


FIG 117 - FLAT ROOF UNITS WITH SITE-APPLIED SHEET AND/OR MASTIC MATERIAL.

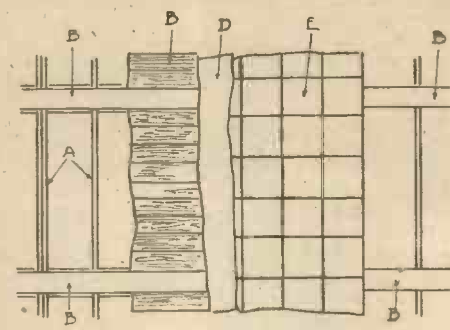


FIG 118 - FLAT ROOF UNITS WITH SITE-APPLIED PAVING TILES ON WATERPROOF SHEET MATERIAL

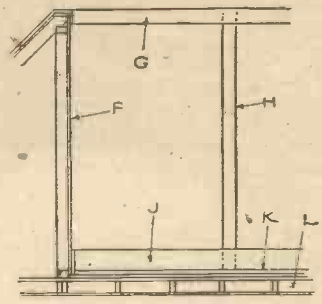


FIG 119 - SECTION SHEWING SKIRTING AT JUNCTION BETWEEN FLAT AND PITCHED ROOF; AND COVER STRIPS OVER JOINTS IN VERTICAL CHEEKS OF PITCHED ROOF

Figs. 117 *to* 119.—*A—Structural members of unit. B—Beam. C—Boarding. D—Sheet roofing. E—Paving tiles. F—Covering to vertical cheek. G—Flashing. H—Cover strip. J—Skirting. K—Flat roofing. L—Flat roof unit.*

cheeks and form a very satisfactory joint, and the felt can be turned down at eaves over the gutter.

Variations in Eaves Design

Instead of the ordinary type of eaves with the gutter exposed to view, the method of construction shown by Fig. 112 may be adopted. The gutter, which may be felt lined, is hidden, and the eaves are terminated with a fascia and moulding as indicated.

Fig. 114 shows another method of construction which permits a break in the levels of the eaves of the main roof and the flat roof over a bay or other projection beyond the main wall. The construction is chiefly to suit æsthetic requirements which engineers should be in a position to meet. The main roof breaks a little into the storey height of the room, which is not objectionable. A little difficulty arises with the support of some of the flat roof main beams; but this difficulty is by no means insurmountable. Where the bay occurs—it is usually quite wide and takes up a rather high percentage of the frontage of an ordinary house—the flat roof beams would have their ends supported by a beam spanning over the bay window. Elsewhere along the main wall it will be necessary to terminate and support the flat roof beams on the inclined rafter of the pitched roof. A perfectly sound structural joint can be made by fixing short lengths of timber on the side or two sides of the rafter which is near the beam, these timbers either in themselves or by a bearer resting on them providing a good dead bearing for the beam. There need be no anxiety about the short length of rafter between the wall plate and where the beam rests being strong enough; it will be a short inclined strut well bound by the general framework of the roof.

General Details

Fig. 113 depicts a part section of the combined pitched and flat roofs extending from the flank wall to either a party or another flank wall. It shows two types of flat roof beams with the roof units supported by them, and an outline of the balustrading or guard rail at the rear of the house. Fig. 115 shows a pre-built pitched roof unit with boarding to form the foundation for sheet roofings such as built-up felt. Fig. 116 gives evidence of how a pre-built pitched roof unit can be factory-made with battens complete to suit any class of tile or slate roofing which must be site-applied.

Figs. 117, 118 and 119 show details of the pre-built flat roof units prepared for the various types of roofing materials.

(*To be concluded*)

Eighth Army "Ducks" Get Through

INDEPENDENT amphibian companies of the R.A.S.C. have done a big job with the Eighth Army in Italy. Whilst the big battle of the Sangro River was at its height one of these units carried supplies in their "ducks" over ground which the transport could not negotiate, so relieving the badly congested roads. Working day and night the men of this unit (who took part in the Italian and Sicilian landings) supplied front line troops. In 24 hours, they transported 700 tons of materials to forward elements; this included 60,000 rounds of artillery ammunition, 45,000 rations, and 15,000 gallons of petrol.

(Right) A little light refreshment during a halt on the way.

(Left) Driver E. W. Kelly washing down the decks of a "duck."

On their return trips they have evacuated Allied wounded and many prisoners of war. Although they often put to sea to reach the battle area, there are no naval men attached to the company. In this particular unit there is not one man who had had any sea-going experience before joining the Service.

These photographs were taken when the unit was operating across the Sangro mouth between Fossaccsia and Casal Bordino.

The New Coventry in the Making

A Marvellous Model of a City, to the Designs of Mr. D. E. E. GIBSON, M.A., A.R.I.B.A., City Architect of Coventry

ALTHOUGH post-war planning is much in the air so far as Government decisions on the Uthwatt, Scott and Barlow reports are concerned, local municipalities, even some which have not been blitzed, are working hard on their post-war planning, housing and traffic problems.

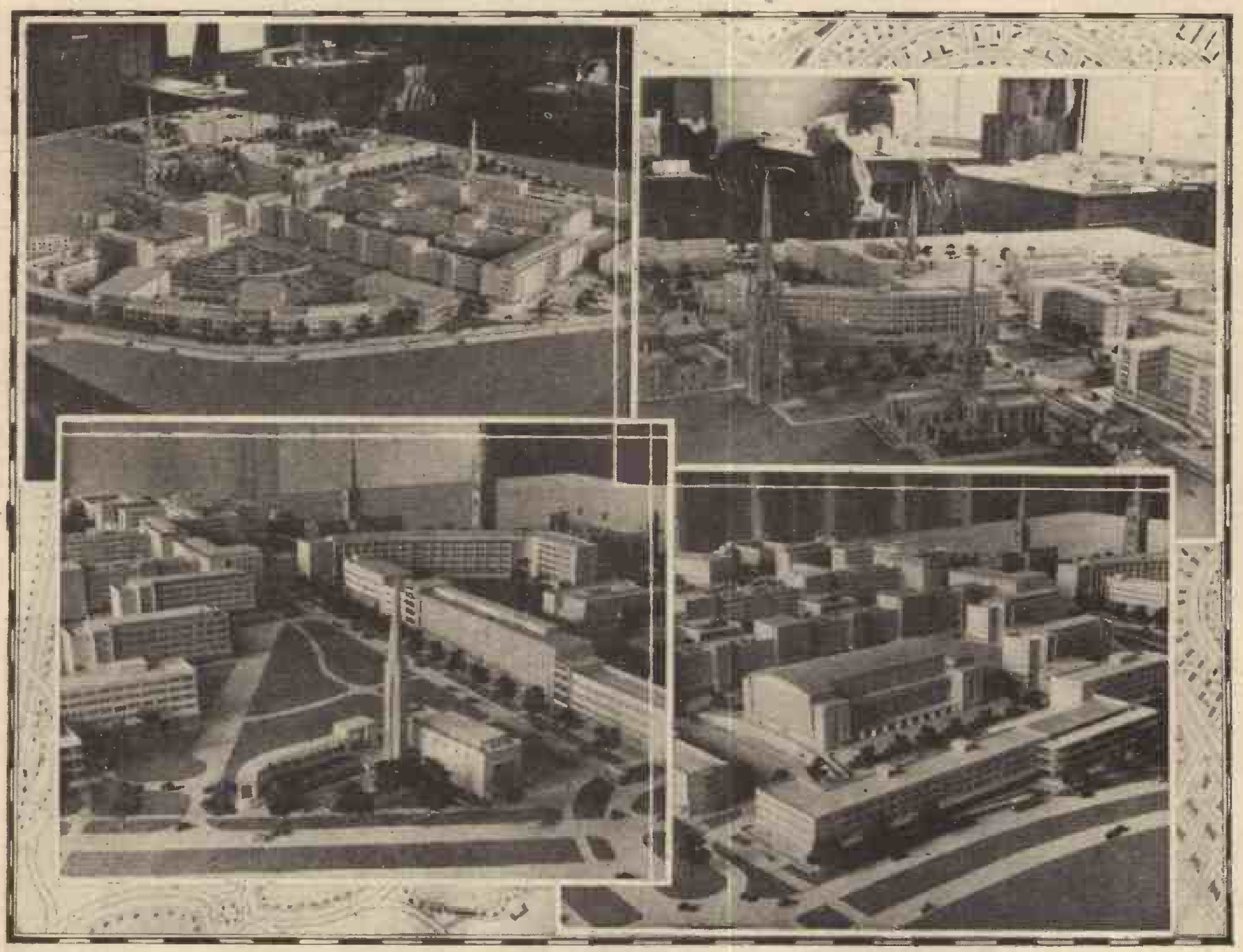
Some of them have already commenced making models—or having models built by commercial firms, where labour conditions permit—of their proposals, so that they can be visualised by the council and the various inhabitants of the respective boroughs.

No city in this country has suffered more from the blitz for its size than the city of Coventry, and certainly no city is so far advanced in its post-war planning programme as this prosperous Midland city, famed for light engineering and motor-car building.

Replanning Scheme

Mr. D. E. E. Gibson, M.A., A.R.I.B.A., the city architect, and also a recognised authority on many phases of housing and planning, has been busily engaged for the last three years on the replanning scheme. Mr. Gibson is a man with a vision, and his idea in planning the new Coventry has been to give England at least one city of to-day worthy of her great tradition of architecture and building, of which parts of the cities of London, Bath and Cheltenham are historic examples.

The replanning scheme, which covers more or less the central area of Coventry, is approximately three-quarters of a mile by half a mile. With the almost total destruction of the main shopping centre, retail shopping facilities have been confined to small temporary structures, erected on short-term agreements pending the Government decisions on the main redevelopment scheme. This central area will have to be entirely rebuilt, with the exception of one or two historic buildings, the fabric of which is untouched, and this gives a unique opportunity for up-to-date planning. And interwoven with this scheme



FOUR VIEWS OF THE MODEL OF NEW COVENTRY

(Above). A general view of the model city of Coventry, showing the amusements centre in the foreground, to the right hand the pedestrian sanctuary and shopping centre, and beyond it the big market hall, industrial buildings, etc. To the right of the cathedral spire is the civic centre, with the new municipal buildings, banking block, etc., and right in the background are the cultural buildings, including schools, technical college, library, art gallery, etc.

(Below). Christchurch, the little church of which only the spire remains, with its sunken garden and pool of remembrance following the line of the body of the church, also the colonnade built alongside, and the memorial hall attached to the church tower. On the right are the new municipal buildings and on the left the commercial blocks.

(Above). In the foreground is Holy Trinity Church and the Cathedral spire, and to the left and extreme right foreground are some of the old buildings still to be included in the modern scheme, such as the old Council chamber, the Priory, Bluecoat School, etc.

(Below). The large market hall with its mass of kiosks at the side, surrounded by commercial buildings and warehouse blocks, and next door to it the large rectangular shopping centre, which is for "pedestrians only."

[The model was made by Bassett-Lowke, Ltd.]

is that for rebuilding Coventry Cathedral and its associated Christian centre to the plans of Sir Giles Gilbert Scott, which, however, cannot be finalised until the future of certain properties owned by the Corporation has been determined. So far only one of Coventry's many destroyed churches has been restored and rededicated—the church of St. Francis at Radford.

A seven-year programme of educational reconstruction to march in step with the Government's programme has been prepared by the Director of Education. Eight large schools were destroyed and three others badly damaged in the air raids.

A wonderful model of Mr. Gibson's re-development scheme has come into being through the generosity of Lord Iliffe, director of the *Midland Daily Telegraph*, and by the time this article appears in print it is hoped it will be on view in Coventry.

It is to the scale of 24ft. to 1in., or 1/288th actual size, and I had the opportunity of closely inspecting the model before it left the works of the makers, Messrs. Bassett-Lowke, Ltd., of Northampton. This scale is sufficiently large to include most of the detail in the buildings, and at the same time is not too unwieldy to handle or too big to comprehend in one glance.

Shopping Centre

The new centre of Coventry is to be built around a pedestrian sanctuary (where no vehicled traffic will be permitted), which is the main shopping area and consists of a quadrangle 672ft. by 192ft., in the centre of which are beautiful gardens, with a cascade leaping down with a series of overshots. Round the edge are colonnades of large modern shops, on the first and second stories of which are projecting terraces with indoor and outdoor cafés and restaurants. This shopping centre is also provided with a complete covered way, so that pedestrians can pass from one section to another and gain access to the restaurants without having to worry about bad weather.

Outside this pedestrian centre the less attractive but equally necessary commercial buildings are grouped.

On the south side there is the large covered market hall—270ft. by 174ft.—surrounded by an open space, again enclosed by commercial and office buildings. To the south-west is the civic centre, consisting of banks building, telephone exchange, government block, police station, police court and law court. To the north-east is the entertainments centre, consisting of theatre, concert-halls, cinemas, etc., in the form of a crescent, and all linked up by a glass-covered way. Adjoining the shopping centre and this section is the large new hotel, in which will be incorporated all new ideas in hotel equipment and amenities. Here, too, is the huge double-decker car-park, with capacity for over 500 cars, and nearby a special four-storey garage with spiral approach to each floor and including the necessary repair and service depots. Near the hotel is Holy Trinity Church, the fabric of which is practically undamaged.

Certain old and historic buildings now standing, such as the old Council House, the Priory and the Bluecoat School, are to be incorporated in the scheme, also the Cathedral Church of St. Michaels, of which only the spire remains. Christchurch, a small church to the south-west, is past repair, except for the tower which stands. Where the body of the church stood is to be converted into a sunken garden with a pool of remembrance. Also, attached to the church tower, it is intended to build a memorial hall in which lectures and meetings would be held.

Cultural Quarter

Leaving this area and going north-west, we find the cultural portion of Coventry, consisting of the schools, technical colleges, central library, college theatre, museum and art galleries, swimming pool, gymnasiums, tennis courts, and all those facilities which make for a progressive, intellectual and healthy culture in the younger generation.

The north-east corner is at present laid out in grass land, pending further decisions as to the planning of this part of the city.

The area covered by the scheme is 2,736 ft. by 2,208ft., which means that the model is 9ft. 6in. by 7ft. 8in. It is a most attractively executed architectural model, and is the best possible method—short of the real thing—of showing the people of Coventry what is proposed for their fine city in the future.

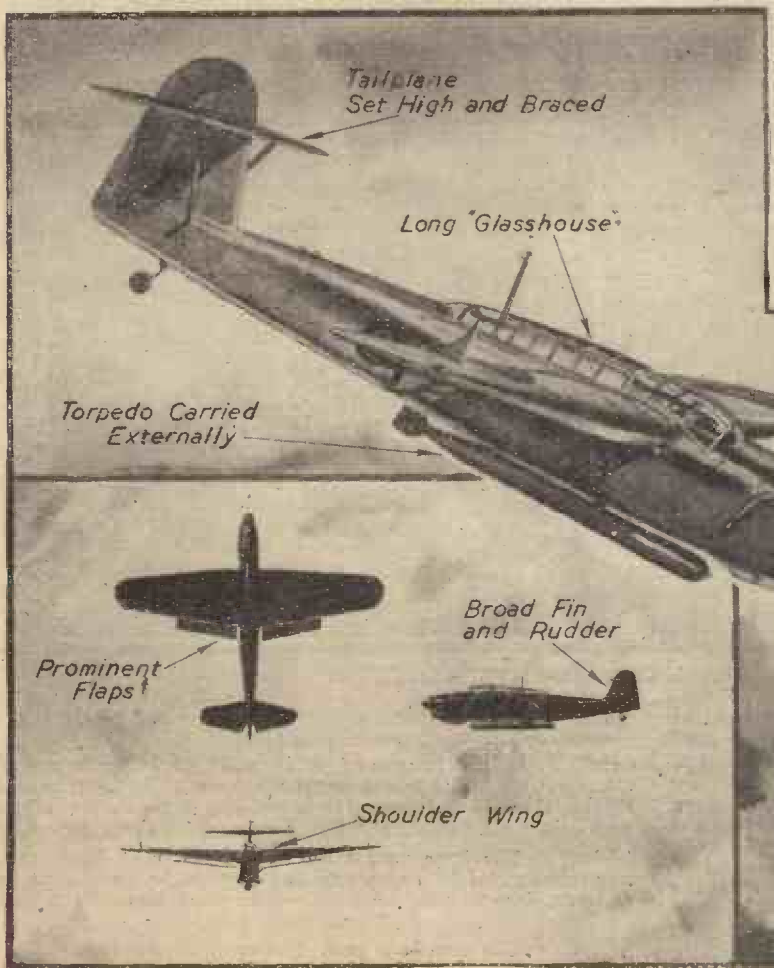
The Fairey Barracuda

These illustrations show the Fairey Barracuda—one of the latest machines introduced into the Fleet Air Arm. It was the Barracuda which made the highly concentrated and successful attack on the "Tirpitz" in Alten Fjord. It will be seen that the machine is not particularly pleasing in appearance, but Fleet Air Arm requirements cannot always be accommodated by the designer in a symmetrical and sleek exterior.

The Barracuda is fitted with a Rolls-Royce Merlin XXXII. It has high power for take-off, manually operated armament mounted in the rear cockpit, and a high rate of climb.

It may be recognised by the shoulder wing with projecting flaps. It will be observed that on the broad fin the tailplane (braced with taper struts) is set high.

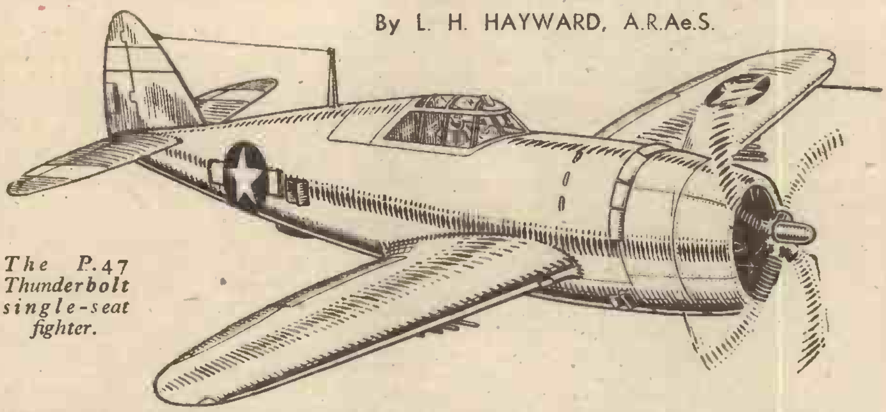
The cockpits are streamlined.



AIRCRAFT ON ACTIVE SERVICE

6.—The Republic P.47 Thunderbolt

By L. H. HAYWARD, A.R.Ae.S.



The P.47 Thunderbolt single-seat fighter.

THE Republic P.47 Thunderbolt, low-midwing monoplane, single - seat fighter, is designed and manufactured by the Republic Aviation Corporation at Farmingdale, Long Island, New York, and Evansville, Indiana, and is extensively "shadow" produced throughout the United States of America. It has the distinction of being the heaviest single-seat, single-engined fighter aircraft on active service at the present time throughout the world. The leading particulars are given in the table below.

Construction

The elliptically shaped wings are all metal structures with flush riveted, stressed skin covering, and unlike most modern fighter aircraft, the control surfaces including the split trailing edge flaps are entirely metal covered. The Thunderbolt fuselage is an all metal monocoque structure with light alloy stressed skin covering, and is considerably larger than that of any other single-engined fighter aircraft, as it houses the turbo-supercharger which assists in maintaining engine power output up to an altitude of approximately 25,000 feet.

Spent exhaust gases are ejected to atmosphere through a duct in the underside of the fuselage, just forward of the tail wheel. The tail unit and rudder are entirely metal covered.

Undercarriage

The electrically operated undercarriage retracts inwards and backwards, the wheels being housed in the centre section of the wings when retracted. A flap completes the fairing over the retracted leg.

Like the Typhoon, the wheel track is considerably wider than usual and enables the aircraft, which lands at a speed of approximately ninety miles per hour, to be used on rough and advanced landing grounds without the possibility of the aircraft tipping over. The castoring tail wheel is fully retractable, and is faired in by two small sliding shutters.

Engine

A Pratt and Whitney, Double Wasp, 18-cylinder, two-row radial, 2,000 horse-power, air-cooled motor with a turbo-supercharger, drives an electric, four bladed, constant speed, fully-feathering airscrew. Two oil coolers with shutters to regulate the air-flow, and the air scoop for the supercharger turbine are housed underneath the engine and contained in the large diameter cowling.

Air travels along a duct leading from the front scoop to the supercharger impellor situated in the rear of the fuselage. It is compressed and sent through inter-coolers—housed within the fuselage slightly behind the trailing edge of the wings—to the engine carburettor. A semi-circle of gills, which can be opened or closed by the pilot, controls the flow of cooling air over the engine.

To extend the range of the Thunderbolt a large bulbous auxiliary fuel tank can be fitted underneath the fuselage. Fuel is drawn from this tank at the commencement of a flight. When this supplementary supply of fuel is exhausted the pilot switches over to the main fuel tanks and by a very simple mechanism jettisons the empty auxiliary tank.

Span	Length	Height	Weight (Loaded	Armament	Motor	Motor Power
41ft.	32ft.	13ft.	13,550lb.	Eight 0.50 machine-guns	Pratt & Whitney Double Wasp	2,000 h.p.

The installation of the auxiliary tank gives the aircraft a range of approximately 650 miles.

Fire Precautions

To minimise the dangers of fire, all the electrical wiring on the Thunderbolt is protected by an asbestos firewall built in the cables between the outer braid and the actual current carrying wire. This precaution renders the electrical circuits fireproof as the cable will not burn or ignite even under intense heat. Furthermore, the communication of flame to adjacent circuits is not possible.

Armament

The arrangement of the eight 0.50 inch calibre machine-guns is interesting and distinctive. Four guns are fitted in each wing and they are staggered back so that the protruding portion of the muzzle of the inboard gun is considerably larger than that of the outboard gun. Orifices provided in the underside of the wings allow the used cartridge cases to fall away. The guns are electrically operated, and they all fire together automatically. The electrical wiring is so arranged that the failure of one gun will not affect the operation of the others.

A bullet-proof windscreen and armour-plated bulkheads are fitted to protect the pilot as much as possible.

In Service

Highly efficient and extremely fast, the Thunderbolt, developed to meet the need for a high altitude fighter, is proving to be all that was demanded of it. With an all up weight of nearly six tons, this aircraft is giving a better performance at altitude than any other machine at present in service.

The first official mention of Thunderbolts on active service was made in May, 1943, when they were escorting American bombers attacking targets in occupied Holland. Very large numbers have now come into service with the United States Army Air Force, and almost every day some reference is made in official statements to the exploits of the Thunderbolts.

A Thunderbolt, fitted with an extra 100-gallon petrol tank and 500lb. bombs, ready to take off on a mission to railway yards in Belgium.

The Story of Chemical Discovery

The Chemical Basis of Photography

How Chemistry has Aided the Photographic Art

PHOTOGRAPHY, the recording angel and the ever-present handmaid of the sciences, arts and industries, indisputably owes its truly indispensable position in the modern world to the practical application of chemical science and chemical discoveries.

Photography rests intrinsically upon a foundation of practical chemistry. Without the reasoned application of chemical knowledge, photography, although it might, perhaps, have been initiated, could never have progressed to its present-day status of efficiency.

The world's first photographic portrait. A Daguerreotype photograph of Miss Caroline Draper, taken by her brother, Professor Draper, in New York in 1840.

The remarkable light-sensitivity of silver salts, particularly in the presence of other associated and admixed compounds, constitutes the fundamental factor of photography's inception and growth.

How the light sensitivity of silver salts was first applied in the discovery of the photographic process is a long story which has been detailed more than once in past issues of this journal. What we are primarily concerned with in this present article is not a narrative of the historical progress of photographic invention, but, rather, with the realisation of the continuous aid which chemical science has given to photography at the various stages of its growth.

In the beginning, photography was a very uncertain, tedious and difficult affair. You sat in front of a camera for anything up to half an hour whilst the rays of light which were reflected from your countenance impressed themselves upon a silvered copper plate which had been highly polished and subsequently exposed to the vapour of iodine so as to give rise to a thin film of silver iodide on the surface of the plate.

Developing the Daguerreotype

The plate was subsequently "developed" by submitting it to the fumes of mercury. Mercury particles amalgamated with the areas of the plate which had received the most light so that, in this way, a delicate, shimmering image of mercury-on-silver was gradually built up.

Such was the "daguerreotype" which caused such a furore throughout the world in 1840 and in the immediately succeeding years. It was the invention, after many years of amateur chemical dabbling, of Louis Daguerre, a French scenic painter and an enthusiastic chemical experimenter.

About the same time, an Englishman, William Henry Fox Talbot, of Laycock Abbey, Wiltshire, introduced his celebrated "calotype" process of photography. Fox Talbot made his pictures by coating paper with silver chloride, and by exposing the coated paper to light in a camera. He found, also, that by soaking his pictures in a solution of common salt, or, better still, in a solution of potassium iodide or potassium bromide, all the unchanged silver chloride on the surface of the paper was dissolved away, thus giving rise to a more or less permanent photograph.

In short, Fox Talbot discovered the principle of "fixing," which is, of course, essentially a process of chemical solution, the unchanged sensitive silver salt which has not been acted on by light, being removed from the surface of the paper by the fixing agent.

John Herschel, discoverer of "hypo" as a fixing agent.

Enter "Hypo"

It was Sir John Herschel who first suggested the use of the nowadays ubiquitous "hypo" as a fixing agent. As far back as 1819 Herschel had discovered that solutions of hyposulphite of soda (more correctly known nowadays as sodium thiosulphate) possess the property of dissolving silver salts. It was at his instigation that "hypo" fixing for photographs came into practical being about 1841, although, it is said that the first individual to use this salt for fixing purposes was the Rev. J. B. Reade, who made his first trials in 1837. Hypo was expensive in those days. Instead of costing 6d. per lb. as it does nowadays, its price was in the region of 3s. 6d. per ounce!

A London chemist named Goddard discovered that by mixing a little bromine with the iodine used for the sensitisation of daguerreotype plates, the sensitivity of the plates was very much enhanced. Also, M. Fizeau, a French chemist, devised an "invigorator" which was applied to the daguerreotype plate after development in order to strengthen the image and to heighten its colour. Fitzeau's "invigorator" was nothing more nor less than a solution of gold chloride. In effect, it comprised the first photographic toning solution, the parent of a long line of chemical substances which have ever since been used for "toning" the photographic image on glass or on paper.

Principle of Development

But despite these improvements to the daguerreotype process, this system of photography was doomed to an eventual failure. Both the Rev. J. B. Reade and William Henry Fox Talbot had hit upon the principle of photographic development, whereby a weak or even an invisible photographic image can be enormously built up or "developed" by treating the plate or paper with a solution of a chemical, such as gallic acid or pyrogallic acid, which has the effect of precipitating grains of metallic silver over those parts of the sensitised surface which have received the most light-exposure.

Thus, with the introduction and establishment of the twin principles of developing and fixing, the art and science of photography began to grow apace. Fox Talbot's "Calotypes" were never really satisfactory. They could only be made on paper, and such paper negatives had to be impregnated with wax in order to render them sufficiently translucent for printing purposes.

It was, therefore, necessity, aided by chemical knowledge, which led to the invention of the glass negative. This materialised about 1848. It was the invention of Niepce St. Victor, a French experimenter, who mixed his sensitive silver salts with egg albumen (white of egg), and coated the solution on to glass. In his final process, St. Victor dissolved potassium iodide in the

A calotype (paper) negative of Pevensey Castle, Sussex, taken about 1844 by Dr. Diamond, a photographic pioneer in England.

albumen which he used for coating glass. Then, immediately prior to the plate's exposure in the camera, he sensitised the plate by flooding it over with a solution of silver nitrate, which substance, acting on the potassium iodide in the albumen, gave rise to a precipitate of silver iodide, which is light-sensitive.

Collodion Process

The introduction of glass plate photography caused a revolution in the art. An Englishman, Frederick Scott Archer, employed collodion (a solution of gun cotton in a mixture of alcohol and ether) as the viscous medium for holding the sensitive silver salts on to a glass plate. Thus, about 1850, the "collodion" process came into practical being. Scott Archer was a sculptor, an amateur chemist, and an enthusiastic photographic experimenter. He wanted to make use of photography in order to preserve records of his sculptures. Unfortunately, however, Scott Archer died young before he had been able to reap the benefit of his discoveries. His widow and children almost starved, but they were ultimately saved from such a tragedy by the grant of a Government pension of £50 per annum.

The collodion process of photography, coupled with the gradually increasing sensitivity of photographic emulsions, resulted in a great extension of the application of the photographic art. The collodion plates, however, laboured under the enormous disadvantage of requiring to be exposed in a wet condition. Furthermore, the plates had necessarily to be developed in the same wet state before their surface had time to dry. Thus it was that the amateur and the professional photographer alike had, in those days, to carry about with them fully fitted-up "developing tents" in which cumbrous, yet portable, dark-rooms, the collodion plate was sensitised by chemical treatment with silver salts immediately prior to its exposure in the camera and, also, developed, fixed and washed immediately after its exposure.

In spite of the fact that many beautiful photographs were taken by the collodion method, a search was made by numbers of photographically-interested individuals for a method of producing plates which could be exposed in the dry condition.

It was essentially a chemical quest which was entered into, for it was only a chemical method of preparing such ideal plates which would suffice for success in this matter.

The First Dry Plate

At last, the required success came to a medical man named Richard Leach Maddox, of Southampton. He conceived the notion of embodying grains of light-sensitive silver bromide in a stratum of gelatine which was coated on to the glass plate.

The idea was taken up commercially about 1872, but the first of the dry plates did not meet with much success. They were relatively insensitive. Furthermore, they were almost consistently unreliable! But the principle of the gelatine "dry" plate came as such a relief to all classes of photographers that more and more research was put into the making of a satisfactory dry plate. Gradually, therefore, such plates took upon themselves improved characteristics in consequence of the introduction of modified chemical methods for their manufacture. Ultimately, except for specialised uses, such as for photo-block making, the collodion "wet plates" became a thing of the past. "Gelatine" had firmly established itself in the photographic world.

The chemical principle of embedding silver bromide grains in a medium or an "emulsion" of gelatine led up, also, to the introduction of high-speed photographic printing papers. "Bromide" paper, and, at a later date, its offspring, "Gaslight" paper (the invention of the late Dr. Bakeland, the "father" of synthetic resins) came into being, ultimately going far towards displacing all other present and past types of photographic printing papers.

The Rev. John Bancroft Reade, Vicar of Bishopsbourne, the first successful photographic pioneer in England.

An early wooden camera having a spectacle glass for a lens.

Nowadays, bromide paper is world-used. Its slower modification, "gaslight" paper, is only a degree or two less widely employed, particularly by photographic amateurs.

Dye Sensitising

A new chemical departure in photography arrived soon after the introduction of dry plates. This was the technique of "dye sensitising."

The old varieties of silver bromide emulsions were notoriously insensitive to all colours of light except to blue, violet and ultra-violet rays. An Englishman named Wortley attempted to confer some degree of yellow sensitiveness on the dry plate emulsion by coating it with a film containing a yellow dye and, also, by modifying the composition of the emulsion. Wortley was unsuccessful, but his work gave several hints to a certain Dr. Hermann Vogel, a German experimenter, who conceived the notion of actually dyeing the gelatine of the emulsion with a yellow dye which was capable of absorbing a certain proportion of the blue light from the rays which were allowed to impinge upon the emulsion.

In this way, Hermann Vogel produced a photographing emulsion which was slightly more yellow-sensitive than former emulsions had been. The idea was taken up in England and on the Continent. In London, an individual named Edwards manufactured gelatine dry plates to which he applied the term "orthochromatic." These plates were sensitised by the dyestuff *eosine* (the dyestuff of red ink), which process conferred yellow and, to a small extent, green sensitiveness upon them.

Frederick Scott Archer, the London sculptor, who popularised photography by means of his collodion process.

At a later date, the dyestuffs *erythrosine* and *rose bengal* were introduced by plate manufacturers for the same purpose. Indeed, erythrosine is still employed extensively for the making of "orthochromatic" or "iso" plates.

The novel principle of dye sensitising which was originally introduced by Dr. Vogel underwent a greater extension and development when, in 1903, a countryman of Vogel's named Miethe introduced a then new dyestuff, *ethyl red*, as a plate sensitiser. The effect of ethyl red was to render the emulsion red-sensitive as well as orange, yellow and green sensitive. Other dyes, notably *carbo-cyanine*, were introduced for the same purpose. Under the ægis of the former London firm of Wratten and Wainwright, Ltd. (now part of the Kodak organisation) "panchromatic" or all-colour sensitive plates were commercialised.

Discovery of De-sensitisation

Another couple of decades passed when, in the early 20's of the present century, new dystuffs were chemically synthesised. These were *kryptocyanine* and *neocyanine*, blue dyes, which not only conferred red-sensitiveness on the plate but, also, sensitised it to infra-red rays. Based on this discovery of infra-red sensitising was built the present-day technique of infra-red photography, a technique by which photographs can be taken in complete "darkness," that is, in a room into which only the invisible infra-red rays are allowed to penetrate.

Another chemical discovery made in the

present century comprised just the opposite of dyestuff sensitising. It was the discovery of dyestuff *de*-sensitising.

Just as some dyes can confer extraordinary powers of sensitivity on silver bromide-gelatine emulsions, so, also, other chemically synthesised dyes have the power of reducing an emulsion's light-sensitivity almost to zero point.

About 1920 Dr. Luppo-Cramer discovered that the dyestuff *pheno-saffranine* (an orange

Dr. Richard Leach Maddox, the Southampton medical practitioner, who invented the dry plate.

dye), in weak solution, had the extraordinary property of enormously reducing the sensitivity of a plate or a film, so that an exposed plate or film could be bathed for a few moments in a solution of this dye and afterwards developed normally under a relatively strong illumination. The trouble about pheno-saffranine was that it stained the negative badly, making it difficult to print from.

It was not long, however, before the German chemists, notably of the firm of Meister, Lucius and Brüning, working on the pheno-saffranine model, were able to synthesise several new dyes, such as *pinakryptol green* and *pinakryptol yellow*, which were not only non-staining, but also possessed more powerful desensitising properties than the original pheno-saffranine. Later, other dyes of this type were synthesised at Cambridge by the late Sir William Pope.

Thus came into being the chemical technique of desensitisation, which, in its present state of perfection, renders it possible to develop a high-speed plate or film under any type of weak artificial illumination.

By means of dyestuffs, therefore, photographic sensitivity can be controlled in every way. The subject, however, is still under development, and post-war times will see many startling advances in this direction.

One of the most modern of chemical advances as applied to the production of photosensitive material concerns the discovery which was made by S. E. Sheppard, a photographic chemist, in 1925. The story is a long one, and it can only be related very briefly here.

Previous to the last war the sensitivity or the "speed" of photographic emulsions was always relatively slow. By means of patient and careful experiment photographic manufacturers evolved methods of "cooking" or heat-treating photographic gelatine-bromide emulsions (in addition to dyestuff-sensitising them) by means of which the emulsions gained in speed or general sensisivity. Thus manufacturers were able to increase the speed ranges of their available plates and films.

Unfortunately, however, it was found that during the emulsion "cooking" process, the grains of silver bromide underwent a species of growth or enlargement. So big did they become in a highly sensitised emulsion that a definite limit was set to the available "speed" of the plate or film owing to the effect of "graininess" which the enlarged particles of silver bromide created.

Secret of Gelatine

It had, at this time, long been suspected (and even known) that the precise composition of the gelatine used for plate or film making had a very great effect upon the sensitivity of the emulsion. Plate manufacturers attempted to get over this difficulty by ordering from gelatine manufacturers special grades of gelatine which had received the highest possible degree of purification, but, to their disappointment, they found that the purer they obtained their gelatine, the less sensitive their plates and films became.

A Five-year Research

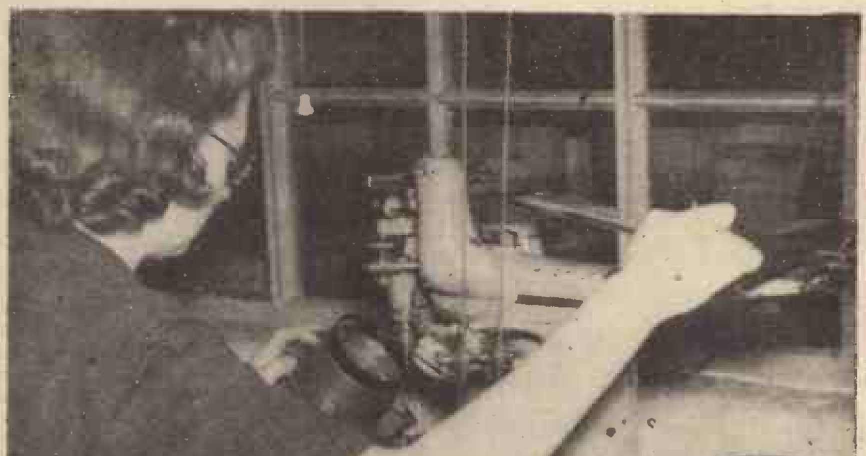
It quickly became apparent that there must exist in gelatine traces of an impurity which are able to exert a powerful sensitising action on the emulsion. After a nearly five-year period of intensive research, S. E. Sheppard, aided by a few other workers, was able to run this powerful sensitising compound to earth. He found it to be *phenyliso-thiocyanate*, the active principle of mustard oil, and a well-known compound. It occurred "naturally" in the gelatine to the extent of five or six parts in every million parts of gelatine. Yet, in spite of this extremely minute trace of the thiocyanate compound, its potency as a sensitiser was well apparent.

Sheppard's patient work on the extraction and identification of phenyl-iso-thiocyanate from photographic gelatine was a masterpiece of patient chemical work.

Phenyl-iso-thiocyanate was known to contain sulphur. Other sulphur compounds of related composition were found to have similar or even greater sensitising powers, and from this discovery dated the introduction of the present-day "super-speed" plates and films which so successfully combine the highest degree of photo-sensitivity with fine grain of the emulsion.

On this modern note our survey of the influence of chemistry on photographic advancement and discovery must stop. For obvious reasons of space we cannot examine the various other chemical processes which have contributed so enormously to the success, the convenience and the general usefulness and enjoyment of photography. The very beautiful platinotype process (now, alas! owing to its expense, obsolete), the carbon and "carbo" processes, the various and ever-advancing processes of "natural" colour photography, the technique of colour filters, the introduction of celluloid films, and the rise of the modern "dry-development" papers which are so useful in document photography—all these and, indeed, many more, are directly based upon chemical knowledge and chemical research.

An early photograph made on glass by Scott Archer's collodion process. Note the ornamental protective case of the period.



The manufacture of optical glass for war purposes is carried on in several factories in this country, and our illustration shows an operative engraving data on aerial photographic lens mounts.

Plastics from Acetylene

A Brief Viewpoint of a Branch of Modern Plastics Production

Part of a modern industrial plant for manufacturing a plastic product.

THE ubiquitous acetylene might well be termed "the Clapham Junction of Chemistry," for just as it is possible to travel almost anywhere in the kingdom from that noted railway station, so, also, starting from the commonplace acetylene gas, can the chemist proceed almost in any direction through the realm of organic chemistry.

At the beginning of the present century acetylene gas was important mainly in respect of its well-known illuminating powers. It was, of course, known to be exceedingly reactive chemically, but this characteristic had been little used outside the laboratory. But with the invention of industrial methods of combining chlorine with acetylene the first of the synthetic, non-inflammable solvents for degreasing, dry-cleaning and other purposes came into commercial being, and acetylene, the erstwhile "carbide gas," found itself promoted very high up in the ranks of the raw materials of manufacturing chemistry.

Acetylene is a simple compound. It consists of two carbon atoms which are very loosely bound together, each carbon atom having attached to it an atom of hydrogen. Acetylene, therefore, is purely a compound of carbon and hydrogen—a "hydrocarbon." Chemists give the gas the formula, C_2H_2, and they visualise its structure as:

$$H - C = C - H$$

Acetylene is rather unstable. At the slightest provocation, its constituent atoms tend to disrupt themselves (sometimes with actual explosive violence) at the "bond" existing between the two carbon atoms. Furthermore, the gas has the power of adding on to itself other atoms or groups of atoms and even of linking up with itself.

To take an example of this latter fact, when acetylene is slowly passed through a red-hot tube, a portion of the gas molecules combine with one another in such a way that part of the gas changes into benzene, C_6H_6. As the well-known chemical equation puts it:

3 molecules of C_2H_2 are converted into 1 molecule of C_6H_6.

Because of the essential reactivity of the acetylene molecule, a very large number of different chemical compounds can be obtained from acetylene gas by subjecting it to the necessary conditions and treatment.

It is this characteristic reactivity of acetylene which underlies its present-day increasing applicaton in the rapidly extending manufacturing technique of the plastics industry. From acetylene as a "starting-point," a number of varied and highly important plastic materials can be manufactured, and there is little doubt, also, that the future range of these acetylene-derived plastics will undergo a still further increase.

Methyl Rubber

The Germans were the first in the field with acetylene-based plastics. During the last war they managed to make some 2,000 tons of "methyl rubber"—one of the first synthetic rubbers—which they produced by the chemical condensation ("polymerization") of a liquid known as dimethyl-butadiene, which latter was produced from acetone. The necessary acetone was made by a tedious and lengthy process from acetylene gas, so that the German "methyl rubber" was essentially based on acetylene.

It was Germany, also, which produced the first acetylene-derived synthetic resin. This the Germans called "Wacker Shellac." It was a sort of imitation shellac, a little more brittle and less gummy than natural shellac, and its electrical insulating properties were not so good. Nevertheless, the Germans used their "Wacker Shellac" for a multitude of insulative purposes as well as for varnish making and the like.

"Wacker Shellac" was made by the chemical condensation of carbolic acid (phenol) and acetaldehyde, the latter substance being a member of the great "aldehyde" family to which commercial formalin, the basis of bakelite resin, belongs.

Importance of Acetaldehyde

Now, Germany's synthetic shellac could never have been forthcoming commercially had it not been for the fact that acetaldehyde can be manufactured from acetylene. When acetylene gas is bubbled slowly through dilute sulphuric acid in which has been dissolved a small amount of mercury salt to act as a "catalyst" or reaction-energiser, the gas is converted into acetaldehyde, a sweet-smelling, highly volatile liquid, which can subsequently be distilled off. Another way of producing this necessary acetaldehyde is to pass a mixture of steam and acetylene through a red-hot tube containing a catalytic material. Acetaldehyde is thus formed and is subsequently liquefied in a suitable condensing apparatus.

Acetaldehyde, therefore, can readily be obtained from acetylene, and it can be used directly for the making of a number of synthetic resins. But acetaldehyde can also readily be oxidised to acetic acid, the acid of vinegar, and acetic acid can be converted into a related substance known as acetic anhydride, which is a sort of dehydrated acetic acid.

Acetic anhydride is nowadays used in enormous amounts in the cellulose plastic, and in the rayon (artificial silk) industries. Much of it is acetylene-produced, so that it is possible to claim at least a proportion of the modern artificial silk industry as "acetylene's own."

A modern process, mainly worked out industrially in Canada, consists of a modification of the older acetylene-steam reaction whereby acetaldehyde can be produced. But in this modernised version, by virtue of certain special catalytic materials, the acetylene and steam are made to react a stage further and to give not acetaldehyde, but *acetone*, a solvent liquid of tremendous industrial importance.

From acetylene-derived acetone, by means of a three-stage chemical synthesis, methyl-acrylic acid is obtained. This material, which was formerly just a chemical curiosity, has, within the last few years, stepped directly into the industrial foreground in consequence of the fact that it very readily undergoes chemical condensation to form a series of synthetic resins which are perfectly colourless and glass-clear in nature and which, indeed, are largely used as substitutes for glass.

Neoprene synthetic rubber—an American product, based primarily on acetylene.

Acrylic Resins

From acetylene, too, can be obtained the normal acrylic acid, and this acid, like its methyl derivative, forms the immediate starting point for the manufacture of another series of artificial resins—the "acrylic resins," which are also glass-clear in character and constitute another series of "organic glasses."

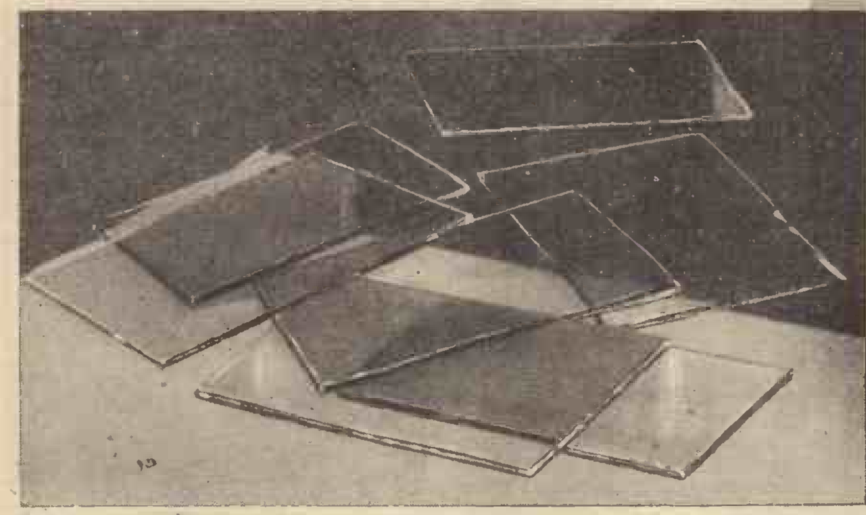
"Perspex," the well-known glass-clear synthetic resin, is manufactured in large quantities from methyl acrylic acid. It is, therefore, still another example of an important plastic material which is ultimately based upon the commonplace and formerly chemically neglected acetylene gas.

It is possible to convert acetylene into alcohol by means of a modification of the process whereby acetaldehyde is generated by the absorption of acetylene in sulphuric acid, but as, up to the present, it has always been cheaper to produce alcohol by fermentation processes, acetylene-derived alcohol has never been a very economic commodity. Nevertheless, in view of the increasing employment of alcohol in the manufacture of the cellulose plastics, it does seem likely that alcohol from acetylene may ultimately displace the fermented alcohol, at least for industrial uses in the domain of plastics.

Mention has already been made of the fact that when acetylene is passed through a heated tube it becomes converted in part to benzene, the well-known "spirit" of coal distillation. Although this synthesis was discovered many years ago, it has never been successful on the industrial scale. There is little doubt, therefore, that a respectable fortune awaits the inventor of a continuous process for converting acetylene into benzene. for benzene can be converted into phenol (carbolic acid), which latter is one of the vital raw materials of the bakelite series of artificial resins.

"Cuprene"

In connection with the heat treatment of acetylene, it might be of interest to mention here a rather remarkable substance of unknown composition which is obtained by heating acetylene in contact with copper or with copper alloys, or, alternatively, by subjecting acetylene gas to the influence of an electric discharge. This substance, which has been termed "cuprene" (and sometimes "carbene") is a brownish-yellow material. Its most remarkable character is its extraordinary bulkiness and its great chemical inertness. Little is known about the chemical constitution of "cuprene," but, in consequence of its highly voluminous nature, it has found several industrial uses.



A very important group of synthetic resins is that whose members are derived from vinyl acetate, vinyl chloride and a number of similar vinyl compounds. These are the nowadays much used "vinyl resins."

When mercury sulphate is dissolved in small quantity in strong acetic acid and acetylene gas is passed into the liquid, vinyl acetate is formed. Similarly, by treating propionic and butyric acids with acetylene in the same way, vinyl propionate and vinyl butyrate are respectively produced.

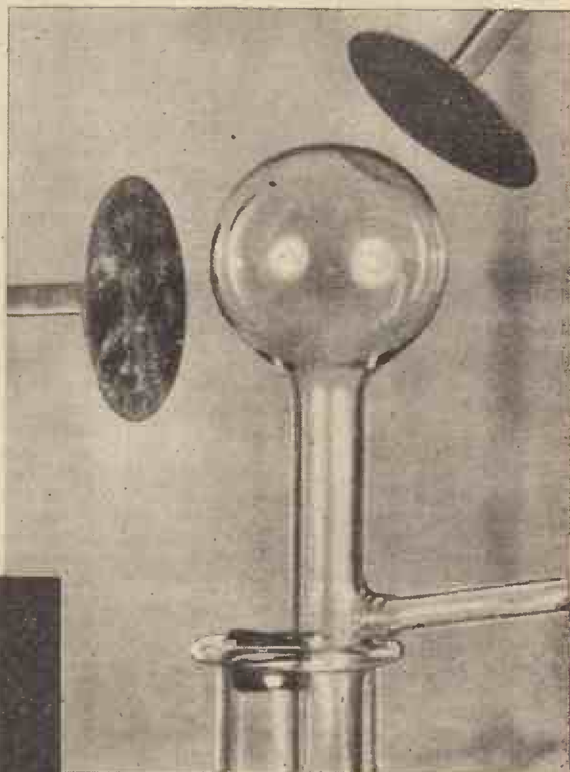
Again, by subjecting alcohols to the action of acetylene in the presence of mercury sulphate, substances known as "vinyl ethers" are forthcoming and, again, by treating certain nitrogen-containing coal-tar derivatives with acetylene gas in the presence of alkali (sodium hydroxide) compounds, known as "vinylamines," which contain nitrogen, are produced.

Now, all these vinyl compounds are intensely reactive. By combining them in different ways, by allowing them to condense with one another or with other materials, a large number of different synthetic resins can be produced. Some of these resins have already reached a stage of industrial importance. Others are being investigated in view of their post-war possibilities, whilst others still have not as yet passed beyond the stage of the research laboratory bench.

One of the beneficial characteristics of the vinyl resins, especially those which contain nitrogen, are their high insulative properties and their elevated melting-points. In these respects they form another stage in the attainment of that ideal of the modern plastics researcher, the evolution of a synthetic resin which will stand red-heat without spoliation or disintegration.

Fibrous Plastics

One of the most recent developments in the science of synthetic plastics has been the commercial production of fibrous resins and related compounds. The best-known of these is the American product, "Vinyon," which is essentially a chemical compound of vinyl acetate and vinyl chloride. Its exact composition is unknown, but it is evidently a vinyl resin, and, for that reason, an acetylene-derived product.



(Right) Glass treatment-chamber for experimental work on the influence of electrical radiations on acetylene and other hydrocarbon gases. (Below) "Organic glasses," the modern transparent artificial plastic resins have the perfectly transparent appearance shown in this illustration. As such they have many important uses, particularly in aircraft work. They are all derived from acetylene.

The Germans have a somewhat analogous compound which they call "Pe-Ce fibre." It is a chlorinated vinyl chloride, also of, as yet, unknown composition.

Both "Vinyon" and "Pe-Ce fibre" are resins which can be drawn out into fibres. The present aim is to develop them so that they can be spun into thread and woven into textile fabrics.

From acetylene may be prepared a compound known as "vinyl acetylene." When this vinyl acetylene is treated with hydrochloric acid gas in the presence of copper chloride or ammonium chloride, it is converted into chloro-butadiene, to which latter compound the name "chloroprene" has been given.

Neoprene Rubber

Chloroprene is a very important acetylene-derived substance because when this chloroprene is chemically condensed with itself it gives rise to the nowadays well-known "Neoprene," which is about the most common of the American synthetic rubbers and the one which is nowadays being produced in steadily increasing quantities.

Neoprene, the American rubber, is, therefore, primarily based on acetylene, although it can also be produced from other materials. It is, however, from acetylene that most of this product is likely to be forthcoming in the future.

Before closing this brief review of the modern acetylene-derived plastics, it will be interesting for us to obtain a glimpse of an entirely new field of chemical research, to wit, that which is endeavouring to produce artificial drying oils for the paint and varnish industries in order to render these important branches of manufacture independent of the natural linseed and other oils.

A "drying oil," as the reader may be well aware, is an oil which, when spread out in thin films, abstracts oxygen from the air, and more or less rapidly changes into a viscous mass and finally into a solid, resin-like material. In the manufacture of oil paints, these drying oils are essential.

By combining vinyl acetylene with acetylene itself it has been found possible to produce an oil which has excellent "drying" properties. Such an oil has been marketed under the style of "S.D.O." (Synthetic Drying Oil). Doubtless further oils of this description will be forthcoming in the course of time.

Although it is possible to produce acetylene gas in a number of different ways, industrial acetylene is derived solely by the well-known calcium carbide reaction, whereby the interaction of this material and water results in the vigorous disengagement of gaseous acetylene.

Carbide Production

Of recent years, many improvements have been made in the manufacture of calcium carbide from coke and lime, so much so that not only is the yield of acetylene gas from a given weight of carbide greater than was formerly the case, but, also, the liberated acetylene is of a much higher standard of purity.

Precision Clockmaking—2

Reviewed from the Aspect of Scientific Craftsmanship, With Special Reference to Self-contained Electric Clocks

By the Late GEORGE B. BOWELL

(*Continued from page 342, July issue*)

Gravity Escapement

OF other clock escapements in common use is the double three-legged gravity escapement as applied to the Big Ben clock, which is the Bloxam escapement improved by Lord Grimthorpe and is ordinarily known as the Grimthorpe gravity escapement. Its use is almost entirely confined to turret clocks. In this escapement the pendulum is not impulsed directly from the escape wheel, but by means of a pair of gravity pallets acting on each side of it. A pallet follows the pendulum for a certain distance, and then is advanced clear by the rotation of the escape wheel, so that each pallet always follows the pendulum for a greater distance than the pendulum, which, on returning, has to lift and unlock the other pallet, and the difference constitutes the impulse. To do this the escape wheel consists of three teeth, or "legs," as with some they are called, but for convenience in the lay-out these legs are duplicated, hence the term "double three-legged gravity escapement." To lift the pallets, three pins near to the arbor lie between the two sets of legs, and each pallet has a hornlike projection to coact with the lifting pins. The legs are locked against stops, one of which is set on the face of one pallet and the other at the back of the other pallet. Thus each time a pallet is moved outwards it unlocks the escape wheel, which then moves through one-sixth of a turn, lifting the other pallet and then locking on it. In this escapement the unlocking occurs always as the pendulum is rising, though it is a relatively light unlocking because of the long legs and their long travel at each beat. A gravity clock needs very much greater driving weight than a dead-beat, but for a turret clock this is an advantage, since it means so much greater turning force to the dial work.

Riefler Escapement

Of other clock escapements there is the Riefler, which is only intended for use as a precision clock. In this the escapement is not directly connected to the pendulum, but is attached to a rocker pivoted on a knife edge and agate mounting. From this rocker the pendulum's suspension spring is supported. In action the rocker moves across very rapidly at each beat, and the pendulum then receives its impulse by a slight rocking of the spring, and otherwise swings quite free of the mechanical parts.

"Power" of a Clock

A clock is a very small-power mechanism. If expressed in horse power it would appear fantastic. One can easily figure this out by comparing the weight and fall—say of the familiar grandfather clock for a week's going —with the mechanical equivalent of one "horse-power," which is 33,000 *foot-pounds* per minute. So if one intends to construct a clock that shall be driven electrically and thus avoid the need for weekly winding (and possibly obtain some further advantages) it is clear that a very small extent of electric supply *should* suffice.

For transforming electrical energy into mechanical motion several means are available. Because of its simplicity an *electro-magnet* is very usually employed; but an *electric motor* may offer some advantage, or for some arrangements it may be quite essential.

Electric Motor Drive

For clock purposes (including turret clocks) several different types of electric motors may be considered. There is the usual commercial form having an armature composed of coils wound on an iron core. These motors of small size are usually referred to as "fractional h.p." and are suitable for use when a mains supply is available. For turret clocks such motors can be used for several purposes, for striking or chiming parts, for instance, and for "self-winding." Though it has been found that a motor of this conventional type would require a larger current than could be reasonably provided by dry cells, but *a more suitable motor* can drive a second's house clock on a current so small that one dry cell suffices for several years' going.

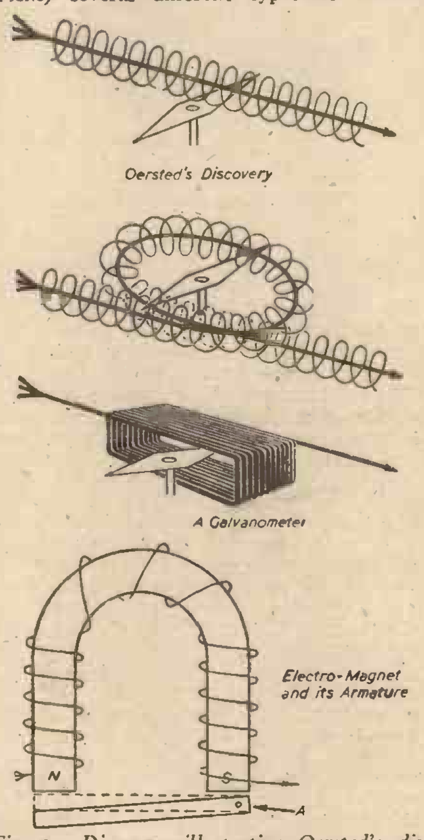


Fig. 2.—Diagrams illustrating Oersted's discovery, and a simple electro-magnet and its armature.

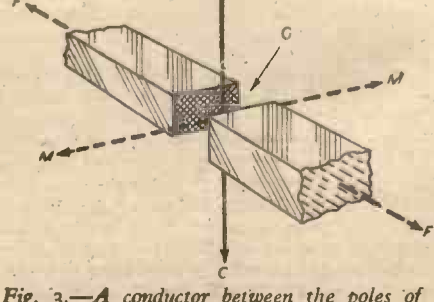


Fig. 3.—A conductor between the poles of a magnet.

Self-winding Clock

It is of special interest here, perhaps, to inquire into the reasons for the great dissimilarity existing between working a turret timepiece from such a continuously running battery motor, and from, say, a self-winding scheme in which a "fractional h.p. motor" is used for rewinding. The "load" is normally that of overcoming friction, but is at times greatly increased by such causes as wind pressure on the hands. The turning force derived from the driving weight must therefore be never less than enough to contend with the abnormal or "overload." The motion then has to be controlled by the escapement, which together with its pendulum must be on a fairly large scale to have dominion over it, as the old clockmakers used to express it. On the other hand, if an electric motor is used to give the motion directly this important matter of overload is automatically taken care of by the motor itself. So if one decides not to drive a turret clock by weights acting at the slow moving end of the train, but by an electric motor acting at the fast moving end of the train, the problem mechanically is simple enough and clear enough—but it remains to be schemed also that the speed of action shall be controlled by pendulum and escapement.

But to return to the merely "self-winding" turret clock, this is adopted by some clockmakers and, so for as I am aware, with quite good results. One obvious way of doing this is by the Huygens endless chain method, in which a driving weight is kept continuously acting on the going part and the motor periodically raises the weight by taking up the slack end of the chain. If one desires to avoid use of chain and sprockets, it would be easy to devise a suitable form of differential gear to serve the same purpose—the Huygens endless chain in fact may be regarded as a primitive form of differential gear. Alternatively, if chain and sprocket is not objected to it might be a practical scheme to incorporate the winding motor (with suitable reduction gear and a sprocket) with the driving weight. Thus arranging that when current is switched on to the motor, the whole self-winding "unit" climbs up the chain. The clock movement proper would then be as usual, except for omission of main wheel and barrel; the sprocket could be fixed to the second-wheel arbor direct. For safety's sake the motor unit would, of course, need to have some convenient guiding arrangement, such as vertical guides, or merely a longish horizontal radius arm, from which the motor switch could be operated and along which the supply leads to the motor could be placed. A normal descent for one hour's going plus a further descent to give, say, a further four hours' drive in case of temporary failure of electric supply would probably meet usual requirements. However, it might be pointed out that such a "simple" job needs much careful consideration of a large number of little details if the result is to be free from danger and dependable in action. Churton Collins says "a fool often fails because he thinks what is difficult is easy, and a wise man because he thinks what is easy is difficult." Applying this to a job of mechanical design it suggests the need for becoming well acquainted with the difficulties and then overcoming them.

Hipp Pendulum

Some notes concerning the "Hipp" clock would here perhaps not be out of place. The "Hipp pendulum," perhaps the most outstanding invention in the history of electric clocks, was devised by Professor Hipp, of Neuchâtel, about 1842; it has been used one way and another ever since, and is still in use. The arrangement is very simple, but the theory of its action is probably not so; the Hipp clock is capable of keeping very accurate time. At the date of its origin the only other electric clock was the Bain (1840). In the Bain clock the pendulum, which in turn drives the dialwork, is impulsed electrically, and the impulse varies according to the condition of the battery. In the 1840's this must have been very antagonistic to good timekeeping. The Hipp also is an electrically-driven pendulum, and the dialwork is driven therefrom, but quite different conditions exist, for the pendulum is so arranged that only when its arc declines to a definite prearranged minimum is the impulse given. This happens whenever a little freely pivoted "nib" fails to trail quite clear over a notched projection attached to a contact spring. On these occasions the nib, returning, depresses the spring ("toggle" fashion) and thus makes a contact, which then allows current to pass to the electro-magnet by which the impulse is effected.

In these clocks the pendulum bob should be heavy, then there is an almost imperceptible difference in arc after an impulse or before. The pendulum may swing, say, 40 seconds or 60, or for any number of times, but the action always secures that *the average amount of impulse is constant*—and (within reason) regardless of battery condition.

As previously stated, in an ordinary clock, in which impulse is given at *regular* intervals, the impulse should occur equally before and after zero in order not to vary its time by varying the controlling force. Also, it must be as constant as possible in order not to vary its time through change of arc. Nevertheless, if it were possible to make a clock so perfectly that the impulse were not liable to vary, then it would not matter particularly about *either* of these "rules." Though by altering the value of the controlling force the natural period of the pendulum would be altered, yet so long as it remained without variation the resulting rate would be without variation. It would seem that the Hipp pendulum, because of the constant average amount of impulse, is more or less completely exonerated from both these rules, paramount though they be for ordinary clocks. And one can go farther, perhaps, and say that even variations in any (reasonable) "load," such as driving dialwork, do not introduce very appreciable errors in rate. Hence the Hipp clock as a timekeeper is excellent, and is bound to go well unless unduly handicapped by ill-proportioned parts, or, of course, by very poor workmanship.

About 35 years ago I constructed a turret timepiece on this plan, the dial was 3ft. and fixed high up on a very exposed corner of a building, and it has always been a good timekeeper. This, then, seems to suggest that for a turret timepiece of relatively small size one might do worse than make it just a Hipp pendulum. This particular clock had a 30lb. cast iron pendulum and a wood rod. The dialwork was driven by a worm and wheel about 3½in. diameter, and the pendulum moved to and from the vertical (iron) plate which formed the frame from the back of which the arbors went through to the dial—a distance of about 18in. The "nib" parts were of tool steel hardened in mercury.

Some turret clock dials are driven as "jumpers" from a master clock, but this is referred to in the notes concerning some jumper systems.

Synchronous Motors

Where a time-controlled electric supply is available, the use of a *synchronous motor* to drive an outside dial is very convenient,

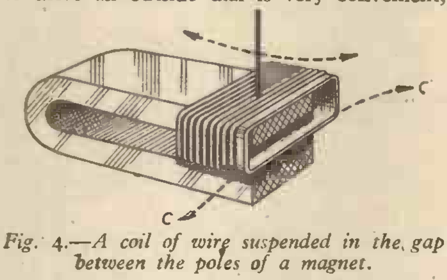


Fig. 4.—A coil of wire suspended in the gap between the poles of a magnet.

but leaves one entirely dependent on immunity from temporary failures of supply. To guard against this, various schemes have been devised to "carry on" during a failure of outside supply, but in general such plans must necessarily introduce a number of extra parts and an undesirable complexity. The alternative of a motor driven by battery current, and having its own time control by a pendulum, might well offer a preferable solution.

Ohm's Law

For the purposes of this article it is necessary to note some outline of the manner in which an electric current flows in a circuit, and of the connection between electricity and magnetism.

With regard to an electrical circuit, there must be a source of pressure and a complete conducting circuit, the flow of current will then result; and always in an orderly manner that can be expressed in definite units of measurement. The unit of rate of flow of the current is called the *Ampere*. That of pressure or "Electro-motive force" ("e.m.f.") is the *Volt*, whilst a unit called the *Ohm* denotes the Resistance of the conductor which forms the circuit.

These three units, Amperes, Volts and Ohms respectively, are so related that C = E/R, by which three letters they are usually signified. This is known as "Ohm's law" and may, of course, be alternatively expressed as R = E/C or E = CR. All of which may seem too elementary to be worthy of careful notice, but it should be remembered that before Ohm's time quite a hazy notion of the behaviour of electric currents existed.

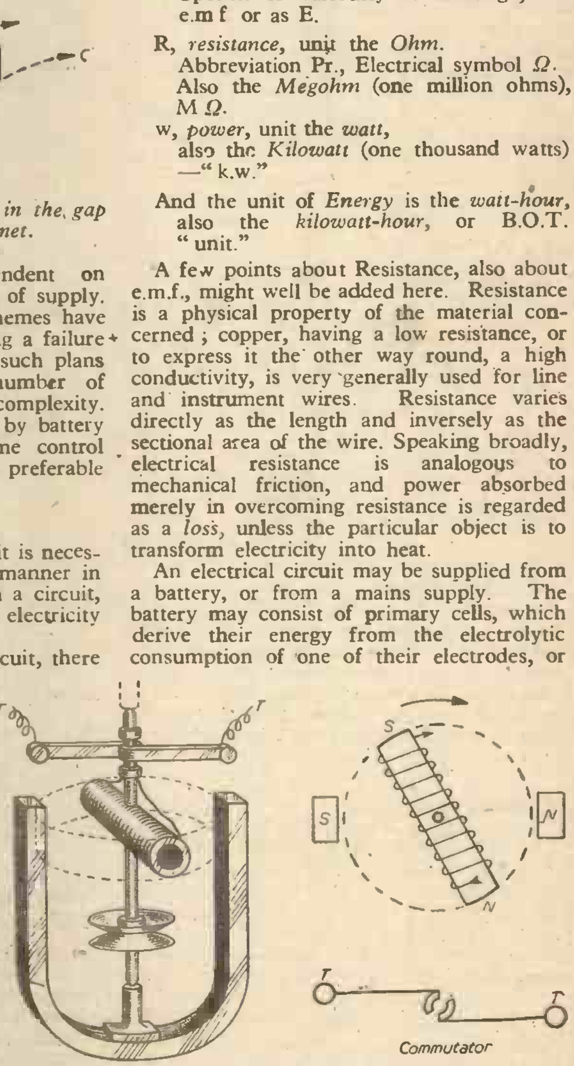


Fig. 5.—Diagrammatic details of the Ritchie electro-motor.

Another unit is the *Watt*, which is the product of Volts and Amperes (W = EC). The Watt is the unit of *power*, since power is the "rate of doing work" and so this must be the rate of flow of the current × the pressure required to maintain that flow.

The theoretical equivalent of the Watt in terms of "horse-power" (h.p.) is 1/746. In practice one must allow for the ratio of actual to theoretical; in very large electrical machinery this "efficiency" may be as high as, say, 95 per cent., but for smaller machinery a considerably smaller efficiency exists. The (actual) mechanical value of 1 h.p. is 33,000 foot pounds per minute.

Electrical *energy* is measured commercially (as by meter from a mains supply) by the Board of Trade "Unit," which represents 1,000 *watt-hours*. Thus, for example, if one has an appliance taking, say, 2000 watts it will work for five hours on the expenditure of 1 unit. Or if, say, 2 watts it would work for 500 hours on 1 unit.

To tabulate these items:

C, *current*, unit the *Ampere*
also the *Milliampere* (one thousandth of an ampere). Abbreviation "m/a," or in the plural "m.a.s."

E, *electro-motive-force*, unit the *Volt*. Spoken of variously as "voltage," as e.m f or as E.

R, *resistance*, unit the *Ohm*.
Abbreviation Pr., Electrical symbol Ω. Also the *Megohm* (one million ohms), M Ω.

W, *power*, unit the *watt*,
also the *Kilowatt* (one thousand watts) —"k.w."

And the unit of *Energy* is the *watt-hour*, also the *kilowatt-hour*, or B.O.T. "unit."

A few points about Resistance, also about e.m.f., might well be added here. Resistance is a physical property of the material concerned; copper, having a low resistance, or to express it the other way round, a high conductivity, is very generally used for line and instrument wires. Resistance varies directly as the length and inversely as the sectional area of the wire. Speaking broadly, electrical resistance is analogous to mechanical friction, and power absorbed merely in overcoming resistance is regarded as a *loss*, unless the particular object is to transform electricity into heat.

An electrical circuit may be supplied from a battery, or from a mains supply. The battery may consist of primary cells, which derive their energy from the electrolytic consumption of one of their electrodes, or of secondary cells ("accumulators"). Of primary cells the only type which really concerns us here is the leclanche cell, of which the "dry cell" in the most popular form. The leclanche cell consists of a carbon, and a zinc as "electrodes," and a solution of sal ammoniac, as the "electrolyte." There is also a layer of manganese di-oxide packed closely on to the carbon. The purpose of this is to prevent formation of bubbles, which otherwise would increase the cell's resistance.

The voltage is independent of the size of the cell. When an external circuit is formed, current will pass through it from the carbon to the zinc, and within the cell this same current has to pass from the zinc through the electrolyte to the carbon. As there will necessarily be some resistance here, called the "internal" resistance, it is quite essential to take it into account in the application of Ohm's law. For example, suppose one has a cell of 1.5 volts to send current through an external circuit of 9 ohms and the cell's internal resistance is 1 ohm, the current C = E/R (of which R is 9 + 1 = 10) will be .15 ampere, or 150 m.a.s.

The internal resistance of a primary battery may, when new, be very small, but it grows with age and with use. Accumulators, unless of small size in bad condition, have quite low internal resistance.

Sometimes a circuit itself may include some source of e.m.f., apart from that of the source of supply; in such cases proper allowance for this is essential before applying Ohm's law to ascertain the flow of current. If such an e.m.f. acts in opposition to that of the source of supply, it is called a "back e.m.f."

So now to consider the connection between an electric current and a magnetic field, for out of this arises the means of driving a clock, or a tramcar (or any of so many things) electrically.

Oersted's Discovery

In 1819 Oersted discovered that an electric current flowing in a conductor is always accompanied by a magnetic field, taking the form of lines of force encircling the conductor, that is, at right angles to the direction of the current. This is shown pictorially in Fig. 2, the spiral lines indicating the magnetic lines of force, by which a magnetised compass needle close to the conductor may be deflected. This magnetic field is but small, almost negligible, in a straight wire, unless the current be large, but is more noticeable if the wire be looped around, and much more so if formed as a coil of many turns.

A magnetic flux, somewhat akin to an electric current, always flows in a closed "circuit," and it meets with less difficulty through iron than through air. Iron is said to have less "reluctance" than air. Consequently if an iron core be provided inside a coil of wire through which a current is sent, the magnetic field produced will be yet further intensified. Fig. 2 shows not only this, but further that the iron core, together with the loose piece of iron, A, called the armature, is formed to favour such a closed magnetic circuit. This, of course, is the electro-magnet, by means of which a current through the coils can give a mechanical motion to the armature A.

The earliest electro-magnet probably was that made by Sturgeon in 1823. So far it is quite simple to follow progress from Oersted, 1819, to Sturgeon, 1823, and beyond that to the construction of electro-magnetic motors. Nevertheless, there are strange phenomena that were not accounted for, but only ascribed to the mysterious "conflict" which occurred at the magnetic field in the process of transforming electric current to magnetic force. The precise *cause* of what lies behind the "conflict" no doubt still remains beyond the ken of man, but in 1831 Faraday made notable discoveries as to its definite *effects*. Amongst them being that if a conductor be moved so as to cut the lines of force in a magnetic field, an e.m.f. will be induced in the conductor; and this e.m.f. will be proportionate to the rate at which the lines of force are being cut.

Fig. 3 shows the air gap G of a magnet, and across this gap the magnetic lines of force are in direction F.F. A conductor CC is lightly suspended to pass through the gap. If CC be moved in direction MM it will cut the lines of force and produce an e.m.f. in CC. Conversely, if a current is sent through CC, motion in direction MM will result. Fig. 4 shows a similarly arranged combination of CC, FF, and MM., which it will be noted are all at right angles to each other, but here a coil of a number of turns takes the place of the single wire of Fig. 3. Numerous other varieties of this arrangement are met with in clock and instrument design and are called "moving coil" systems. It is important to notice that as the induced e.m.f. must result from the motion of CC relative to the magnetic flux FF, this e.m.f. is set up whether a current be sent through CC or not. It constitutes a "back e.m.f.," and is but transitory in any device (such as Figs. 3 and 4) where motion along MM is limited. Though where motion is sustained, as in a dynamo or an electric motor, this induced e.m.f. is not transitory, but is sustained.

It is not essential for the generation of this e.m.f. that there should be a constant magnetic field and a conductor in motion, for alternatively the conductor may be at rest with relation to the field, if the field itself be in a state of change. And this occurs in an electro-magnet's coil; the "back e.m.f." being set up whilst the magnetic flux is changing from zero to its full, and *then* subsiding, by which time the current has attained its "steady" value.

This same action is common to all electrical circuits in which the flow of a current has to set up any appreciable magnetic field, and it is called self-induction or *inductance*.

The Electric Motor

It is but a simple step from the electro-magnet to the electric motor. One of the earliest was the Ritchie, diagrammatically illustrated in Fig. 5. The armature, a soft iron core having coils or winding around it, is fixed to a shaft, and can rotate between the poles S.N. of a permanent magnet. If a current is sent through the winding in such a direction as to magnetize the soft iron core so that (as in Fig. 5) the upper end is s and the lower end n, a turning force, or "torque," would result in direction of the arrow. Simply regarded as magnets, s will be repelled from S, but attracted to N. This torque would only extend over half a turn, but the addition of the *commutator* serves to reverse the connections between the winding and the terminals TT at each half revolution, so that the torque acts always to promote the required direction of rotation.

The commutator (shown separately in Fig. 5) consists of two metal segments insulated from the shaft but fixed to rotate with it. The segments are connected to the winding, and the terminals TT connect to the segments by means of two contact springs or "brushes." In this way the double purpose of forming electrical connection to the rotating part and of "commutating" is served.

(To be continued.)

"Herculean" Power of the R.A.F.

REMARKABLE details were recently released by the Air Ministry, regarding the latest Bristol "Hercules" engine, whose development since its introduction in 1936 has made it one of the most powerful units now doing duty with the R.A.F. In this period it has advanced by over 60 per cent. from its original power, and its reliability and simplicity are used in such extremes of craft as the Lancaster heavy bomber and the fast, hard-hitting Beaufighter. Its elimination of complicated ohv gear and vulnerable secondary cooling has minimised maintenance for aircrews, and to simplify the installation the engine can be supplied as a complete self-contained power-unit for quick 4-point connection to the airframe. It develops over 1650 b.h.p. The accompanying photograph was taken in a Bristol Company factory producing "Hercules" engines for the Ministry of Aircraft Production, and shows final stages in the assembly of these remarkable machines.

Final stages in the assembly of the Bristol "Hercules" engine.

Instruments for Motor-cars and Aircraft

(Continued from page 309, June issue.)

Speed Indicators, Fuel Gauges, and Compass Details

By JEREMY MARTIN

Air Speed Indicator

THIS instrument is designed to provide the pilot with an indication of his aircraft speed relative to the air.

This consists of a capsule which is connected to the pressure feed line of the pitot head; in other words, the air pressure due to the forward movement of the aircraft is directed into the capsule. On some instruments a leather diaphragm is used in place of the metal capsule, the case of the instrument being connected to the static supply. This instrument is in effect a differential pressure gauge, measuring the difference between the still and moving air. Whilst the aircraft is travelling through the air, the pressure of the air flow transmitted to the capsule through the pipe lines, causes the capsule to expand against the static air pressure in the case. This movement of the capsule is transmitted through a suitable magnifying mechanism to a pointer, moving over a scale calibrated in either miles per hour, or in knots. It is obvious that the aircraft is not at all times travelling through the same atmospheric pressure, e.g., when climbing pressure is decreasing, when diving pressure is increasing. If the case was airtight, the pressure within would be that at which the aircraft started and would therefore give an erroneous reading. For example, if at sea level the air pressure in the case were 15lb. per sq. in. and the case sealed off, at 15,000ft. this pressure would remain constant, but the pressure outside would be approximately half. The basic principle of this instrument being air pressure due to forward motion against pressure of air surrounding the aircraft, the reading should be pressure of air flow against 7lb. (approx.), not 15lb. Therefore, as pressure in the case is too great, the difference between the two pressures is lessened, thereby giving less capsule movement, less pointer movement and a resultant under-reading on the instrument. Since, however, the case is connected to the static pipe line, thereby having access to atmosphere, the pressure in the case can at all times equalise the pressure of the atmosphere surrounding the aircraft.

There are various errors which have to be compensated for, e.g., position error. This is allowed for by the makers in their published data sheets. It is caused by, as its name implies, the position of the pressure head in the air flow.

Further errors, e.g., compressibility and square law, are compensated for by various methods, depending upon the manufacturer of the instrument.

Boost Gauges

There are various types of boost gauge manufactured, some relying upon the operating force upon either evacuated capsules or evacuated bourdon tubes. The mechanism is enclosed in an airtight case and connected to the induction system of a supercharged engine. The pressure exerted by the supercharger is fed directly into the case of the instrument and exerts a pressure upon the evacuated capsules, so actuating a pointer through a layshaft, quadrant and pinion. This instrument is calibrated in lbs. per sq. in., and as the capsules are evacuated (as in an altimeter) the instrument will read the barometric pressure in lbs. per sq. in. Since it is essential that the case be airtight, both the case and glass are manufactured from strong materials, and to obviate any surge of pressure breaking the case, or glass, a choke is incorporated in the pipe line connection at the rear. A drain trap is inserted in the pipe line (Fig. 10) to obviate any liquid being transmitted to the instrument.

A small piece of invar steel is fitted to one of the brass links to overcome errors which would result from temperature change.

The boost indicated and obtained will depend upon the power developed by the engine.

Mechanical Instruments
Automobile Engine Speed Indicator

This may be either driven from the wheels or from the clutch drive. The drive is geared down to the instrument and then geared up to engine speed. The drive is transmitted by means of a flexible drive which consists of several strands of steel wire which are woven round a centre core the ends of which are squared off to fit into suitable keyways in the instrument, and at the engine end.

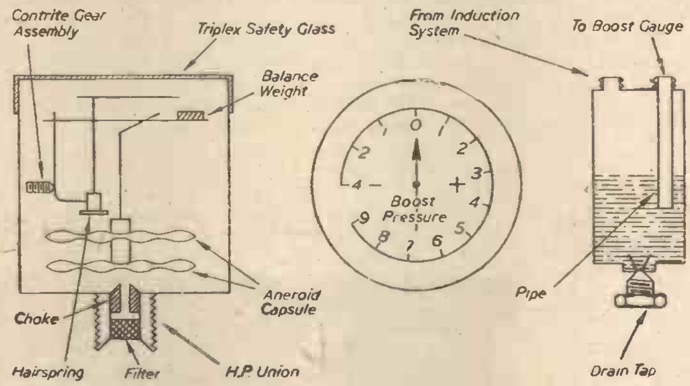


Fig. 10.—Details of boost gauge and drain trap.

The reason for the drive being geared down is to save whip and excessive wear and tear on the drive. The actuating principle of the instrument is centrifugal force. To outline the principle of centrifugal force simply, we can use as an analogy a piece of string to which is attached a small weight. If the weight is suspended vertically and rotated from its point of suspension it tends to travel to a horizontal plane. As the speed of rotation increases, the weight tends to travel through increasingly large circles until such time as the speed developed is sufficient to cause the weight to move in a circle, the radius of which equals the length of the piece of string from point of suspension, to the weight itself. This circle is in the same horizontal plane as the point of suspension (Fig. 11). The speedometer, or engine speed indicator, consists of a governor, similar to that used in the construction of the gramophone motor, attached to a spindle by horizontal pivots. Fixed to the governor is a small pin, the free end of which rests in a flanged collar which in turn is free to slide up and down the vertical standard or spindle. A quadrant and pinion also rests in the flanged collar and connects to a pointer spindle moving over a scale calibrated in miles per hour or revs. per min. As the flexible drive rotates, this being geared to the spindle, the spindle and governor rotate simultaneously. The governor tends to take up a horizontal position against the tension of a spring which is incorporated to return the governor back to its correct position when at rest. As the governor tends to take up the horizontal position, the pin being attached to both the governor and the collar, tends to pull the collar down the spindle. This causes the quadrant to move, and this movement being transmitted to the pointer spindle, the pointer moves over the scale. The greater the speed of the engine, the nearer the govenor reaches to the horizontal, thus giving greater movement of the collar and consequently to the quadrant and pinion. As the speed decreases, the governor, assisted by the spring, tends to assume its original vertical position, thereby moving the collar in the opposite direction and therefore the quadrant and pinion mechanism. Thus the pointer tends to return toward zero, which is reached when the engine is stationary.

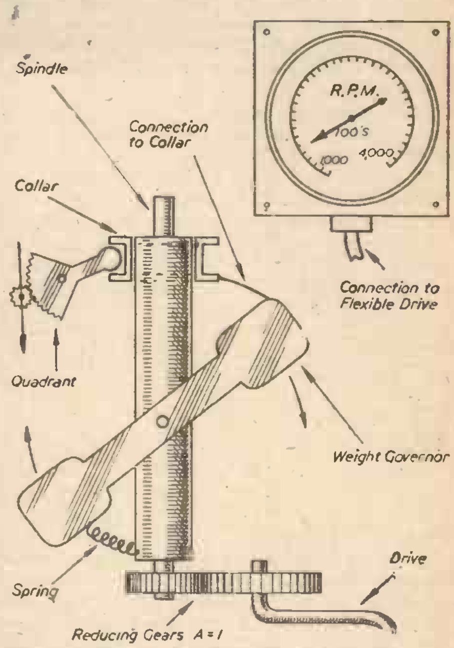


Fig. 11.—Diagram of mechanical engine speed indicator.

The Aircraft Engine Speed Indicator

This instrument is the same as that used in the automobile, with the exception that the flexible shaft is driven off the camshaft of the engine.

Electrical Instruments

With the exception of some types of petrol gauges, ammeters, and voltmeters very few electrical indicators are used in car design. But there are many electrical instruments used in modern aircraft. This is manifest in the design and manufacture of American aircraft, the instruments of which are largely electrical. The following instruments are electrical instruments.

Engine Speed Indicators

With the advent of multi-engined aircraft, it was found that mechanical type indicators were unsuitable owing to the great length of flexible drive involved. There is considerable distance between the outer engine and the cockpit in which the instrument indicator is housed. One system involved consists of a permanent magnet generator and a moving coil indicator. The generator is fitted conveniently near to the engine and is driven by a short flexible drive which is connected to the engine through reducing gears, similar to the mechanical type indicator.

A gear box on the generator steps up the revolutions to engine speed, causing the armature of the generator to revolve at that speed. The voltage generated is therefore directly proportional to the number of revolutions per minute, e.g., 100 revolutions produces 1 volt. Suitable connection is made to transmit the developed voltage from the generator to the instrument in the cockpit. The indicator proper represents a moving-coil voltmeter, but the scale is calibrated in revolutions per minute instead of volts. This is easily understood, as the voltage produced is proportional to the engine speed, e.g., 10 volts equals (at ratio 100 : 1) 1,000 r.p.m. To outline the principle of the moving coil instrument it might be stated briefly that the revolving armature, moving in an electrical field, produces an electro-motive force (e.m.f.) which is proportional to the rate of such movement (providing the flux density of the field is constant). This developed e.m.f. is transmitted to the moving coil instrument, which consists of a coil, suspended on a horizontal axis, and rotating in a magnetic field, represented by a permanent magnet. The current travelling in a conductor (the coil) tends to cut the lines of force emanating from the permanent magnet which causes the coil to revolve against the tension of two hair or torque springs which transmit the current. Therefore the movement of the coil, which is connected to the pointer, is proportionate to the current supplied to that coil. To avoid extraneous magnetic influences, the instrument is sealed in a steel case, which gives the effect of screening.

The advantage of this type of instrument is that several instruments could be incorporated in one case, but each indicator would consist of an individual moving coil instrument.

Fuel Contents Gauge

It is essential for the safety of the aircraft that the pilot should at all times know the actual contents of his numerous petrol tanks. It is obviously impossible for him to climb out on the mainplane with a dip stick; therefore the electrical type of gauge was devised.

There are two parts of this instrument, a tank unit and indicator. The tank unit consists of a flanged hollow pillar, at the base of which is attached a cork float, fixed to an arm, the movement of which is pivoted horizontally, and the cork float rests upon the surface of the gasolene. The arm is free to move in a vertical plane. Attached to the pivoted end is a bevelled gear, actuating a vertical shaft. By means of this gear the vertical movement of the arm is converted

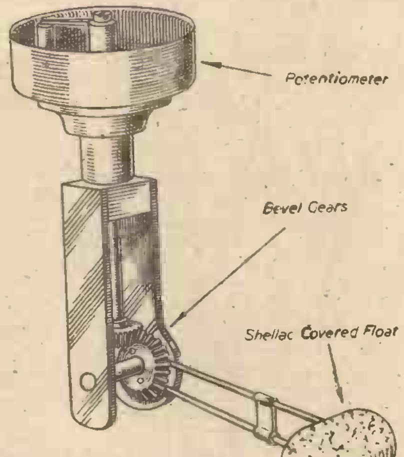


Fig. 12.—An electrical fuel contents gauge.

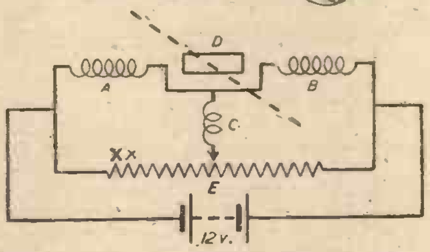


Fig. 13.—Circuit diagram of fuel contents gauge.

to a circular movement of the shaft. At the top of the shaft is attached a contact arm, made from spring steel, which moves over a circular resistance, or potentiometer (Fig. 12).

The instrument indicator consists of a soft iron armature which is pivoted centrally between three electro-magnets. These are situated 120 degrees apart. To the centre of the armature a pointer is fitted moving over a scale calibrated in gallons.

Wiring for Unit and Indicator

It will be seen, with reference to Fig. 13, that the potentiometer is connected to an accumulator and, in parallel is the circuit consisting of three electro-magnets. Since electricity will take the line of least resistance, it is obvious that, as these coils are con-

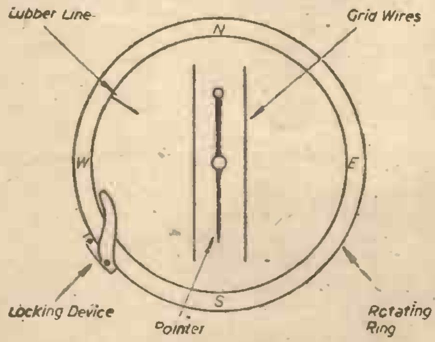


Fig. 14.—Details of aircraft compass.

nected to the potentiometer, variation of the position of the contact arm will cause variation in the field of the electro-magnets, and the soft iron armature will tend to align itself with the lines of force of the strongest field. Referring to the diagram, it can be seen that with the potentiometer arm at mid-point, no current will pass through magnet C, and the current in A and B will be equal; therefore the magnetic field of these two magnets will be equal, and the armature will align itself midway between them. In this instance, it can be seen that the pointer being attached centrally to the armature, will indicate that the tank is half full. If the petrol content of the tank is altered there will be a relative movement of the cork float and consequent movement of the spring contact arm. Assuming that the tank is full, the contact spring arm will take up the position at point X and current will now flow through electro-magnet C. Lines of force from magnet A will link with those of C, and the resultant force will cause the armature to move in a clockwise direction, thereby moving the pointer to indicate "Full." As the tank empties, the contact arm will move in the opposite direction until such time as the lines of force from C will link with those of B, showing "Empty." As the position of the arm changes, the change in resultant strengths of the magnetic fields will be gradual, and so at all times the pointer will show the exact amount of fuel in the tanks.

Owing to the difference in level of petrol in the tank when the aircraft is in flying position or on the ground, the instrument dial carries two readings, which are marked "Tail in Air" and "Tail on Ground," to compensate for this difference.

Flap Indicators

Flaps are fitted to the trailing edges of the mainplane (wings) of an aircraft. Their purpose is to increase the stalling speed of the aircraft and to assist in landing.

It is necessary for the pilot to know the exact position of the flaps at all times whilst flying, and the instrument used is similar to the petrol gauge. The flaps move through an arc, from the horizontal to the vertical, and vice versa. The installation consists, as with the fuel gauge, of two units, a potentiometer indicator and a flap indicator. A rod fitted to the flap moves over a circular potentiometer, and as the gauge is exactly similar to the petrol gauge, the operation is the same.

Electrical Cylinder Temperature Thermometer

This is provided to give the pilot an indication of the working temperature of the engine cylinders. The instrument works on the principle of the thermo-couple. When two dissimilar metals are joined together and heat applied to the joined end, minute impulses of electro-motive force are produced. By connecting the cold ends to a moving-coil meter a measurement of the voltage induced can be obtained.

Two metals often used are copper and constantin, which are found especially suitable for aircraft instruments. The pressure generated is of the order of millivolts, and in consequence the indicator is a very sensitive meter.

The heated junction or junction to be heated is attached to the cylinder at that spot where the greatest heat is developed, and one of each of the cold ends are attached to the terminals of the millivoltmeter.

The heat generated by the engine in running is transmitted through the cylinder casing to the hot junction, and the difference betwen this spot and that at which the lead terminates develops the e.m.f., causing the current to flow through the wire, thus actuating the m/c meter. As an indication it might be pointed out that a difference in temperature between the two ends of 100 c. will generate a voltage of 3.47 m/volts for a given resistance, and with the increase in this temperature difference up to 250 c. the same resistance will give 16.88 m/volts.

Since the voltage is so small any change in the external resistance of the leads will effect the calibration, and in consequence the external resistance of the leads must remain constant. To maintain this given resistance compensating leads are supplied with the instrument at a specific external resistance. To compensate for the change in the temperature of the cockpit, which takes place with changes in altitude, with variation in weather conditions and with the supply of artificial heat, a small bi-metallic spiral is attached to the pointer spindle, the other end of which is attached to a torque spring. It will be seen that if the aircraft engine has not been running for some considerable time the temperature of the day should be recorded, and this may be checked by the use of a standard glass thermometer, allowance being made for calibration. This is done by actuating a small setting screw.

The Compass (Figs. 14 and 15)

No doubt many of us, during our youth, numbered among our possessions a simple compass, consisting of a small box in which was pivoted a piece of magnetised iron, moving over a card engraved with the cardinal points of the compass.

A more elaborate piece of mechanism operating on the same principle is used in navigation. First of all it is necessary to outline briefly magnetism and its use in the compass. From early days ancient mariners were acquainted with the properties of certain metals known as lodestone. These lodestones were of soft iron, and were the forerunners of the magnetic compass as now known. The earth is a magnet, and the lines of force tend to align themselves approximately North and South. It should be pointed out that these are not the geographical North and South, but deviate some few degrees from them. The magnetic North and South does not remain in the same position but moves in a small arc with the passing of time. If a piece of magnetised iron is pivoted, it will align itself along an imaginary line connecting the magnetic North and the magnetic South, and however much outside influence tends to deflect it from this line it will at all times endeavour to return to it. This principle is utilised in the following manner in navigation.

The compass consists of a bowl containing

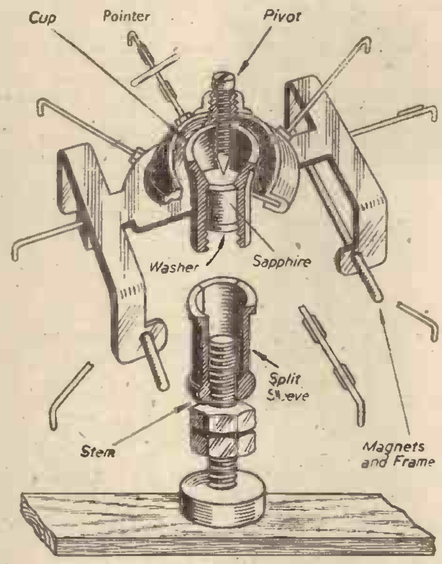


Fig. 15.—Details of compass.

a liquid consisting of a mixture of alcohol and distilled water, and this bowl is sealed with a glass cover to make it airtight. Suspended in the liquid is a magnetic needle with an arrowhead, which is free to move on a vertical axis. The end of the needle pointing N. is marked. On the top of the bowl is a movable ring around the periphery of which is a scale marked off in degrees from 0 to 360. The 0 represents the magnetic North, 90 degrees is East, 180 South, and 270 West. Other points are marked, as in Fig. 14. Two grid wires are fitted to this ring, as indicated. A small line, called a lubber line, is engraved on the underside of the glass cover. The whole ring assembly is able to rotate freely in a horizontal plane, and a locking device is fitted to lock the ring in any desired position.

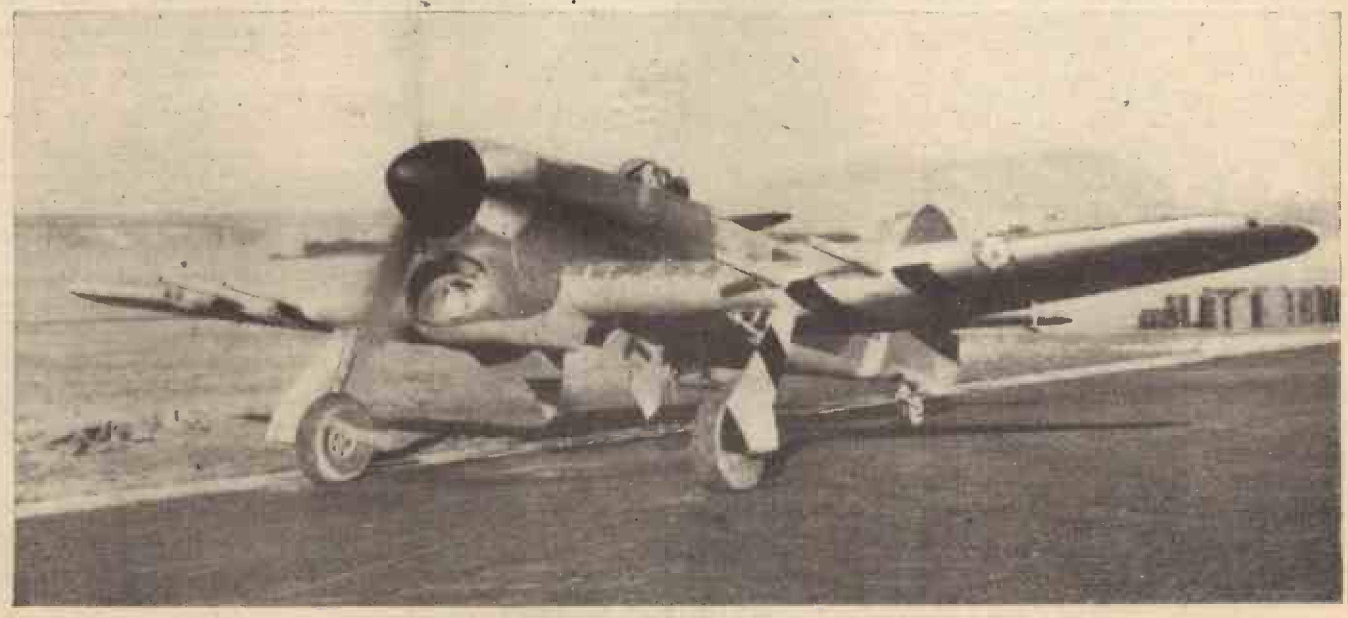
Flying by Compass

If the pilot wishes to fly on a line magnetic North or South, the ring is rotated until the 0 (or 360) is opposite the arrow head of the needle. By ensuring that the needle does not deviate from the North he will maintain a magnetic course on this bearing. If he desires to alter course, say, to due East the ring is rotated until the 90 degrees is opposite the lubber line and the compass ring locked in that position. He then turns the aircraft until the needle aligns itself centrally between the grid wires. It must be clearly understood that it is not the pointer that moves, but the bowl of the compass, and therefore the aircraft to which it is anchored that moves round the needle. It should be realised that the magnetic influence exerted by the earth on the needle is not very strong and, in consequence, the whole system is very liable to outside electrical interference. This is largely compensated for by a corrected box fitted beneath the compass. This box contains several magnets, and by altering the position of the magnets relative to the direction of the needle the outside influences are counteracted to a marked degree. This is very necessary in the case of aircraft, where there is a great deal of electrical equipment. The corrector box is not able to compensate for every influence, and a corrector card is fitted which shows the number of degrees of variation caused on all headings by such influences. The liquid mentioned earlier on is for the purpose of damping, i.e., to stop the needle from oscillating excessively. It might be pointed out, as a matter of interest, that the magnetic influence comes from the centre of the earth, and the needle actually tends to point downwards to the source of the magnetic flux. To obviate this, or at least reduce the effects therefrom, the magnetic system is suspended above its centre of gravity. This reduces the dip to within a few degrees of the horizontal.

The Typhoon Fighter-bomber

THE Typhoon fighter-bomber, with its 1,000lb. punch, has played an important part in the air offensive during the invasion of Europe.

It has already shown itself more than a match for any of its German "opposite numbers." This 'plane carries two 500lb. bombs with thin casings, which have the blasting power of ordinary bombs twice their weight. With this 1,000lb. bomb load it can fly at 400 m.p.h., nearly twice the speed at which our 1939 medium bombers carried the same weight. The new fighter-bomber is superior to the F.W.190 in that the German machine can stay over a particular target for only a few seconds, whereas our 'planes can make deep inroads over enemy territory and remain for some time over their targets.



A Typhoon fighter-bomber travelling at speed down the runway preparatory to taking off.

QUERIES and ENQUIRIES

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

Transformer for Spot-Welding

WILL you please send me particulars of the materials required to build a transformer for spot welding 22g. sheet metal? The available current is 230 volt A.C.—A. Green (Hove).

A TRANSFORMER of about 1 k.v.a. might be constructed on a core built up to 4.5 sq. in. cross-sectional area of Stalloy laminations. The primary could be wound with 360 turns of 16 s.w.g. d.c.c. wire, whilst the secondary could have seven turns of copper conductor of convenient shape, having a cross-sectional area of 0.14 sq. in., bringing out tappings at the 2nd, 4th and 6th turns. It will be understood that all the connections used on the secondary side should be as short and as heavy as possible to avoid high voltage drop.

Electric Heating for Plant Bed

COULD you tell me how to supply current to a built-up plant bed from a wet battery? The bed is about 1ft. deep. Also, what amount of current is beneficial to plants?—G. Mitchell (Bonar Bridge).

THE simplest way of heating your plant bed would be to pass current through a length of resistance wire laid zigzag fashion in the ground at the bottom of the bed. We cannot give you details of the exact current you would require for best results, but it is probable the full output of an ordinary wet primary battery would be needed. You may be able to obtain some useful information dealing with simplified heating of hot beds from the E.R.A. Report Ref. W/T7 published by British Electrical and Allied Industries Research Association, 15, Savoy Street, London, W.C.2.

"Floriation" in Brickwork

WILL you kindly inform me if there is any method to prevent salt from coming out on the walls of a house? I have tried to prevent it by continual painting, but it persists in coming out through the paint and presents a most displeasing appearance.—F. W. Kane (Belfast).

THERE is no satisfactory method by means of which you can prevent salts coming out of new bricks. This phenomenon of "floriation" of "efflorescence" is very well recognised one. It results from chemical action taking place within the brick, whereby the latter become more matured. Once these chemical actions have proceeded to finality, they cease and do not re-occur. As a general rule, the phenomenon of "floriation" takes from 9-12 months to complete itself, after which is does not occur again.

It is inadvisable to try to use any material or preparation to seal up the surface of the brickwork, as, under these conditions the salts may affect the mortar of the brickwork.

We can only suggest that you allow penty of time for this natural process to complete itself, after which, if your wall is already painted, you give it a good coating of underpaint, and finally paint over this. You can, to a certain extent, stop the floriation spreading by painting strong shellac solution (in methylated spirit) over the wall, but, in our opinion, this is not to be recommended, since the floriation must complete itself if the bricks are to become matured and stable.

Polarity Indicator

CAN you give me any information concerning the electrolyte to use in a liquid type polarity indicator, which is to be wired in series with lamps for testing power mains?

Also, what is the value of current which ought to give an indication with the electrodes (say) quarter of an inch apart in a half-inch bore tube?

What is the effect on the electrolyte should the test set be used also on A.C. mains.—R. Wilson (Aston).

YOU could use two small lead plates in a test tube containing water to which has been added a few drops of sulphuric acid, or a diluted solution of electrolyte from an accumulator. When D.C. is passed bubbles of gas will be given off from the plates, a small quantity of oxygen at the positive plate, and a large volume of hydrogen at the negative plate. In a short time the positive plate will turn brown. A current of one third of an amp. should give a good indication. When connected in series with a lamp and fed from an A.C. supply, both plates will give off an equal volume of oxygen and hydrogen and the electrolyte will become decomposed in time, that is, the water will be given off as gases.

Arc Welding Set

I DESIRE to construct an arc welding set employing an oil cooled transformer and resistance, to work on 230 volt A.C. mains giving an output range of 15 to 175 amps. Could you please give me details of the transformer and resistance required, with topping points, and also where same may be obtained?—J. Bowes (Farcet).

IN the first place it would be wise to inquire whether the supply authority will permit the use of a single-phase welding transformer of this capacity on a single-phase supply, and if so, whether the mains are large enough to carry the full load current of about 80 amps.

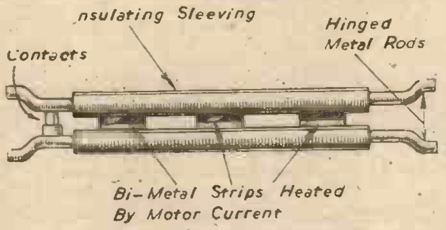
A transformer having an open circuit voltage of 100 could be made up, using a laminated core with a central limb 4in. square in cross section. The outer limb centres could be about 7in. from the centre core and the limb length about 12in. The primary could have 79 turns of conductor having a total cross sectional area of 0.05 sq. in., and the secondary could have 36 turns of conductor having a cross sectional area of 0.118 sq. in. To drop from 100 to 30 volts on full load would need a resistance of 0.4 ohms and this would need to be able to carry 175 amps., the desired tapping points could be determined by trial. It would be more economical to use a choke to reduce the voltage on load. Actually it is doubtful if there is anything to be gained by home manufacture of a transformer of this capacity, and the purchase of a complete transformer and choke equipment would, no doubt, give more satisfactory results.

Protection Against Single-phasing

CAN you enlighten me on the following subjects:

(1) Is it possible to fit something in circuit with a 3-phase motor to prevent it single-phasing? What I mean is in the event of one phase fuse blowing to stop the motor instead of its continuing to run.

(2) Could you give me details of how to build



Bi-metal device for preventing single-phasing.

a cable fault track? Should a buried cable break, would it be possible to insert a small wireless set at one end and work along with a frame aerial hearing the signal until the break is reached, when the signal would cease?—A. E. Amond (Hingham).

IN order to provide absolute protection against single-phasing you require some device which will trip the starter in the event of the current in any one supply line falling below the no load current of the motor, or in the event of the current in the supply lines becoming unbalanced. Either of these devices could be arranged to open the no volt circuit, by separating auxiliary contacts, to cause tripping.

The first mentioned device may be an electromagnet coil connected in each phase of the supply to the motor, and arranged to release an armature or plunger if the current falls to zero. The second mentioned device could comprise a bi-metal strip connected in each phase of the supply to the motor, or heated by a resistance coil connected in each phase. As the current in each phase should be balanced and equal, the strips should bend by an equal amount when the motor runs. Two insulated rods can be hinged and arranged to bear against either side of the strips, as indicated in the illustration; contacts on, or actuated by the rods, being adjusted so they are separated if the strips do not move equally. The Electrical Apparatus Co., Ltd., of Vauxhall Works, South Lambeth Road, S.W.8, manufacture single-phase preventive trips operating on these systems. It should be noted that correctly set line overload trips may be used with star-connected 3-phase motors to provide the same degree of protection against single-phasing as they do against pure overload. An overload trip coil connected in the rotor circuit of a slip ring motor, and controlling the supply to the no volt coil of the starter, will protect such a motor against single-phasing.

Provided the cable is not carried in armouring, conduit, or lead sheathing, a test set could be used in the way you suggest. The frame aerial could be made on a triangular frame having 3ft. sides, this being wound with about 200 turns of 26 S.W.G. wire connected to a telephone receiver. An interrupted current could then be passed through the faulty cable, and the aerial carried over the cable route. The note in the telephone should alter when the frame is over the fault.

Glyceryl Mono Stearate

CAN you please answer the following questions:

1. How can I make glyceryl mono stearate and diglycol stearate?

2. What is a suitable solvent for copper stearate?—P. Fletcher (Widnes).

(1) GLYCERYL mono stearate may be prepared by heating stearic acid with excess of glycerine at 220 deg. C. as long as the mass continues to increase in volume. When this action stops, the product is allowed to cool down and its upper layer is collected and recrystallised first from alcohol and then from ether. Needles of glyceryl mono stearate are thus obtained. They are soluble in warm alcohol and/or ether. The mono stearate may also be purified by distillation *in vacuo*.

Diglycol stearate may be prepared by heating silver stearate with ethylene bromide for two or three days at 100 deg. C. The product is extracted with ether and is thereby obtained in the form of shining scales, resembling stearin.

Both glyceryl stearate and glycol stearate are commercial commodities and may be obtained from Messrs. A. Boake, Roberts and Co., Ltd., Carpenters Road, Stratford, London, E.15.

(2) The best solvent for copper stearate is warm naphtha. Turpentine and linseed oil are also solvents.

Colloidal Suspension of Iron

WOULD you please inform me where I could obtain colloidal suspension of iron or how could same be made at home? Could pyrophoric iron be introduced into some liquid to achieve same result?—G. Carden (Wembley).

TRUE colloidal suspensions of iron are not obtainable commercially. They are very difficult to prepare on account of the oxidisability of iron in presence of moisture. The best way of preparing such suspensions is by forming an electric arc under water (containing a little ammonia) between two iron electrodes. Colloidal iron suspensions cannot be obtained merely by introducing pyrophoric or other forms of finely-divided iron into water.

What is commercially known as "dialysed iron," or, sometimes, "colloidal iron," and is, in reality, a colloid suspension of iron (ferric) hydroxide, is obtainable from any firm of chemical suppliers as, for instance, Messrs. Harrington Brothers, Ltd.; Oliver's Yard, City Road, Finsbury, London, E.C. The price (pre-war) was about 1s. per lb. Despite its popular name, however, this preparation is definitely not a true suspension of metallic iron. It is a colloidal suspension of iron hydroxide, and, as such, has its uses in medicine and as a chemical reagent.

Books on Metallurgy

(1) CAN you recommend any good books on Metallurgical Chemical Analysis and a dictionary or encyclopædia on Metallurgy, not just the metals, but metallurgy as a whole?

2. I should also like to know of any good charts on Qualitative and Quantitative Analysis.—H. Crockett (London, S.E.).

(1) THERE is no published dictionary or encyclopædia dealing with the entire subject of metallurgy. The nearest approach to such an encyclopædia is the "Dictionary of Metals and Alloys," edited by F. J. Camm (Messrs. George Newnes, Ltd.). Alternatively, "Handbook of Metallurgy," by C. Schnabel (2 vols., 25s. each), might suit your needs.

Suitable books on metallurgical analysis are the following: C. H. White: "Methods of Metallurgical

Analysis" (16s.); N. W. Lord: "Metallurgical Analysis" (24s.); F. Ibbotson and L. Aitchison: "Analysis of Non-ferrous Alloys" (12s. 6d.); Lundall, Hoffman and Bright: "Chemical Analysis of Iron and Steel" (33s. 6d.); W. Macfarlane: "Practical Guide to Steelworks Analysis" (9s.); J. Park: "Practical Assaying" (9s.).

All the above works are expensive, but you might be able to obtain secondhand copies of some of them from Messrs. W. and G. Foyle, Ltd., Charing Cross Road, W.C.2. Alternatively, you could request your local library to obtain some of them for you.

2. There are many books on chemical analysis, both qualitative and quantitative. For your purpose, however, we imagine that any of the following will be most useful:

Qualitative Analysis.—Dobbin and Marshall: "Salts and their Reactions" (6s. 6d.); G. W. Sears: "Systematic Qualitative Analysis" (10s.).

Quantitative Analysis.—W. F. F. Ahearcroft: "Quantitative Analysis" (2s); Clowes and Coleman: "Quantitative Chemical Analysis." The latter is a standard, albeit somewhat advanced work on the subject.

Silver and Chrome Plating

I WISH to electro-plate, silver-plate or chrome (chrome preferred) the following metals: brass, aluminium, or copper, these being models I have made. Could you inform me of the best way to make apparatus and material, also cost?—Sidney Kay (Warwick).

OWING to the difficulty of obtaining the chemicals used in plating chrome and other metals at the present time, we fear that you will not stand much chance in obtaining such materials direct from suppliers.

In our opinion, your best plan will be to communicate with Messrs. W. Canning and Co., Ltd., Birmingham, and to ask whether they can supply you with their ready-made plating salts for copper, silver, cadmium and other types of metal plating. These ready-made salts used to be prepared at quite a low price by Messrs. Canning, who are experts on the subject, and if you can procure these, together with the issued instructions for their use, you will have far more success at plating than would be the case if you relied upon the use of copper sulphate for copper plating, silver nitrate for silver plating, nickel ammonium sulphate for nickel plating, and so on.

In any case, however, before you commence plating you should study up the subject by referring to some technical book such as may be found in your local reference library.

Testing Minerals for Precious Metals

I WOULD be glad to know if there is a simple inexpensive method of testing samples of rocks, sand, etc., for precious metals such as gold, silver, platinum, and, if so, what it is.—R. Johnson (Rathmines).

THERE are no simple or easy means whereby precious metals may be detected with certainty in minerals and rocks. The analysis of minerals and other deposits calls for considerable chemical knowledge, some of which you might be able to acquire from a perusal of a textbook such as T. Crook: "Economic Mineralogy: A Practical Guide to the Study of Useful Minerals" (25s. net). It is obviously impossible for us within the space of a single reply to give you all the various tests which have to be made for precious metals such as platinum and gold. All we can say on this subject by way of guidance is that platinum and gold generally occur in the metallic condition, and as such they are insoluble in concentrated nitric acid. Much of the yellow glistening material which is often found in minerals and which is frequently mistaken for gold consists of iron pyrites (iron sulphide), which is readily soluble in acids. Platinum and gold are only soluble in a mixture of nitric and hydrochloric acids. Silver often occurs in lead ores and cannot be distinguished by sight. It dissolves with the lead in the ore and is only to be separated from the lead by a chemical process.

We are sorry that we have only been able to give you such meagre information, but the subject which you have touched upon in your query is a vast one and it cannot possibly be comprehended by any short answer, or otherwise reduced to a set of guiding rules.

Celluloid Varnish

COULD you tell me how to dissolve Cellophane? I wish to use it as a varnish. I have tried celluloid varnish for this job, but it is of no use. This varnish is not intended for glass, but an absorbent surface.—T. G. Brain (Highgate).

ONE of the most valuable properties of Cellophane is its essential insolubility and, this being the case, it is impossible to make up a varnish from it. Cellophane is a specially manufactured form of cellulose. It is insoluble in alcohol, ether, acetone, amyl acetate or other similar compounds. Any solvent which might be found for it (such as one containing caustic soda), would destroy the nature of the material, and make it useless for your purpose, or for any other use.

We would suggest, therefore, that you prepare a thin celluloid varnish by dissolving scrap celluloid in a mixture of 2 parts of acetone, and one part of amyl acetate. This varnish would have the properties which you desire.

Orchid Spores

CAN you inform me of a firm who could supply me with some orchid spores, and of the method by which they are grown in test tubes? I would also like to know the temperature needed for growing the spores of the Odontoglossums, Cattelyas, Dendrobiums and Miltonias. Could you also tell me of a firm where I could obtain some tropical water lilies.—J. A. Poole (Lawford).

YOU will find it very difficult to obtain orchid spores at the present time. You might, however, make inquiries from the following firms:

Messrs. Bees, Ltd., Liverpool; Messrs. E. Gerrard and Sons, 61, College Place, Camden Town, London, N.W.1; Mr. L. Haig, Beam Brook, Newdigate, Surrey; and Messrs. De Von and Co., 127, King's Cross Road, London, W.C.1.

Failing satisfactory results from any of the above, apply direct to The Director, The Royal Botanical Gardens, Kew. From Messrs. De Von and Co. (above mentioned) you may be able to obtain tropical water-lilies.

Orchids can be germinated from their spores in test-tube culture media of gelatine, but this is not a good method. In fact, every species of orchid really requires separate and distinctive culture for its germination, and the particulars of such can only be given by the supplier of the orchid spores, unless, of course, you refer to a textbook on orchid culture, particulars of which latter could be forwarded to you on application to Messrs. W. and G. Foyle, Ltd., Charing Cross Road, London, W.C.2.

Anti-gas Filter for Shelter

I SHALL be glad if you will give me information regarding the installation of an anti-gas filter and pump for my Anderson steel shelter.

(1) What is the composition of the filter (including protection for the new "smoke gas"), and what quantities are required?

(2) What is the most suitable type of pump to use?

Quantities and sizes should be based on the assumption that the full complement of eight people may be using the shelter at any one time.—F. H. Laver (Sheffield).

(1) Most anti-gas filters in use nowadays are composed of activated charcoal sewn up in flat cloth discs of coarse muslin. The charcoal or carbon is specially prepared and it cannot be made at home, but you may be able to obtain it from a firm specialising in this class of material such as Messrs. Sutcliffe, Speakmann and Co., Ltd., Leigh, Lancashire. The composition of the new smoke filters for attachment to gas masks has not been disclosed, but it probably contains a mixture of shell charcoal and potassium permanganate or some similar oxidising agent.

In our opinion, it is always a very difficult (and often an impracticable) proposition to instal a gas filter in an Anderson shelter, because the shelter cannot be made sufficiently air-tight. If, however, you wish to make experiments in this direction, you should obtain a small drum or can holding about 7lb. of material. This should be fitted with perforated ends and it should contain about 5 or 6lb. of activated charcoal mixed with about ½lb. of powdered potassium permanganate together with a little dry slaked lime. The material should be sewn up into a number of flat muslin discs. These discs are packed very carefully into the container, some inert spacing material such as pot fragments being placed between them to keep them out of actual contact and to make a free way for the air which is drawn through the container.

(2) An ordinary hand pump may be used with such a device, but it is rather better to blow or suck the air through by means of a small electric fan.

No special pumps for the above purpose are on the market, and, as we have already remarked, the whole subject of gas-proofing an Anderson shelter in the manner you suggest is a very difficult one. It is probable that your experiments will not be very successful. Nevertheless, provided that you do not spend a great deal of money on the matter, we think you will gain much interest by continuing your trials.

Treatment of Dry Rot

I SHOULD be much obliged if you could furnish me with the following information regarding the treatment of dry rot in wood.

I understand that magnesium silico fluoride and sodium fluoride have been used in the treatment of dry rot and should like to know if these are to be recommended (a considerable area has to be treated).

Where could such substances be obtained and what would be the approximate cost per lb.? What concentration of solution should be used?—W. Clarkson (Falkirk).

THE eradication of dry rot from woodwork is usually a difficult and uncertain matter, since dry rot is caused by a fungus which insidiously spreads itself through the inner fibres of the wood. A large number of various compounds have been tried for the cure of dry rot, and whilst many give good results, we are of the opinion that none of these can give an absolutely certain cure.

Wherever possible, woodwork infected with dry rot should be rigorously cut away and burnt immediately.

The precise chemical treatment of dry rot depends to a large extent upon the type and situation of the wood. For instance, a simple treatment with ordinary creosote oil, applied liberally and hot to the wood, will cure the dry rot, but, naturally such treatment may not be possible in every instance in view of the staining properties of the creosote. A solution of zinc naphthenate in naphtha, say 1lb. of zinc naphthenate in a gallon of naphtha, will also prevent dry rot attacks, and will actually kill the fungus.

Solutions of sodium fluoride and magnesium silicofluoride may be applied to the woodwork in concentrations of about 1lb. of the salt to a gallon of water. Such solutions (as, also, a solution of zinc chloride and copper sulphate) are quite good so far as they go, but in general water solutions such as these do not penetrate sufficiently into the wood to be thoroughly effective.

We would advise you, therefore, not to use such solutions but to employ zinc naphthenate dissolved in naphtha, as directed above. This solution is non-staining, and it should be applied hot. If a staining liquid is not objected to, use ordinary creosote, also hot. These two liquids penetrate deeply into the wood and are much more effective than any aqueous solution. Zinc naphthenate (or copper naphthenate) may be obtained from Messrs. A. Boake, Roberts and Co., Ltd., Stratford, London, E.15, price about 1s. 6d. lb. Naphtha can also be obtained from this firm, but you should also be able to obtain it locally (price about 4s. gallon), and thus save carriage costs.

Sodium fluoride costs about 1s. lb. and magnesium silico fluoride about 2s. 6d. lb. Both of these may be obtained from Messrs. Harrington Bros., Ltd., Oliver's Yard, City Road, Finsbury, London, E.C.1.

Bear in mind the fact when treating dry rot affected woodwork with any solution, that the solution should be applied hot and liberally, and if possible several applications should be made. Particularly take care to apply the solutions to the ends of the woodwork, since it is at these areas that the liquids are best absorbed. If at all possible, bodily immerse the woodwork in the liquid for several hours.

Urea-formaldehyde Cement

I SHALL be extremely obliged if you will let me know:

(1) The cost of urea-formaldehyde cement per lb.

(2) Method of manufacture, including proportions of carbon dioxide, ammonia and formaldehyde.

(3) A good casein (powder) mixture to make moulded objects.

(4) Parting medium in moulding urea-formaldehyde articles?—G. Reynolds (Kingsbury).

(1) There are many types of urea-formaldehyde cements and varnish-cements, and we are somewhat at a loss to know the precise type to which you refer. However, their prices (pre-war) range from 1s. 6d. to 3s. 6d. per lb., and you will be able to obtain their present-day costs from any of the following firms: Bakelite, Ltd., 68, Victoria Street, London, S.W.1; Imperial Chemical Industries, Ltd., Millbank, London, S.W.1; A.B.C. Plastic and Moulded Products, Ltd., 61 and 63, Old Compton Street, London, W.1.

(2) The manufacturing process of all these cement products is retained more or less secret, particularly in the case of the newer products at the present time. All we can tell you is that the urea is condensed with about twice its weight of formalin in the presence of caustic soda. Usually, the condensation reaction goes on under slight pressure, say under a pressure of 1½-2 atmospheres. A study of recent patent literature might assist you, but we doubt whether you will be able to obtain details and quantities concerned with actual manufacturing operations.

(3) A suitable moulding powder such as you require may be made up according to the following formula: Casein powder (moulding type), 3 parts; filler, 3 parts. The filler may comprise almost any fine fibrous material, such as micro asbestos, mixed with an equal weight of kieselguhr, wood flour, pulp, and/or pigment, such as chromium oxide, iron oxide, etc.

You will probably be able to get your casein material from Afcon, Ltd., 32, Victoria Street, London, S.W.1; or from Erinoid, Ltd., Lightpill Mill, Stroud, Glos.

(4) As a "parting medium" in moulding plastic articles, we suggest that you use stearic acid, or high grade castile soap powder. These are usually effective in all cases of mouldings.

Electric Light Plant

I WOULD be obliged if you would answer the following questions:

(1) If it is impossible to get A.C. supply by grid system to proposed electric plant of roughly 150 h.p. in units of 10 to 30 h.p.? Would a 250 h.p. 6-cylinder Diesel engine, running at 600 revolutions, be large enough to drive an alternator and supply current to switchboard, etc., so as to drive above mentioned plant?

(2) Can you tell me the usual units necessary to supply A.C. current at 400 volts 50 cycles in this fashion? Consumption to be approximately 100 kilowatts at full load.

(3) What is the correct definition of K.V.A.?

(4) Would it be necessary with above plant to also have small I.C. engine, dynamo and batteries to carry lights?—R. T. Brompton (Farnley).

(1) ASSUMING the motors are used as nearly as possible on full load, and that fairly high speed motors are used, the alternator would need a capacity of about 175 k.V.A. Such a machine could easily be driven by a Diesel engine having a b.h.p. of 250.

(2) The alternator would need an exciter, or small D.C. dynamo, to supply its field windings; and this exciter could be direct coupled to the engine and alternator, or could be driven through belt from the engine. You would need a main switch to control the output of the alternator, this being fitted with an overload trip in each of the three phases. A voltmeter and ammeter would be required, together with a field regulating resistance to control the voltage. The main switch should feed auxiliary switches, each with an overload trip in each phase, or could feed a large distribution fuse box. This distribution gear could feed direct to the motor starters, each of which should have overload trips and a no volt trip.

(3) k.V.A. is the apparent power input or output of an electrical machine. In the case of a single-phase machine the calculated k.V.A. is $\frac{\text{volts} \times \text{amps}}{1,000}$; and in a 3-phase machine k.V.A. is $\frac{1.732 \times \text{volts} \times \text{amps}}{1,000}$, where the voltage is measured between any two phases. Kilowatts is equal to k.V.A. × power factor. k.VA. is a measure of the capacity of an alternator, since the current output is limited by the size of the conductors; but K.W. is a measure of the true power output or a measure of the power required to drive the alternator, neglecting losses.

(4) With a 3-phase 400 volt alternator it is usual to bring out the neutral point of the windings to a terminal on the machine. Lighting circuits can then be connected between any of the phases and the neutral terminal, as there will be 230 volts between these points. However, as presumably you will require a lighting supply when the alternator is not working, you could obtain this from a battery which could be charged by a separate dynamo or from the alternator through a suitable A.C. to D.C. rectifier.

Copper Plating on Steel

I WISH to copper plate a quantity of small mild steel clips which have a covering of rust on them. Can you give me a formula for both removing rust and coppering?

I presume the method to be caustic wash (to remove oil) pickle, wash, copper coat and final wash (hot water) and intend using a fish frying basket for the clips.—S. Pope (Stirling).

WE think you should have no trouble in removing the rust by boiling the clips in a 20 per cent. caustic soda solution, or by immersing them in a mixture of approximately equal parts of strong commercial sulphuric and hydrochloric acids, or, alternatively, in "dipping" acid. The clips must, of course, be thoroughly well washed afterwards.

In order to copper plate them you may use a solution containing about 6 oz. of copper sulphate to the gallon of water, the solution being acidified with a little sulphuric acid. This solution, however, is liable to give a loose deposit of metal, and the following solution is far better:

Copper carbonate	5 oz.
Sodium cyanide	10 oz.
Sodium thiosulphate ("hypo")	1/32nd oz.
Water	1 gall.

Sodium cyanide is highly poisonous, but you may be able to obtain it (on stating the purpose for which it is required) from Messrs. Harrington Bros., Ltd., Oliver's Yard, City Road, Finsbury, London, E.C.1. The other materials may also be obtained from the same source.

The above solution should be used at a temperature of about 100 deg. F. Use a copper anode and a current of about 2 volts at 4 to 6 amps.

Messrs. W. Canning & Co., electroplaters, of Birmingham, also manufacture special copper plating salts, which will well serve yout purpose, particularly if you cannot obtain sodium cyanide.

The following is a method of plating the clips with copper without the use of an electric current. We do not guarantee its efficiency, but we think it is worthy of a good trial:

De-rust the clips by dipping. Afterwards wash well. Place them in hot water at 200 deg. F. for five minutes, and then immerse them in the following solution at 200 deg. F. for a further five minutes:

Water	1 gal.
Caustic soda	4 oz.
Trisodium phosphate	2 oz.

Rinse the clips in cold running water. Then immerse them for 20 seconds in a 50 per cent solution of hydrochloric acid. Again rinse in cold running water and immerse in the follwing plating solution until the desired copper deposit is obtained

Copper sulphate	1 oz.
Sulphuric acid	1½ oz.
Water	1 gal.

Finally rinse the clips in cold water. Then transfer them to a hot soap solution, and again rinse them in hot water. Dry the clips in warm sawdust.

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

Design and Layout of Roads in Built-up Areas

SOME striking recommendations are made in a memorandum on the "Design and Layout of Roads in Built-up Areas," submitted to the Ministry of War Transport, at their invitation, by the Council of the Roadfarers' Club. The main points are here summarised.

They state that accidents are not primarily due to carelessness on the part of motorists or cyclists, but that there has been a great deal of carelessness on the part of pedestrians. We do not hear anything of the thousands of accidents which are avoided by careful motorists and cyclists. It is true to say that, but for the general care exercised by motorists and cyclists the accident rate would be far higher. Often, accidents are caused by vehicular traffic travelling at reasonable speed having suddenly to swerve to avoid a careless pedestrian; thus, in skilfully avoiding one accident, another is often unavoidably caused. It is their view that, if regulations can prevent accidents, they should be made equally applicable to all road users. At present it is impossible for a pedestrian to commit an offence in relation to road use. Responsibility should be shared by all.

The Roadfarers' Club thinks the speed limit should be abolished, and with it built-up areas. It must be apparent that the experiment of the built-up area, which in London alone has reduced average speed to about 8 m.p.h., has not contributed anything to road safety. Neither have pedestrian crossings and traffic lights. It is their view that a succession of traffic lights along any main thoroughfare, for example, Oxford Street, must act as a series of dams and cause the traffic stream to overflow its banks. They think that traffic is safer if kept fluid and apart, not uselessly coagulated by an arbitrary red signal which brings traffic to a stop, irrespective of whether other traffic wishes to cross.

Control of Pedestrians

IT must now be realised that roads are made primarily for traffic and not as footpaths, and if the accident rate is to be reduced it would appear that some measure of control of pedestrians in relation to their use of the road is inevitable. The law as it stands has been designed to enable pedestrians to continue to be careless without risk of prosecution, although unfortunately there is considerable risk of injury or death. They fail to see why pedestrians should cheerfully accept this risk and refuse to accept the concomitant responsibility, not only to themselves, but to other road users. They subscribe to the view that the roads are free for all to use, but they should not be used carelessly, or in such a manner as to endanger others.

Road islands should be abolished. They create a series of bottle necks along the road, and thereby form a number of danger points. Particularly is this so in very narrow roads.

Horse-drawn Traffic

ON a long-term policy horse-drawn vehicles should be prohibited from the streets of busy towns and cities. They are slow moving, and in conjunction with traffic lights and other devices introduced to slow down traffic, have reduced travel in busy places to a farce.

Bus Stops

THEY think that buses and trams should not be permitted to stop at traffic lights, but far beyond them. They are aware that a committee investigated this matter and suggested the present stopping places, but think the adoption of their recommendation was ill advised. Quite often when the lights are green the bus will stop to put down or pick up passengers. Following cars cannot pass because of the presence of an island refuge, and by the time the bus is ready to start the lights have turned to red, causing considerable delay and further traffic congestion. It should also be made an offence for public service vehicles proceeding in opposite directions to stop opposite one another, thus bottle-necking the road and creating conditions where accidents may occur.

Wood Blocks

THEY are aware that the Ministry of Transport has already advised against the further use of wood blocks. These are particularly dangerous. They wear shiny in a very short time and cause skids; in heavy rain they spring out of position and cause lengthy traffic delays and traffic diversion.

The Gyratory System

AFTER several years of experiments, they do not think that a case can be made out for a continuation of the gyratory system. Hyde Park Corner provides a good example of the gyratory system, which merely transfers the original danger points to other points. It does not get rid of them, and, additionally, it creates a number of other dangerous scissor cross-overs and one or two dangerous hair-pin bends.

Parking

COLLATERAL parking of cars should be permitted. There are insufficient parking places in towns and cities, and far too much prosecution of motorists who, using their cars for business purposes, thus cannot help breaking the law. The two-hour parking place a bus ride away from the driver's destination is not a fair or reasonable solution.

Fly-over Crossings

THEY realise that it must take many years to re-plan London, and they endorse the views of Sir Charles Bressey, which are set down in his report, and therefore there is no need to repeat them. They think, however, that fly-over crossings are the real solution to the problem of the cross-roads, with over-bridges and subways for pedestrians, the use of which should be made compulsory.

Kerb Heights

KERB heights should be standardised, and the sharp, exposed edge should be replaced by a rounded one. Many accidents are caused by people stumbling from the pavement due to deep kerbs, where they had anticipated one of normal height. Such high kerbs also cause damage to the running boards and wings of cars.

Colour of Road Surfaces

EVERYONE is agreed that a whitish road surface is best for travel at night, and they think the use of the tarred surface should be abolished. It is now possible to build roads with whitish surfaces which are reasonably dust-free. They appreciate that in addition to the colour the nature and durability of the road surface must be taken into consideration, but it is their opinion that the concrete surface is acceptable to motorists and to cyclists.

Traffic Density

IT is their firm view that most of the accidents in built-up areas have been caused by the methods adopted to reduce them. It is well known that the black spots in London, for example, occur where the traffic is densest, and therefore slowest.

Accidents increase owing to the extra traffic density at the rush hours in the morning, at midday and in the evening. The City of London, in fact, has more fatalities per square mile than the square mile of any other borough in London, and these accidents have increased as so-called safety measures have increased.

Scientific Research

THEY support the plea of Lieutenant-Col. Mervyn O'Gorman for scientific research into the cause and cure of road accidents, and into the design and construction of roads. Up to the present there has not been scientific research of this nature, although numbers of borough surveyors and associations have submitted valuable memoranda.

Road Signs

THEY think there should be fewer road signs and traffic directions. They think that many of these would vanish if the fly-over crossing system were adopted. The club is of opinion that flashing electric signs and reflected roadside advertisements should be prohibited. The driver's attention should not be diverted from the road by unnecessary traffic directions, nor distracted by advertisements.

Street Name Placing and House Numbers

URBAN authorities should be compelled to put up the five nameplates that are essential to every street junction. The hesitant searching for a particular house or a particular turning, perhaps a sudden braking when these are observed, provide the possibilities of accidents. The names of street turnings should be let into the road and provided with reflectors so that they can be seen at night. All houses should be clearly numbered on the outside, and the naming of houses abolished. Houses should be only located by means of numbers, all fixed at standard height and of standard size.

Road Cambers

NO one has yet decided what is the correct width for a street, and until this is decided the correct degree of super-elevation cannot be determined. There should, however, be a standard super-elevation on all roads of the future, and particularly on bends; the banking should be as on a race track.

Railway Crossings

THERE are nearly 3,000 railway crossings operating across the roads of this country. It is impossible to plan roads whilst this state of affairs is allowed to exist. The railways on a long-term policy should be compelled to carry the roads over the lines.

Toll Bridges

IT is high time that all toll roads and toll bridges were abolished.

Cycle Paths

WHERE possible, properly constructed cycle paths should be provided. They are aware of the criticisms of cyclists towards some of the cycle paths at present constructed, e.g., the Great West Road. These cycle paths debouch cyclists on to the main roads at the very points known to be dangerous, namely, crossings. Also, these paths are cut up by runways into private garages and works. Such are little safer than the main roads. They do not think, however, that cyclists are justified in opposing the principle of cycle tracks. The cyclists maintain that they are being segregated from roads which they have a perfect right to use, and that motorists should be segregated to special motorways. Apart from the fact that it is easier and cheaper to provide tracks along existing roads, the construction of special motorways throughout the country is a practical as well as financial impossibility. If the road problem is to be solved every section of road user must be prepared to make concessions.

The Divided Road

THEY are in favour of the divided road for purposes of segregating traffic proceeding in opposite directions.

Pedestrians

THE roads should contain provision for overbridges and subways, the use of which should be made compulsory. This alone must considerably reduce the number of accidents, for the majority of accidents occur to pedestrians.

Fog

ROADS should contain some means of guiding road traffic during fog. As it is, during a thick fog, traffic is brought practically to a standstill. Such traffic as proceeds is a danger to other road users. It is well known that accidents increase during fog. At crossings and turnings some system of reflecting paint or reflectors should be employed. In this connection they feel that the headlights of cars are placed far too high. They could be lowered by at least 12in., to give a clearer view of the road, and would also help in normal driving conditions to eliminate dazzle

Around the Wheelworld

By ICARUS

By Eaton Bray Church, Beds.

The Bricknell Gear

MY old friend Jack Masters, one of the early racing cyclists, has sent me an interesting cutting, detailing his experiments with the Bricknell Hand Gear. This gear was attached to the handlebars and assisted in propelling the machine. I quote the letter as it appeared in "The Cyclist" for December 18, 1901.

"Some months ago there appeared in your columns a letter from a correspondent regarding his experience with the Bricknell hand gear. I had at the time been riding the gear for some time, but I thought I would give it a more extended trial before passing an opinion.

I have now been using the hand gear continuously for the past twelve months, during which time I have ridden it a considerable distance, and my experience has only further strengthened the opinion I formed, when reading your correspondent's letter, that his actual experience of the gear was very limited indeed. As far as I can remember (I am writing from memory), some of his objections were: (*a*) loss of power on hills when hand and foot gear do not synchronise; (*b*) gear getting choked with snow, dust, and mud; (*c*) noise of gear in running. The first objection tends to bear out my opinion that your correspondent's trial was not a very lengthy one, as I admit that when first using the hand gear, this feeling of loss of power is apparent, but it entirely disappears when the muscles of the arms and shoulders have become sufficiently accustomed to the unusual movement to enable the rider to work the gear effectively. Your correspondent further stated, I believe, that he was not over strong, particularly in the back, and he could, therefore, hardly expect to obtain much advantage from the gear until by its continual use he had sufficiently strengthened those parts of the body which the hand gear brings into play, any more than a man rather weak in the back and legs could expect to become a 'flier' without very extended exercise to develop the weak parts.

With regard to the second point, although I have ridden the hand gear in snow and slush, dust, and some of the greasiest and thickest mud I have ever met, I have never had occasion since I started riding the gear to clean out the teeth; nor do I see how it is practicable that with ordinary usage the teeth could become choked, as the meshing of the teeth is quite sufficient to keep them clean and drive out any foreign matter in the same way that the inner surface of a naked chain is kept clean and bright.

With regard to the noise, I find that if properly adjusted and carefully fitted, the gear works very quietly; far quieter, in fact, than a good many chains one meets. Sometimes when riding fast over rough cobbles, etc., a slight rattle is naturally apparent, but only when riding fast on a rough road. The gear must, however, be carefully fitted, as, otherwise, doubtless it would be noisy.

My opinion, after a full season's riding, is that the advantage of ten per cent. claimed for the Bricknell gear is fully experienced if the rider will only have the patience to educate himself, as it were, to its use. Over one of my favourite short rides for tests of all sorts, from near the G.P.O. to Hatfield and back about forty-two miles by the route I take), I have repeatedly beaten the best times I have done without the Bricknell by from 15m. to 30m. Taking the outward journey alone, I have beaten this by 23m. I merely cite all this, as it is a ride over which I can make very trustworthy comparisons, but I have found the same result over other rides where I have been able to compare the times. On long rides I have frequently experienced a gain in speed, whilst finishing considerably fresher than I have done with the fixed handle-bar; in fact, last August, after a ride of 140 miles through the Kentish hills, during which my riding average was fourteen miles per hour, I was surprised to find how fresh I felt at the finish.

Under adverse circumstances (mud, wind, etc.), the gain in ease of propulsion becomes very apparent, as here one is more inclined to ride one's ordinary pace, and then the lessening of fatigue with the Bricknell becomes very marked. I have also, like Mr. Knipe, found the gear a great preventive of sideslip, which I attribute to the driving motion given to the front wheel instead of its being pushed from behind.

I have not found the motion of the handlebar at all unpleasant or disconcerting; in fact, rather the contrary, as one can feel the direct result of pulling on the handle-bar, as most cyclists do when putting forth even a slight effort.

In conclusion, I may add that I have no interest whatsoever in either the British Cycle Hand Gear Co., or in the sale of the Bricknell gear. I ride it (as do four or five of my friends) simply from choice, as the result of conviction that it will prove of material assistance, and from my experience (which is fully endorsed by the friends above referred to) I can say that I would not now ride without the hand gear, as I find that the disadvantages urged against it are completely outweighed by benefits to be obtained by using it consistently."

It is Not Hume's Bicycle

I HAVE on more than one occasion referred to the Bartleet collection of old bicycles. You will remember that I preferred to refer to Bartleet as the librarian of cycling. He relied for his knowledge on press cuttings which were often wrong. Bartleet collected a number of very old machines, but he was not too careful in his labelling of them. One of those machines, as shown in plate 55 of his book, purports to be "the actual bicycle ridden by W. Hume at the Queen's college sports, Belfast, on May 18, 1889"—the date of the first race on pneumatics. Now I have pointed out before that this is wrong, and when Bartleet's collection was presented to Coventry, I at once wrote to Major Watling, director of British Cycle and Motor Cycle Manufacturers and Traders Union, Ltd., pointing out the many inaccuracies in Bartleet's collection. There are many of us who know how inaccurate Bartleet was, but I am more interested now in posterity. Unless the matter is put right at once, in 100 years' time these things will be accepted as fact. Coventry, the home of the bicycle, does not, I am sure, wish to appear stupid, and it must believe me when I say that some of Bartleet's collection is inaccurately labelled.

At the Roadfarers' luncheon the other day, one of the members who was present at that historic race in Belfast in 1889, and took part in it, stated in the presence of several members that Hume's bicycle is now in the Belfast Museum! The machine in Bartleet's collection, which he claimed to be Hume's bicycle, was the property of Sir Arthur Du Cros. He went further; he stated that *Bartleet was well aware of this fact*! Moreover, the original wheel on which Dunlop fitted the first pneumatic tyre is in the Edinburgh Museum. One would be led to believe from the label near the front wheel of Bartleet's alleged Hume's bicycle that that front wheel also had the original tyre fitted to it by Dunlop.

Bartleet's collection is now, I understand, in Allesley Hall. It was never sent to Willoughby. Now I think the time has come when a committee of investigation should be appointed to verify Bartleet's claims.

Endangering the Sport

THE following letter which I have received from the Events Secretary of the London Section of the B.L.R.C. speaks for itself:

"It may interest some of your readers to learn that a recent 25 promoted by the Southern Coureurs, B.L.R.C., which attracted nearly 80 entries, was cancelled on the advice of the police. The reason given was, that this particular road, a main artery to the south coast, was being extensively used by the military authorities for transporting invasion convoys. The Chief Constable of the area concerned expressed the hope that it would be possible to promote the race at a later date.

The following week-end, another 25 was promoted, not by a B.L.R.C. adherent club, over exactly the same course. Shortly after the start of the event, a convoy approached and continued throughout the duration of the race, the riders having to turn literally in the convoy. No untoward incidents arose.

It would appear, however, upon reflection, in view of the B.L.R.C.'s policy of police notification of events, slightly incongruous to level the charge of endangering the sport, at one particular organisation."

N.C.U. Touring Handbook

I HAVE received a copy of the N.C.U. Touring Book for 1944. It contains up-to-date lists of recommended establishments throughout the country, as well as pages of useful matter to the tourist. It costs 10d. by post to club members and associates, but is, of course, free to private members.

N.C.U. Gold Badge Awards

THE Emergency Committee, at their meeting in Manchester on Saturday, June 3rd, 1944, approved the award of the Gold Badge of the Union to Mr. L. F. Dixon, of the London Centre, in recognition of his many years of service, and also to Mr. H. Crookes, hon. secretary of the South Yorks and North Derby Centre. It is claimed on behalf of Mr. Crookes that he holds the longest period of honorary official services of any Centre secretary, having been hon. secretary of the South Yorks and North Derby Centre for over 30 years.

R.T.T.C. Notices

A MEETING of the National Committee, R.T.T.C., was held recently in London, and the following decisions have been announced.

All entrants in National Championship events must have been normally resident in England, Wales, or Northern Ireland for a period of not less than three months prior to the date of entry.

As from July 15, performances by riders who enter on the line in events included in this competition will not count for the purposes of the table. The competition will be restricted to the performances of those riders whose names appear upon the starting card as issued to competitors in the event.

It is a condition of the competition that events limited by the promoters to less than 60 entries are not eligible. As some misunderstanding has arisen regarding this condition, the National Committee wish to make it clear that provided an event is open for the acceptance of between 60 and 100 entries the riders' performances are included in the table whether or not the actual number of entries received is below 60.

Herne Hill—August Meeting

THE Herne Hill Management Committee announce the following programme for the Opening Meeting on August 5th, 1944 (not necessarily in the order given, which will be published later).

Event No. 1—Half-mile handicap (President's).

Event No. 2—1,000 metre championship.

Event No. 3—5 miles championship (24 selected riders).

Event No. 4—2 miles team pursuit race. Four teams from Centres.

Event No. 5—10 minutes tandem pursuit race (6 teams).

Event No. 6—10 minutes roadman's pursuit race.

Event No. 7—Half-mile handicap (ladies).

Event No. 8—2 miles point-to-point, for ladies.

All entries and inquiries should be addressed to the Secretary, National Cyclists' Union, at 35, Doughty Street, London, W.C.1. Telephone: TERminus 4368.

PARAGRAMS

A Bevin Boy

DICK CLARKE, Leicester Forest C.C., has been directed into mining. He hopes to continue, and to maintain, a full road programme.

Notts Boys Back

TWO members of the Broad Oak Road Club have returned from service with the Forces. They are Stewart Banham and Thomas Robinson. Despite a serious leg injury, the latter has made rapid progress in again finding his "speed" legs.

Home from Germany

SANDY LOWSON, White Heather C.C., is back home after three years in a German prison camp.

Chester Road Club Loss

VICTOR CARTER, Chester Road Club, has been killed in action. He was an outstanding personality in the Cheshire area.

C. Hassall Decorated

CYRIL HASSALL, Derby Ivanhoe C.C., has been awarded the D.F.C. and bar. He has been serving with the R.A.F. for over four years, and before the war was an appreciated and hard-working club official.

Vic Moss Killed

VIC MOSS, Pyramid Wheelers, has been killed in action in Italy. He had survived nearly two years' continuous fighting: first in North Africa and then in Italy. He was in the battle of Long Stop Hill.

Tropical Twiddlers

FROM the Indian shores comes news of yet another Services club, the Tropical Twiddlers, the majority of whom are members of the Senior Service who enjoy brief shore leaves awheel.

Good Progress

BECONTREE Wheelers recently elected 21 new members at the club's annual meeting.

Track Racing in Scotland

THERE is a determined effort to revive track racing in Scotland, and promise of activity in Glasgow and other towns is assured.

Double Harness

J. LEIGHTON, Bellisle C.C., and H. Ellis, well-known Scottish clubman-official, have married.

Tee-side Loss

FLT. LT. KEN GATE, Tees-side Road Club, has been killed in action.

Barnsbury Commando

MARINE COMMANDO ALBERT HUDSON, Barnsbury C.C., sustained severe leg injuries in the initial landing in Normandy.

N.C.U. Officials Honoured

L. F. DIXON (London) and H. Crookes (Derby) have been honoured by the N.C.U. Emergency Committee with the Union's gold badge of honour.

The Jarvis Twins

TWIN daughters have been born to Mrs. Betty Jarvis (Rosslyn Ladies C.C.), whose husband "Jerv," is a member of the Upton Manor C.C.

L. J. Maxwell a Prisoner

L. J. MAXWELL, Upton Manor C.C., is a prisoner of war in Germany.

Killed in Burma

S. BOTTOMLEY, Nun-Brook Wheelers, has been killed in action in Burma.

Missing

APPRECIATED member of the Derby C. and A.C., and of the Derby Ivanhoe C.C., Flight Sergeant George Wilson, R.A.F.V.R., has been posted "missing" from an operational sortie.

Scot in Hants

JOHN WOTHERSPOON, West of Scotland Clarion C.C., a physical training instructor with H.M. Forces, has contacted local clubs in the Hampshire area. He also hopes to compete in some Hampshire events.

Agreed!

IN order that cadets shall begin on the right lines, a commanding officer of a Birmingham A.T.C. squadron is seeking the co-operation of clubmen and well-known cycling personalities in order to start a cycling club among cadets in his squadron.

Medgett's New Rôle

WELL-KNOWN East Anglian clubman Eric S. Medgett is acting as a liaison officer with a Polish unit in this country. Among the men are many who rode professionally in various European countries prior to the war.

Buckshee Wheelers Extend

A BRANCH of the now famous Buckshee Wheelers has been formed in Khartoum, with Harry Shaw (Spartan Wheelers) in charge.

Swindon Wheeler Decorated

CONGRATULATIONS, mingled with anxiety, have been received by members of the Swindon Wheelers following the announcement that Pilot Officer B. Cubbage, R.A.F.V.R., had been awarded the D.F.C., and that he was posted as "missing" following a raid over Berlin.

In German Hands

TOTTENHAM Paragon C.C. have heard that one of their members (C. Powell) is a prisoner of war in German hands.

Rugby Activities

THE Rugby C.C. has been resuscitated. Ralph Dougherty, famed pre-war road man with many Open wins to his credit, is the hon. secretary.

Club Record

BY clocking 1 hr. 57 mins. 47 secs. in an Open "50," P. G. Marks and W. H. Gray beat their club (Archer Road Club) record.

Champion Jack Simpson

BY clocking 1 hr. 0 min. 54 secs. to win the Solihull C.C. Open "25," J. Simpson, Barnsley C.C., wins the first 25-mile road championship of England.

Tricycle Association News

R. A. WISHART (Medway C.C.), of 2, Cornwallis Road, Maidstone, Kent, is the new hon. secretary of the Tricycle Association. He succeeds Harry Clarke (Southgate C.C.), who retired.

Cole's Comeback

CHAS. COLE, veteran member of the Luton Wheelers, who first commenced time-trialing 22 years ago, has been putting up some remarkable rides in his 44th year. In a recent event he was third, against strong opposition, with a 1 hr. 4 mins. 25 secs. for 25 miles.

Record Claim from Scotland

A CLAIM to the Scottish 25-mile road record has been made by D. Scott, Crawick Wheelers, who clocked 59 mins. 55 secs. in a Scottish Open event.

New Ealing T.T. Course

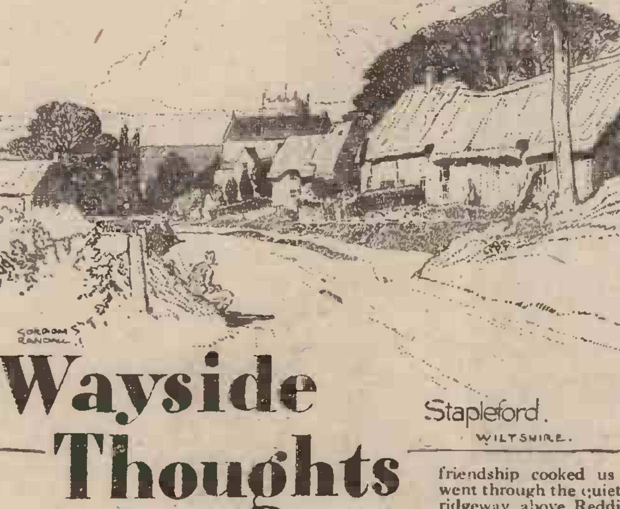
TAKING advantage of the opening of the new Western Avenue extension, the Ealing Cycling Club has taken into use a new set of time trial courses, ranging from 10 to 100 miles, starting in the Northolt area. These new courses have become known as the "Ealing Victory Courses," and have been approved by the London Section of the B.L.R.C.

Owing to the vastly increased scope of the club's racing activities since its affiliation to the B.L.R.C., the Ealing Cycling Club has decided to split the racing secretary's work in the following way: Len Davies, 36, Tolworth Rise, Tolworth, will continue to handle all massed-start and team time trial matters, while John Davis, 51, Old Oak Common Lane, East Acton, W.3, will resume his old job of time trial secretary, handling all time trials and club events, etc., in addition to his present duties as social secretary.

Secretaries of promoting clubs are requested to note this change when sending out forms to avoid delays.

"Tyre Queen" Crowned

GWEN HARDWICK, a lass of 14, from the mileage department in the offices at Fort Dunlop, was crowned Tyre Queen from among 60 claimants by Ernie Lotinga recently.



Stapleford. WILTSHIRE.

Wayside Thoughts

by F. J. URRY

The Folder

NOW that the B.S.A. folding bicycle has been given the free run of publicity, I can tell you I've been riding one for the past nine months, not every day, as I have other machines to air, but sufficiently frequently to say its running qualities and rigidity are minor revelations to me. I saw this type of machine "on test" quite a long time ago, as my home to work journey passes close to the big Small Heath factory, and I was interested in the unique design. The folding feature had not been then added to the ensemble, but the design was there ready to receive it, and there is no doubt that for the purpose to which the machine has been put, it has done a fine job. My particular mount only differs from the illustrations you have seen by the fitment of ordinary pedals and the reversal of the handlebar to give me the easy comfort of a North Road drop. The gear is a single one of "sixty," which makes my daily journey simple; nor is there any reason why a multispeed hub should not be fitted when those desirable components are once more obtainable. Then, so equipped, here is a type of bicycle that can be carried in the boot of a car to give the owner exercise, the beauty of slow movement in delectable country, and that boom which is so great a virtue of cycling, silent travel. Candidly I cannot measure any difference between the running qualities of my "folder"—taking into consideration the lesser resiliance of the war grade tyres—and any other of my machines, and that I admit was a surprise to me, necessitating a considerable total of miles before the complete conviction arrived. I do not say I would ride a "folder" for preference, but that such a design can fill a special purpose as that indicated, in addition to its paratroop performance, is, I imagine, a fact which will be of considerable interest.

The Wrong Approach

SOME of us are rather apt to sneer at the motorist turned cyclist, as in our enthusiasm for the pastime we were also apt, pre-war, to sneer at the cyclist turned motorist. It is a mistake, and is not calculated to improve relationships, which surely should be the objective of every good road user. I think it far better to help the new-comer to cycling, or the returnee, to a fuller appreciation of the pastime by persuading him or her to adopt a style and position a wee more in keeping with comfortable travel. There is a lot of sound gumption in that attitude, and if ardent cyclists adopted it we should have more ardent cyclists still. Because I am an all-out cyclist I do not expect everyone else to be, yet it gives me considerable satisfaction to know that if people ride at all, they are far more likely to keep active cyclists by the power of persuasion than by the taunt of criticism. As to the cyclist who turns motorist, is it not a fact that in the majority of cases he does so for family reasons? And in any case he is probably a much better motorist with the road apprenticeship of cycling behind him. Toleration is good for all of us, and though we do not always get it from other traffic interests, that is no reason why we should not give it and add still another sense of freedom to the claims we so frequently make that cycling is the very embodiment of that desirable virtue in human kind.

You Can Make It All Holiday

MORE than ever is it true that the cyclist has a holiday at call any day and any time. I have never doubted the fact for the simple reason that most of my holidays have been taken in the company of a bicycle; but in these times when breaks are of short duration, and, when they do come to us, arrive with a suddenness that is a little bewildering, how excellent the bicycle fills the need for change. A free day, and you can pack some lunch and be away before the sun is high—thirty miles away—and the morning still reasonably young, spend a lazy afternoon in some delectable spot of your choice, find a comforting cup of tea at almost any cottage (if you have been wise enough to take a little of the herb and a trifle of sugar with you) and wander home in the cooler hours a very contented individual. It really doesn't take much to make a holiday if the spirit is right, and I find that is a fact among my old cycling friends. Three of us did this on a golden day at the end of May, dodged the crowds by taking the lanes to the Avon valley, had lunch near the comely Worcestershire village of Cropthorne, crossed the river at Fladbury, and soon after found a kindly farmer's wife who brewed our tea, and in happy friendship cooked us eggs and thus refreshed we went through the quiet land of The Lenches on to the ridgeway above Redditch, and from there along the lovely lanes to within three miles of home. A very perfect little outing and a real day's holiday made possible by using bicycles as they are intended to be used. A bicycle, a small degree of fitness and the knowledge how to use it in conjunction with the pastime, and you have the answer to the holiday problems without worrying yourself or your fellow creatures. For the farmer's wife seemed pleased to see us!

New Models

I HAVE recently been riding a machine with a very short wheel base. Why a short wheel base? you may ask. Well, it is generally agreed that such a design makes the mount a good hill-climber, and that virtue automatically means easier cycling for such as me, or faster travelling for the lads who like to streak along. The tandem is a poor hill-climber, because of its wheel base, which is why numerous makers have tried to shorten the distance from axle centres and thereby reduce drag. In the old days makers obtained this desideratum in the design of singles by curving the seat tube, and that indeed is one method by which the modern speed tandem does the trick, but, generally speaking, curved frame tubes have gone out of fashion; why they should have done nobody knows, for most of our chain stays are curved when they could be straight, and we say nothing about it. However, this is not a treatise on design, but a report on performance, and I am bound to say this short base bicycle seemed to me a specially good climber, and for that receives top marks. But the machine was fitted with 1¼in. section tyres (and I like 1⅜in.), so vibration was noticeable, particularly as I have to cover several miles of setts on my daily journey. Lacking rubber grips and my favourite type of saddle made a difference, too; but I think these defects would be overcome for riders of my type, seeking ease by the use of the larger section tyres and a good roomy saddle. To-day this machine is only in the experimental stage; indeed, the model I was riding was the only one in existence, but I think it can and will be developed as a suitable mount for both the club racing lad and the jolly old tourist. We want a change in pattern, and I'm glad to see some of our makers are very much alive to the possibilities of the future, and the interest to be evoked by a change in design.

Lessons From the Lads

LETTERS from many of my young friends on the fighting fronts make most interesting reading, not because they give me any information that has not been made public weeks ago, but by reason of the fact that, without exception, these communications are full of the memories of the days along the road, and the high hope of creating more such fragrant recollections in the years to come. I suppose it is natural my friends, knowing my habits and inclinations, should write in this strain, for the fellow feeling among cyclists is very real, and the fact that in so doing they create pictures of past happiness for themselves and me is very good for both of us. I have heard cynics say on occasion that no one would ride a bicycle for pleasure if the opportunity of owning and driving a car come within the orbit of their finances. Don't you believe it, for I know hundreds of people who own cars for business and family reasons, yet will not give up their cycling until age puts an end to their activities, and they know by experience—even as I do—that the length of their cycling life is prolonged because of their habit. Indeed, I think this pastime becomes much more delightful as you grow older, for by then you have absorbed its true philosophy, which seems to me to be a silent method of travel and observation; which is just geared walking, without any risk of becoming foot-weary. As you grow older the miles per day do not count as an element in the joy of the game; but the loveliness on the way, the sights and sounds, and smells, and the quiet activity are the very essence of holiday-making. Yes, these letters from the lads make me feel glad that a big throng of expert cyclists will come into the pastime at a time when their enthusiasm and knowledge will be of tremendous value to the millions of novices in our midst.

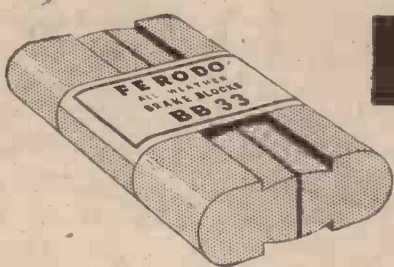
Sartorial Sense

A SURPRISING thing that struck me about many of the cyclists I met during a recent run was the fact that, while most of them had much to learn about riding, they had very freely adopted the kit of club riders' summer get-up, and some of them must have been a trifle uncomfortable. The weather was good, but it was cold, and when the sunshine ceased functioning there was a chill in the wind that must have made the wearing of brief shorts and light linen jackets a little arctic. I know my own ordinary raiment of a full-dress cycling suit of tweed was never burdensome, even during the sunny hours, and I cannot conceive that many of the girls and boys I saw during the holiday hours were as comfortably clothed. Personally, I think we are inclined as a clan to make this clothing habit too much of a fetish, and shorts and open-neck shirts are scarcely the wear when the east winds of spring are prowling around. I think this business of "dressing the part" has been overdone, for it adds nothing to the enjoyment of cycling as cycling, and can be uncomfortable, if not dangerous to health. In any case, I would rather be too warm than too chill, for you can always shed a garment in the former case, whereas, in the latter, even the addition of a pullover does not affect the below-the-waist comfort. Too many people have followed a fashion in this matter (an excellent fashion in high summertime) at the expense of complete happiness, which must include the greatest possible degree of comfort, the joy of lounging, and riding without the necessity of brisk movement to keep the blood circulating. The playing of games certainly demands special clothing, and cycling is no exception to that rule; but it seems to me that in a game that varies so widely in bodily exercise from mile to mile, discretion in garment selection is needed, and comfort should be the foundation of that selection rather than the presentation of a hardihood that sometimes is so obviously a handicap to the easy enjoyment of the pastime.


"Looking out the way," near Gaddesden Row, Herts.

AWHEEL . . .
IN SAFETY

When the winding road calls again and you are spinning awheel far afield among your favourite haunts, look to your safety. You will be wise if you fit Ferodo All-weather Brake Blocks. Wet or dry they possess great holding power yet grip smoothly and noiselessly, providing safety in all emergencies. Be sure to fit



FERODO

ALL-WEATHER BRAKE BLOCKS

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CYCLORAMA

By H. W. ELEY

By the pond at Welwyn, Herts.

Pickwick Bicycle Club

AT the last "Austerity Lunch" of the Pickwick Bicycle Club, members and guests were given a treat—for Lord Nuffield, the newly elected president, spoke, and regaled those present with fascinating reminiscences of his early days, and particularly of the days when he was cycle racing in Oxfordshire. And what a versatile rider he was in those days! "Any distance you like" seems to have been his lordship's motto!

Evening Rides

EVENING rides have always appealed greatly to me, and one blessing of double summer-time is that one can get in a good ride between tea-time and bed-time. And how good it is to get away from the towns and slip into the real country—the country of orchards, where the apple trees are all dressed in pink and white; the country where the cuckoo calls from some hidden haunt; the country where, down by the little reed-fringed pool, one may see the moorhens and coots, and occasionally witness the quick dive of the water vole into a hole in the bank. Good to ride slowly home before the purple dusk gathers; better still to time oneself so well that one reaches the friendly door of the "Hunter's Horn" just in time for a mug of ale and a quiet smoke. Yes! we have something to thank William Willett for . . . even if some of our farmers are inclined to grouse at this extension of the original boon. To most of us it is good.

The Late Lord Lonsdale

IN all the many eulogies of the late Lord Lonsdale, that king of sportsmen, I do not recollect having seen any mention of his being a cyclist, yet I seem to recall that in bygone years he was a keen rider. It would be surprising if he were not, for his lordship loved almost every kind of sport and pastime . . . and I cannot believe that he was insensible to the delights of the bicycle! What a picturesque figure he was! As one sporting writer said, somehow even Derby Day will never be the same again, now that Lord Lonsdale, complete with buttonhole and cigar, will not be there to grace the occasion. . . .

The Drought

OUR farmers are privileged to grumble, whatever the state of crops or weather . . . that is accepted. But, according to one old Warwickshire farmer with whom I talked this week, there is real cause for grousing just now . . . for the land needs *rain*. It is crying out for it. And until the doors of heaven open, and the precious rain soaks the ground, the grumbles will go on. Ah, well! I have always found that somehow or another the vagaries of English weather "work out" . . . and seed-time and harvest do not fail. . . .

[*The farmers have now had their wish!*—ED.]

Oldest Cycle Dealer!

TO anyone at all interested in shops and retail trading, it is always rather fascinating to see a legend over a shop indicating that the business was founded in the long ago. I have in mind one or two old grocery shops in county towns with the good wording on the facia board "Founded in the Reign of George the Third." Now, I wonder who is our oldest cycle dealer? Although the bicycle is not really old, there must be many dealers whose businesses have been established a great time; and it would be very interesting to know which town can boast our very oldest cycle dealer? Whoever he is, and wherever he trades, he must have some absorbing memories of the old days!

Care of Tyres

RECENTLY I had to visit the cycle sheds at a big Midlands factory—sheds where hundreds of bikes are parked each day. I was quite shocked to see how many of the tyres were grossly under-inflated! Poor tyres!—they all needed AIR; and I was reminded that, in these days of control and restrictions, air, at any rate, is not rationed! The tyre manufacturers have issued an enormous amount of publicity on this vital question of inflation, but it would appear that most of it has gone unheeded by cyclists. It is a pity, for under-inflated tyres not only give less comfort to the rider, but their life is inevitably shortened.

Social Clubs

APART from the true cycling club, with expert riders and serious intentions as to distances and racing, the cycling movement is helped a lot by those social clubs attached to our various churches. The other day I talked with the energetic secretary of such a club, and was pleased to learn of the keen spirit of the boys and girls who went out for Saturday afternoon runs. No great distances were covered, and maybe the riders were not "experts"; but they got a lot of fun out of cycling, and that is a good thing! What a sociable thing cycling is! Nothing approaches it for the promotion of good companionship and friendly intercourse.

Old Inn Signs

MANY lovers of the English scene deplore the decline of the good old painted inn sign. It has, unfortunately, become the fashion among some of our brewers to standardise their inn signs. No longer does an inn called "The Cock" rejoice in a splendid colourful sign depicting a fierce-looking rooster; instead, there is just the standardised legend "Bungs' Ales"—a legend reproduced in the same way on all the signs of the brewers' inns. It is a pity this passing of one of the glories of our land. Who has not, after a long and uphill ride, felt a glow of pleasure at catching sight of a swinging inn sign showing a wheatsheaf, or a swan, or a noble white lion? Perhaps it is but a wartime fashion, and maybe the good old signs will return. Let us hope so, for they did much to add to the interest of our countryside. Personally, I love them all . . . Black Horses, Red Lions, Brown Bears, Unicorns, Crowns, and Foxes. . . .

The Ubiquitous Bike!

WHAT would a man do without a bike? I have just seen a man riding happily along . . . to his allotment—spade, fork, and a hoe tied to his machine; he is independent of buses and trains, and his good bike carries all his gardening impedimenta. And I see another man, golf clubs over his back, cycling just as happily to the links. And round the corner comes a woman cyclist, with her small child sitting comfortably in a specially designed little chair attached to the bike. What *should* we do without the bicycle?

Our County Towns

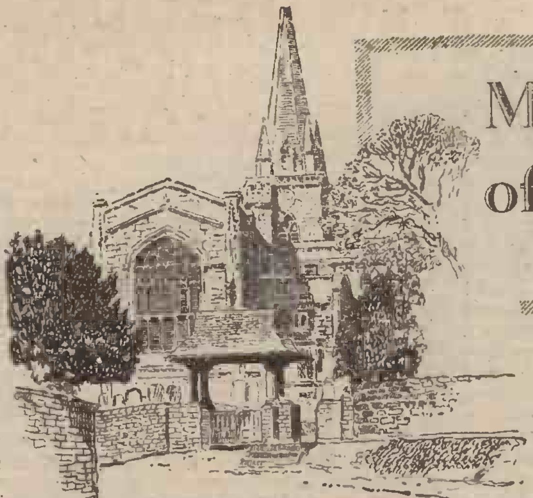
MOST of our county towns have charm and historic interest; I think of Warwick, of Norwich, of Chester . . . and of Shrewsbury; and the latter is a prime favourite of mine. I love its old timbered houses and the quaint names of some of its streets. I love Wyle Cop; and as for the surrounding country, I think it is equal to any in England; and when I muse upon possible cycling tours in the good days to come, I often find my thoughts turning to Salop . . . with pleasant riding around Wenlock Edge, and stately Ludlow, and all that lovable part of the county which Mary Webb made her own in those delightful books "Precious Bane" and "Gone to Earth." Yes, a goodly land this Salop, and Shrewsbury is one of its chief glories. . . .

Harry Ryan

ONE of the most popular men in the trade, in the person of Harry Ryan, of Dunlop, has been ill. I gather that he is now making good progress, and should soon be back in harness. No man is better liked in the trade; no man has a greater reputation for integrity of purpose and genial good will. A host of friends will rejoice that Harry Ryan is better.

My Point of View

BY "WAYFARER"



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

She Rang Her Bell

THE other evening, as I was approaching a blind corner where I had to turn sharp left, a bicycle bell was rung. I immediately responded by operating my tinkler. The next moment, round the corner, riding "hands off," came a young damsel. At sight of me, tucked well into the hedge, she hurriedly grasped her bars, swerved, and passed by, and nobody was any the worse. Yet I could not help feeling that somebody was asking for trouble. True, the damsel rang her bell but . . . !

Litter and Salvage

THE disfiguring of our countryside by means of litter can never be justified, because waste can never be justified. During a recent tour I was concerned to observe that the grass verges of some of our roads were cluttered-up with cardboard cartons, bearing evidence that they had contained food for the U.S.A. armies. I looked at the matter purely from the disfigurement point of view, and wondered what could be done about it. Then I realised that the matter possessed another aspect, and I at once got busy. My personal contacts with the Ministry of Supply gave me a line, and I approached the question from the salvage standpoint. All these hundreds—perhaps thousands—of cartons (each one with an inner casing) must be invaluable as salvage, and I now have reason to believe that the littering of our countryside in the manner indicated will be stopped, the material thus saved being turned to a good purpose.

This Scented Land

A YOUNG friend of mine who returned to this country in the late spring, having completed his R.A.F. training in Canada, tells me that he was impressed by the delicious scents which greeted him in our countryside. These would most likely be may blossom, lilac, broom, and growing beans—each delightful by itself, but forming a precious combination to anyone who has lived without countryside scents for a period. The probability is that we who are stay-at-homes (a relative term !) do not realise all the delights of the scented land in which we live. The joys are there for months on end, and we take them for granted. It is not possible for one to choose between them, nor is it necessary for one to say which one likes best. I, personally, have a weakness for any of those named, as well as for meadow-sweet, clover, and honeysuckle. The gifts of cycling are manifold and various, not the least being the readiness with which we can obtain our share of the scents, as well as the sights and sounds, of this land of ours.

The Unfolding Picture

PRACTICALLY every Saturday in the half-year just closed I have had my tea at a remote cottage hidden away in a Worcestershire lane ; practically every Sunday in the same period I have obtained my lunch at a cottage in the old Forest of Arden. If that sounds monotonous, believe me it has not been so. Considerable changes in route have been possible, and I am impressed by the point that it is no more monotonous to consume your Saturday tea or your Sunday lunch in the same place than it is monotonous to have your breakfast at home on most days in the year—and year after year !

Yet there has been sufficient sameness about my journeys to and from Hanbury and Henley-in-Arden to enable me to study with delight the unfolding picture which Nature has constantly presented. On the first day of the year, as already recorded in this place, primroses were shining out of the verges of the Worcestershire lane mentioned. At that period the fields were bare ; the trees and hedges were naked. But, unseen, life was functioning, and there came an occasion when the vegetation seemed to leap into the open and when Nature's colour-scheme advanced with a rush. The drab hedges of yesterday were to-day a splendid study in rich green.

Week by week, almost without exception, I have enjoyed grand views, ranging from Edge Hill and the Cotswolds to the Malverns and the Clees. There have been wonderful skies across which all the colours of the rainbow were splashed. I have fought stiff breezes ; I have travelled "on the wings of the wind." There have been black nights (sometimes with a million "lamps of Heaven" hanging out) and moonlight nights. There was one night which presented me with a "mixed grill" in the shape of a snowstorm and a thunderstorm. I have travelled through a network of deserted lanes and sped along fairly busy suburban roads. So much joy have I extracted from this programme of "monotony" that I have actually resented missing one or two of the trips owing to the fact that I was week-ending away from the district.

Midsummer Sanity

ON the arrival of that day which, oddly enough, is known as Midsummer Day, I decided on something in the way of celebration, and so I played truant from work. It took me nearly four hours to achieve 41 miles before lunch (including a stop for "elevenses" at Stratford-on-Avon), and I had then reached a farm at the base of the Cotswolds. After a chat with the farmer, I went over the hills in search of the London-Aberystwyth Road and Moreton-in-Marsh. Picturesque Bourton-on-the-Hill claimed me next. Despite the heat of the day—welcome enough after recent samples of "summer" !—I thoroughly enjoyed my climb up the long slope to the roof of the Cotswolds, the road passing between delicious examples of domestic architecture, with gardens full of colour. Visibility was not at its best, but the grand views were well worth seeing. After pushing along towards Broadway, I turned downhill towards that gem of the Cotswolds, Chipping Campden, of which a very comprehensive picture can be obtained during the drop.

Ignorance Which Appals

DESPITE the fact that cycling is one of the most popular of recreations—if not *the* most popular, so far as active participation is concerned—the ignorance of the public as regards the pastime is really appalling. This is seen in some of the questions one is asked. Knowing that I am addicted to cycle-touring, somebody will enquire of me as to the distance I do in a day, supplementing the question by hazarding a guess : "20 miles ?" Pitiful, isn't it ? Another, learning that I am going to such-and-such a place, ejaculates : "But that's 60 miles ! Will you put up for the night somewhere on the way ?" That, too, is pitiful—from my point of view. And the other day a person I met about 100 miles from home asked : "Do you have many punctures ; did you have any on the way here ?" Despite the vacuous-minded people who like to strew our roads with broken glass, punctures are still few and far between, and "trouble" of this sort in the course of 1,000 miles would be considered highly unreasonable.

Notes of a Highwayman

By LEONARD ELLIS

Water and No Water

CYCLISTS who stand fascinated by the tremendous spectacle of a waterfall must be quietly amused by the frequent calls for water economy in a dry season. And yet they are probably among the most understanding of people. Those who have been privileged to see most of the rivers and falls of this country may have seen also the drastic changes wrought on the face of nature by a dry spell. Some water features seem to be more easily affected than others, and of course Lodore Falls, in the Lake District, at once comes to mind. Here it is a standing joke, not unknown to our poets, that after a very short dry spell the falls simply disappear. With a sudden storm Lodore is very soon a thundering cataract in full glory. Then there are the famous underground rivers in Staffordshire, Derbyshire and elsewhere. These always carry much water underground, but some have a visible stream as well, and this top layer disappears quite soon if not fed by good rain showers. I know one pretty little waterfall that makes a brave showing in a wet season, but at the first hint of drought the river ceases a few hundred yards from the lip of the fall and just percolates underground.

Dried-up Rivers

DURING the last six months I have seen the little Bucks river Misbourne so depleted that I was able to lift out a beautiful speckled trout quite 18 inches long. I am not a fisherman, or I would have boasted of its weight. She had floundered and flopped along from pool to pool until she was practically stranded on a sandy bottom. Three times I grabbed her and three times she gave a convulsive jerk and slipped from my fingers. The last desperate leap took her into a deeper pool from which she escaped. One of the most impressive water spectacles in North Wales is the uniform creaming cataract over the Vyrnwy Dam. Usually water is plentiful in Wales, and the lake which gives Liverpool its water is full enough to send a deafening torrent over the dam into the valley beneath. But even here water can be so scarce that the fall is silent and the great masonry slope is bone dry. Only at the base of the wall can be heard the tinkling of the little stream that must always flow by law to give the valley its compensation water. Lake Vyrnwy is a charming spot and so completely off the map that it makes an instant appeal to most cyclists anxious to get away from the din and turmoil of the city, or the sights and sounds of war. It is one of those places that can be reached by a reasonably good road.

Lakeside Roads

THE road to Vyrnwy takes us through Shrewsbury and through Llansantffraid yn Mechain and Llanfyllin along a road running roughly parallel to the Tanat Valley. On leaving Llanfyllin one feels almost at the outpost of civilisation, and campers are advised to stock up their provisions. There are no other villages until Llanwddyn on the lake side is reached, and this could hardly be called a shopping centre. A fairly good road runs all round the lake, a distance of nine or ten miles, and from this two rough mountain tracks can be followed. The better one goes nearly due north and emerges on the north side of Bala Lake. This road, the Bwlch Rhiw Hirnant, is heavy going, reaches a height of 1,641ft., and offers fine views of the mountains. The other track leaves the lake by the site of submerged Eunant and goes west and north-west. Eventually after much hard going it joins the Bwlch-y-Groes only 300yds. from the summit. The track is only 3½ miles long.

Conway Falls, North Wales.

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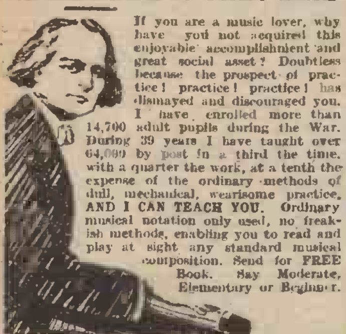

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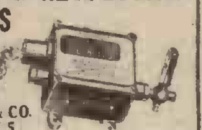

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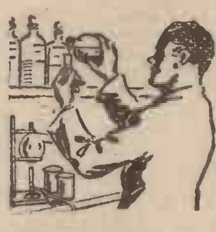

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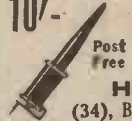

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