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ELEMENTS OF REFRIGERATION

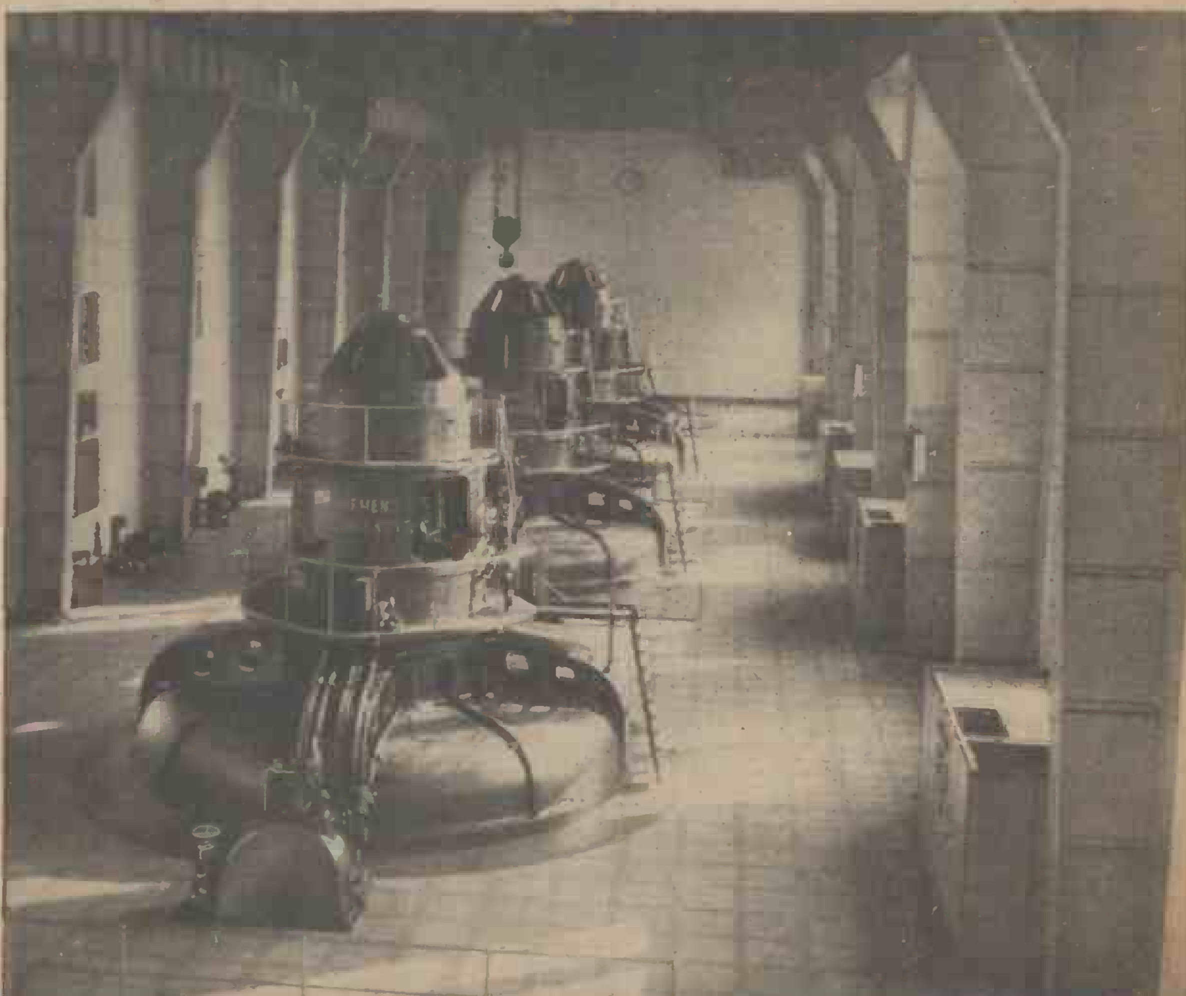
NEWNES

PRACTICAL MECHANICS

9d.

EDITOR: F. J. CAMM

APRIL 1946



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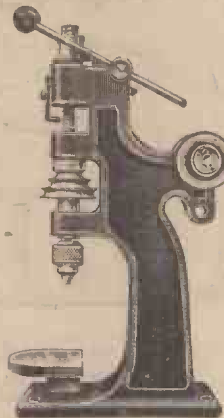

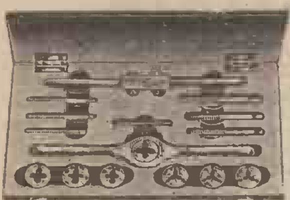

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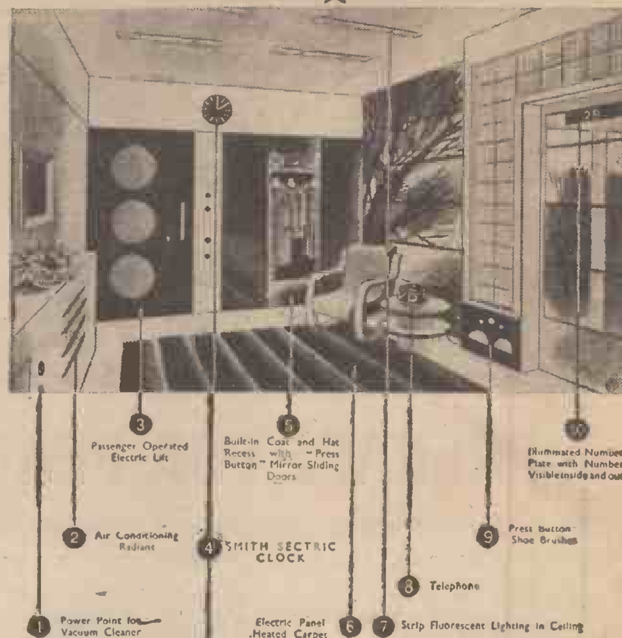

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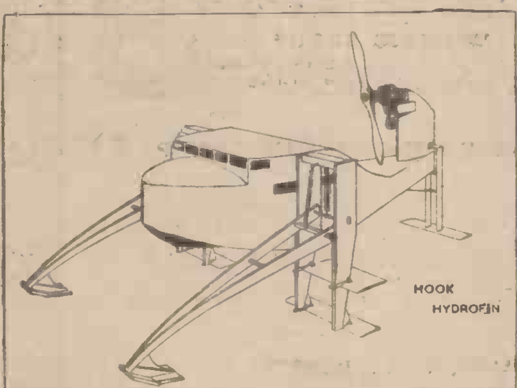

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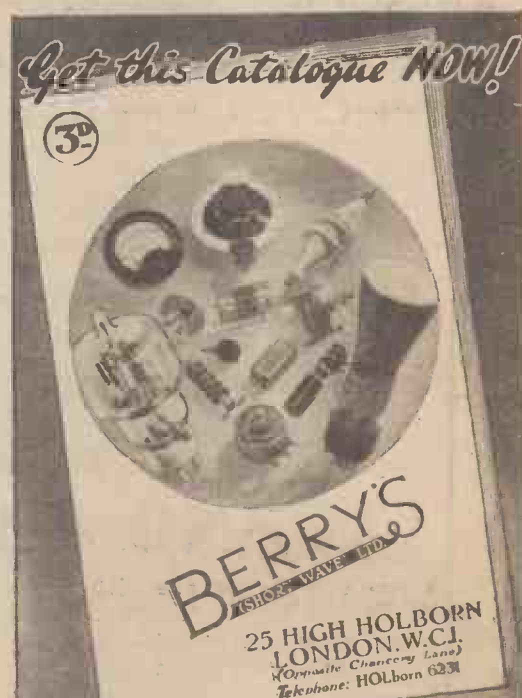

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PRACTICAL MECHANICS

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

Editor: F. J. CAMM

VOL. XIII APRIL, 1946 No. 151

FAIR COMMENT——BY THE EDITOR

The British Interplanetary Society

IT is not so many years ago that the Interplanetary Society was regarded with scorn by so-called scientific people. The V-1 and the V-2 and the atomic bomb have, however, placed the society in the forefront of scientific institutions. It has a most important duty to perform in disseminating knowledge on this modern scientific subject.

The Interplanetary movement commenced in this country in October, 1933, when P. E. Cleator founded the British Interplanetary Society with headquarters in Liverpool. E. Burgess in June, 1936, formed the Manchester Interplanetary Society, and a journal, *The Astronaut*, appeared in April, 1937. Thereafter followed the Paisley Rocketeer Society in Scotland, the Leeds Rocket Society and the Hastings Interplanetary Society. Then occurred an internecine conflict resulting in the formation of the Manchester Astronautical Association in December, 1937, followed by the disbanding of the Hastings and the Leeds groups.

The outcome was the production of a common bulletin which also contained news of a Midlands group of B.I.S. members.

A few months before the war the M.I.S. voluntarily disbanded and the P.R.S. followed suit. The B.I.S. continued and convened an emergency meeting at the commencement of hostilities at which it was decided that the society should cease to function for the duration of the war. The M.A.A. thus became the only functioning body by holding its meetings and issuing periodically a journal under the title of *Spacewards*.

Astronautical Development Society

THERE was another group of interplanetary enthusiasts operating at Surbiton, Surrey, known as the Astronautical Development Society, and our contributor, K. W. Gatland, was responsible for its organisation. Contact between these two societies was made in 1941 and in early 1942 a joint monthly bulletin was issued followed in October, 1942, by the joint journal *Spacewards*.

There resulted an affiliation of the two organisations resulting in the Combined British Astronautical Societies in 1944. Regular meetings of this body were started in September, 1944, and a few months later the possible amalgamation of the B.I.S. and the C.B.A.S. was discussed. Many other meetings followed, and on June 13th an informal but important meeting of the B.I.S. took place in London at which it was decided to reform the society and apply for incorporation. In the following June the prospects of forming a national society were discussed. At a later meeting this was unanimously decided upon and L. J. Carter was authorised to prepare a Memorandum and Articles of Association and to make the required application for the incorporation of the British Interplanetary Society. The certificate of incorporation was obtained on December 31st, 1945, from which date the B.I.S. commenced its activities.

We set these facts on record because, living as we are in the midst of history, it is proper that future generations should know how the interplanetary movement started. The early days of the Royal Society of Arts, the Institution of Mechanical Engineers and many other learned societies, are punctuated by the same difficulties as have beset this new movement. We have no doubt that in one hundred years' time the B.I.S. will be regarded with the same scientific reverence as the other learned societies. Certainly it has justified the vision, the energy and the enterprise of those who have sponsored the movement, and the wisdom of those who saw that there was strength in unity and none in division and separate rivalries.

The personnel of the B.I.S. is composed of scientific people, not cranks, and it has a most important task to perform in educating the public to the possibilities of the atomic era and the rocket era as well as the jet-propulsion era in which we all now live.

No doubt as time goes on the terms of membership will be made more difficult, and it behoves all those who have a genuine scientific interest in the subject to get into touch with the British Interplanetary Society whose registered offices are at Albemarle House, Piccadilly, London, W.1.

Radio Noises

IT has long been accepted that, since the sun emits electromagnetic waves in the form of light and heat, it must also emit radio waves of extremely weak intensity. Normally, this intensity is so feeble as to be quite undetectable on radio receivers in the 1 to 10 metre band.

But it has been recently found by British radio workers that, when there is a big and active sunspot group on the sun the solar radio emission can be increased up to 100,000 times in the 1 to 10 metre band; and this radio emission can then be detected on sensitive receivers on the earth's surface. It is natural to assume that these abnormal bursts come, not from the sun's disc as a whole, but from the localised active sunspot area. Many present-day Army receivers, particularly those used in radar, are now so sensitive that they can detect this abnormal solar emission, when it occurs, if their receiving aerials are pointed in the direction of the sun. The effect produced on listening in headphones or loudspeakers is that of a hissing noise, hence the term "radio noise."

At present there is a large and important group of sunspots on the sun's disc which can easily be seen by the naked eye, looking through smoked glass. This group, according to the Astronomer Royal (Sir Harold Spencer Jones) is the largest observed since 1926. Since the sun itself is rotating (it makes a complete rotation in 27 days) it was expected that the sunspot group would cross the central meridian on February 5th last, Solar noise from it was detected by Mr. J. S. Hey and his colleagues, Maj. S. J. Parsons, Maj. J. W. Phillips and Mr. G. S. Stewart, of the Operational Research Group, Ministry of Supply, on January 30th, on their equipment in Richmond Park. Through the kind co-operation of Lt.-Col. H. A. Sargeaunt (Superintendent, Operational Research Group, Ministry of Supply) a continuous watch has been maintained. Valuable assistance has been given by Army operators, mainly from A.A. Command. It is believed that this is the first time that the noise phenomenon has been continuously studied in this way.

The Demonstration of Solar Noise

THE demonstration of solar noise had been arranged by Sir Edward Appleton, G.B.E., K.C.B., F.R.S., and the Operational Research Group, Ministry of Supply. The solar "noise" was demonstrated as a disturbance on a cathode-ray screen such as is used for the delineation of radar echoes. It was also demonstrated as an audible hissing noise on a loudspeaker and on a measuring instrument which indicated the strength of the radiation. The wavelength of the receiver used was about 5 metres. Proof that the radio noise comes from the sun was demonstrated using a directional aerial.

It has long been known that sunspots affect short-wave radio transmission because they cause abnormalities in the ionised reflecting layers in the upper atmosphere. We now know that when sunspots become active the sequence of events is somewhat as follows:

(a) First, the enhanced radio noise is heard. The radiation causing this noise travels with the speed of light, and travels from sun to earth in about eight minutes.

(b) The radio noise is usually followed by and associated with short-wave "fade-outs." These are due to the formation of an absorbing "blanket" underneath the Heaviside layer so that radio waves are strongly absorbed there. This "blanket" is due to a burst of ultra-violet light and causes a fade-out of from half to one hour's duration.

The Elements of Refrigeration—1

An Outline of the Principles Involved, and their Application

By R. WINTER-EVANS

IT is probable that of all the applications of heat to everyday life that which is least understood is the process of refrigeration, but there is no reason why this should be so. With the prospective increase in the number of domestic refrigerating units in use, it is hoped that a brief elementary outline of the principles on which these machines work, and the practical applications of these principles may be of interest. As far as possible all references to thermodynamic theory will be avoided, and the subject will be treated in as general a manner as possible. It is, however, necessary to have a clear idea of what is meant by the term "Heat."

Heat

In the early days of science heat was considered to be a material substance, this theory being known as the "Caloric Theory," and any increase or decrease in the amount of heat contained by a body was supposedly due to the presence of a greater or smaller amount of this substance, known as the "caloric," and assumed to be of a fluid nature. It was shown, however, that an apparently infinitely great amount of heat could be extracted from a body whilst its weight remained to all intents and purposes unaltered. The experiments that showed this, considered in conjunction with later ones, led to the abandonment of the caloric theory, and what is known as the "Molecular Theory of Heat" is now universally accepted. This states that heat is due to the motion of the molecules of a body, the temperature, or intensity of heat depending on the velocity and amplitude of vibration of the molecules composing the body.

All matter is, it is supposed, built up of a very large number of vibrating molecules; in a solid these are restrained in their motion, so that they do not change their positions in relation to each other; in a liquid this restraint is less, relative motion being possible between the molecules in addition to the molecular vibration; a gas has this restraint still further removed, and the molecules are free to collide with one another, and with the surface of any container holding the gas. These collisions with the surface of the container cause what is known as pressure.

Let us now examine in the light of this theory, what happens when a body is heated. Most bodies expand when heated, and this expansion is probably due to the increased velocity of the molecules forcing them further apart in their efforts to find more room. Eventually, after further heat has been added, the vibrations become so fierce that the attraction of the molecules is to a certain extent broken down, and the body becomes a fluid. The addition of yet further heat will cause the attraction to break down completely, and the liquid has then become a gas.

When the temperature of a body is stated, it simply means that degree of hotness that the body possesses when compared with some standard intensity of hotness, such as that of melting ice.

Front view of a Kelvinator refrigerator with the double doors open, showing the interior.

In general, when heat is added to a substance, the temperature of that substance rises. The heat added whilst the temperature of the substance is rising is known as the "Sensible Heat," as the fact that heat is being given to the body is evident from the rise of temperature.

Latent Heat

If the temperature of a solid is raised sufficiently by adding heat to it, a point in the temperature scale will be reached when a change in the physical state of the substance commences, and it begins to turn to a liquid. In order to make this change of state complete, and turn all the solid into liquid, it is necessary to continue the addition of heat, but it will be found that, as long as the change of state is continuing, the temperature will remain constant. The heat necessary to effect this change of state without raising the temperature is known as "Latent Heat" because, although heat is being added, the addition is not indicated by a rise of temperature.

Again, if after the solid has completely changed to liquid, still further heat is added to the liquid, it will be found that the temperature rises, until once more a point is reached when a further change of state commences. This time the liquid is turning to vapour, and again it will be found that heat must be added until the change is complete, but that no further rise of temperature takes place until the liquid is completely vaporised.

Reversing these processes, it will be found that as heat is given up by a vapour it will fall in temperature, until a point is reached where further heat is given out, but no further fall in temperature occurs. At this point the vapour commences to liquefy, but once liquefaction is complete, further abstraction of heat will result in a further fall of temperature, until, at a still lower temperature, the liquid commences to solidify. Here again there is a pause in the fall of temperature until solidification is complete, when it recommences.

This may be summarised by saying that a gas cannot become a liquid without giving off heat, nor can a liquid become a gas without absorbing heat, both these changes taking place at constant temperature. For example, a steam radiator may heat a room, and the steam will turn to water in the

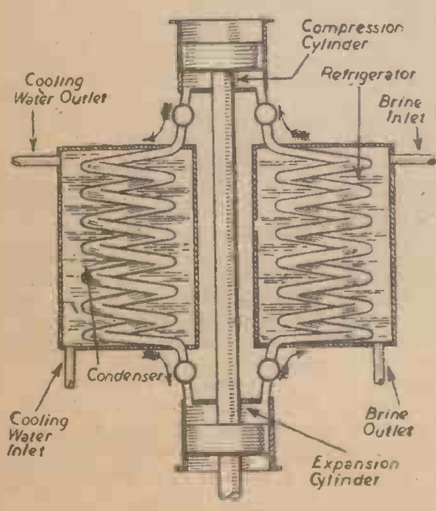


Fig. 1. (Left)—Section of a primitive refrigerating machine.

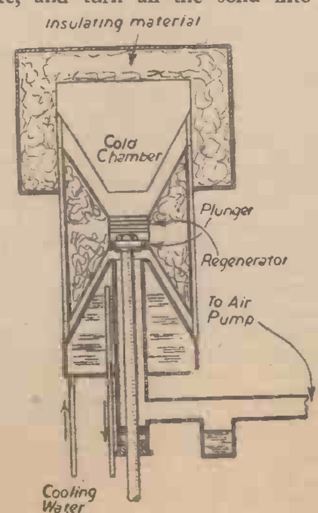


Fig 2. (Right)—Sectional view of a Kirk regenerative refrigerating machine.

process, but the water will be at the same temperature as the steam. Heat may also be supplied to a kettle, and the temperature of the water in the kettle will rise until it reaches boiling point which is 212 deg. F. at atmospheric pressure. At this temperature further heat may be added to the water, but it will become no hotter. Instead it turns to steam at the same temperature of 212 deg. F.

There is one more fact to be remembered before passing on to the study of refrigeration proper; this is that when a liquid is subjected to pressure, it will not vaporise at the same temperature as when it is not. More heat must be added as the pressure is increased before the change commences. Compare the water in a kettle, subject only to the pressure of the atmosphere, with that in a boiler with a working pressure of 200lbs. per square inch. Whilst the former will boil at the temperature of 212 deg. F. mentioned above, the water in the boiler must reach 381 deg. F. before it starts to boil.

It is the correct application of the facts outlined above that enables us, by doing work, or applying heat to a given system, to produce ice on even the hottest day, and although water and steam are not suitable for this purpose, the properties mentioned are common to all liquids and gases.

Primitive Refrigerating Plant

The cycle of a simple refrigerating plant is as follows: The working fluid, air, ammonia, carbon dioxide, or some other fluid absorbs heat from its surroundings in the cold chamber, thus carrying out the desired cooling. The heat thus absorbed raises the temperature of the fluid, which then passes to a condenser, where circulation of cool air or water removes the surplus heat, and returns the fluid to its liquid form if necessary. It then passes to what may be known as the expansion chamber, where it is free to expand. No heat is provided to assist this expansion, however, and it must therefore be done at the expense of the internal heat energy of the fluid, and its

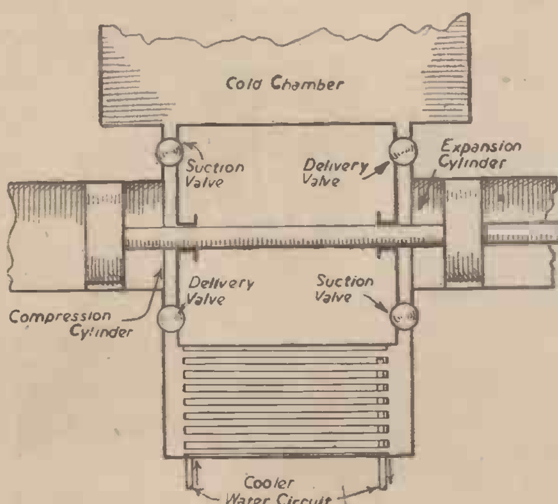


Fig. 3.—Bell-Coleman refrigerating machine.

temperature falls considerably. At this low temperature it then passes once more to the cold chamber, and the cycle recommences.

Fig. 1 shows diagrammatically the arrangement of a primitive refrigerating machine, which will be seen to consist of four main components, the compression cylinder, the expansion cylinder, the refrigerator, or evaporator, in which the working substance receives heat from its surroundings, and the condenser, in which it gives up this heat. It may be assumed that the refrigerator consists of a coil of pipe through which the working substance is passed, and that this coil is surrounded by a supply of brine which it is required to keep at a low temperature. The condenser is of similar construction, and the cooling water which surrounds the coil in this instance removes the heat absorbed from the brine.

In most cases the working substance is a volatile fluid, and this will enter the condenser in the form of a gas. In its passage through the coil it gives up its heat to the surrounding water, and condenses to the liquid state, before passing on to the expansion chamber, or cylinder. Here it is expanded without any change in its total heat content, vaporising, and falling in temperature. Heat is needed to effect the vaporisation, and there is no outside source of heat available, so that it must come from the fluid itself. This explains the fall in temperature, which continues until it is equal to that in the refrigerator, to which the fluid is then discharged. Here it takes up heat from the surrounding brine, which is cooled, whilst the degree of vaporisation of the fluid is increased. Still in vapour form, it passes on to the compression cylinder, where it is compressed until its temperature is again the same as that in the condenser, to which it is then discharged in preparation for the next cycle.

Various factors, which need not be considered here, have led to modifications in the components of the machine. It is the usual practice, when the refrigerant is a volatile liquid, to omit the expansion cylinder, and allow the condensed vapour to pass through an adjustable throttle, or expansion valve, on its way from the condenser to the refrigerator. This gives a very much simpler machine, without a very great loss in thermodynamic efficiency.

Classification of Refrigerating Machines

There are three main classes of refrigerating machine, known respectively as cold air machines, vapour compression machines, and absorption machines. Of these, the first is practically obsolete, but it has, nevertheless, an important place in the history of refrigeration, and may be briefly considered here.

Cold Air Machines

These, in their turn, may be divided into two main classes. In the first there are machines in which the same air is passed through the cycle over and over again, always at a pressure above atmospheric, whilst the second class consists of machines from which the air is discharged at the end of each cycle of operations, and a fresh charge drawn in for the succeeding cycle. These are known as closed cycle and open cycle air machines respectively, and it was the open cycle machine that found the more extensive application.

Closed Cycle Air Machines

A typical example of this type was the Kirk Regenerative Refrigerating Machine, a diagrammatic arrangement of which is given in Fig. 2.

From this figure it will be seen that the machine consisted of a cylinder with a double conical plunger. At the centre of the plunger there was fitted a regenerator, consisting of a number of sheets of metallic gauze through which the working substance, in this case air, was free to flow in either direction. The purpose of this regenerator was to abstract heat from the air as it flowed through in one direction, and to return this heat to the air as it returned in the reverse direction. If the regenerator were perfect, the whole of the heat abstracted from the air would be returned, but this was impossible in practice owing to losses from radiation, conduction, etc. By moving the plunger downwards, the air was

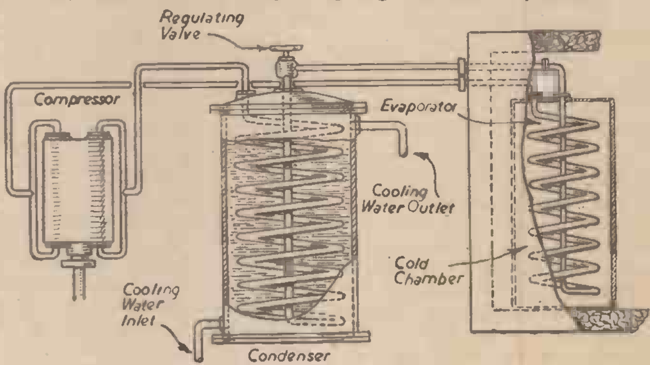


Fig. 4.—Vapour compression machine.

displaced upwards through the regenerator into the space around the cold chamber. It should be noted that the movement of the plunger did not at any time produce a change in the volume of the air, but merely served to move it from one position to another. The space below the plunger was connected to an air pump, not shown, by means of the pipe, and the action of the machine was as follows.

The plunger was moved to the top of its stroke, forcing the air downwards through the regenerator into the space below the plunger. Here it was compressed by the movement of the air pump piston, and circulating water around the lower space was used to carry away, as far as possible, the heat of compression. The plunger then returned to its lower position, and the compressed air passed up through the regenerator, giving up heat to the elements, and falling in temperature. As soon as the plunger reached its lower dead centre, the piston of the air pump moved out, allowing the air to expand. In order to effect this expansion, heat was needed, and this was abstracted from the cold chamber, thus effecting the necessary cooling. At the end of expansion, the plunger was again moved up, once more transferring the air to the space below the plunger, taking heat from it in the regenerator, and cooling it ready for the next cycle.

Open Cycle Air Machine

This is frequently known as the Bell-Coleman machine, and is shown diagrammatically in Fig. 3, and the action is as follows.

A quantity of air is drawn from the cold storage chamber past the suction valve into the compression chamber, as the piston moves outwards. On the return stroke of the piston this air is compressed, the suction valve being closed, and a pressure of some 70lbs. sq. in. is reached. The discharge valve then opens automatically, and the compressed air, by now at a high temperature, is delivered into the cooler, shown in the diagram as a number of tubes through which the air passes, these tubes being cooled by water circulating outside them.

The cooler reduces the temperature of the air from the high figure at the end of compression to slightly above that of the cooling water. At the same time the pressure of the air remains appreciably the same. From the cooler the air, still at high pressure, but now at a much lower temperature, passes through the valve to the expansion cylinder, where it is allowed to expand down to atmospheric pressure, doing work on the piston as it does so, and thereby giving up its internal energy. This, in turn, reduces the temperature of the air to a great extent, possibly to as low as -120 deg. F. The return stroke of the piston sweeps the air, now at low temperature and atmospheric pressure, into the cold chamber, where it cools the goods stored therein. Thus in a refrigerating plant of the open-air type, the storage chamber is kept at a low temperature by continuously removing a quantity of air from the chamber, cooling it, and returning it to the chamber.

The chief advantage of the air machine is that the refrigerant it uses is both plentiful and cheap, and in the event of a leak developing it is also completely harmless. Its performance, however, is anything but economical, one of the chief factors contributing to this being the low thermal conductivity of air, which calls for a very large temperature range in the machine. Other considerations were the size of the machine, which tended to be bulky, and, in open cycle machines, the presence of moisture in the air. This moisture is not deposited during the compression of the air, as the increase in temperature more than covers the increase in the pressure, but some of the moisture may be deposited in the cooler, and this will eventually form snow in and about the expansion cylinder, choking and blocking the passages. Different methods of overcoming this difficulty have been tried, with varying success, but as machines of this type are now obsolete, there is no need to consider them in detail.

Vapour Compression Machines

This type of refrigerating machine is, commercially, the most important. The process on which the machine works allows an actual coefficient of performance nearer to the ideal than any other machine, and at the same time permits a construction that has much to commend it practically.

Fig. 4, which is purely diagrammatic, shows the essential components of a vapour compression refrigerating machine, omitting all items which may be classed as refinements for the sake of simplicity. A study of this figure will show that the machine is identical with that illustrated in Fig. 1, with the exception that the expansion cylinder of the latter has been replaced by a regulating valve.

The general action of the machine shown in Fig. 4 is as follows, the working substance being, of course, a volatile fluid. During the suction stroke of the compressor piston a quantity of the working substance is drawn from the evaporator, or refrigerator, into the compressor cylinder at a low temperature, which we may say is T_2. It will be shown later that the fluid enters the compressor in the gaseous state. On the return stroke of the piston this vapour is compressed to a higher pressure, and its temperature is raised to T_1. At the end of compression, the working substance is discharged into the condenser, where it liquefies, still at the temperature T_1, and gives up its latent heat to the cooling water around the coil. From the condenser the liquid returns to the refrigerator by way of the regulating valve, expanding to a lower pressure, and falling in temperature from T_1 to T_2 in its passage through the valve. As it does so, part of the fluid vaporises, so that it enters the evaporator or refrigerator as a mixture of vapour and liquid with the liquid predominating. In the refrigerator, the remainder of the liquid evaporates, and in so doing abstracts heat from its surroundings, shown as brine in the figure. The working substance is now once more in the vapour state, at the lower pressure, and is returned to the compressor for a further cycle of operations.

Choice of Refrigerant

Ammonia and carbon dioxide are the two most commonly used refrigerating substances in machines of the vapour compression class, but sulphur dioxide, ethyl chloride, methyl chloride, and dichlorodifluoromethane are also frequently found, and even water has been tried. Any liquid is, in fact, a possible refrigerant, but certain features, both practical and thermodynamic, have to be taken into account when making a choice. The thermodynamic considerations are outside the scope of this article, but the more important of the practical requirements may be considered.

First and foremost is the size of the machine that will be required, and it will be found that a machine using carbon dioxide will have the greatest compactness, with ammonia next on the list.

Another important factor influencing the choice of refrigerant is the pressure limits of the machine. These limits are fixed for any given refrigerating agent by the temperatures in the condenser and evaporator, and should be neither excessively high nor low, as otherwise there will be considerable difficulty in keeping the joints gas tight, and preventing loss of the working substance, or ingress of air.

The working substance should, of course, be reasonably cheap, and freely available; it should be harmless to human beings, and to commodities, and leaks should also be readily indicated and located. No refrigerant has yet been found to meet all these requirements, but of those available, carbon dioxide and ammonia come nearest to the ideal.

(To be continued)

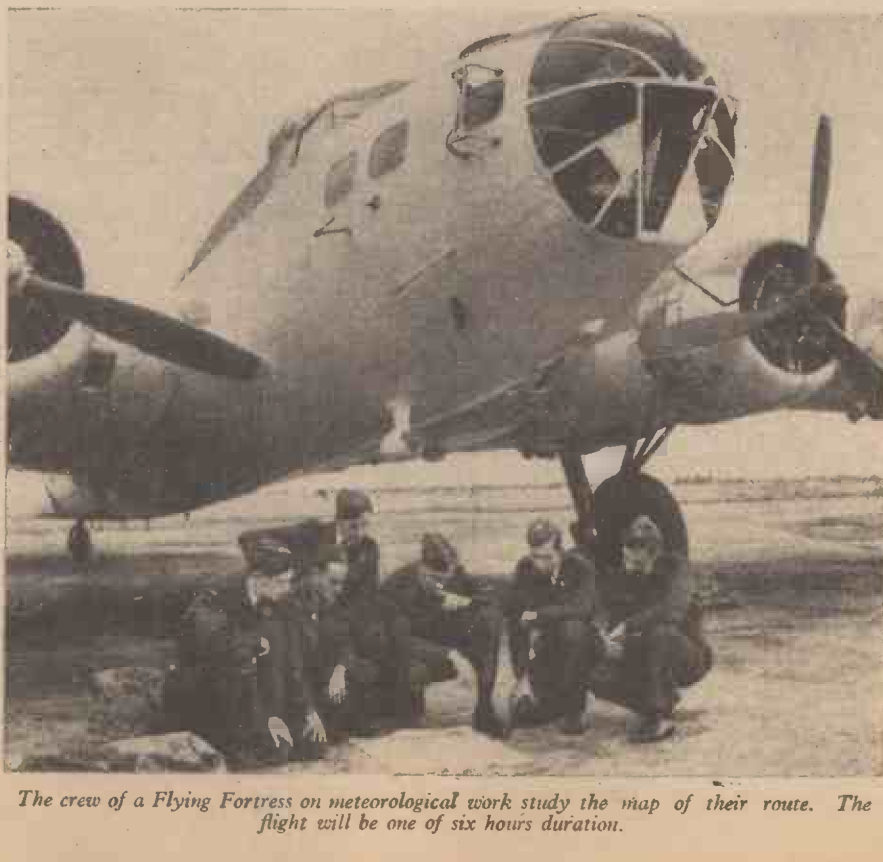
In Search of a "Deep Depression"

THE accompanying illustration shows part of the work of the R.A.F. Meteorological Service.

Twice a day a Fortress goes up on a six-hour flight over the North Sea (at four a.m. and ten a.m.) on a set course, up to a height of 18,000ft., taking meteorological observations. These "met" flights, as they are called, are also supplemented by Hurricanes flying up to 30,000 ft. on upper-air observations, on regular one-and-a-half hour flights. A crew of seven goes on these met. flights; first and second pilots, met. air observer, navigator, flight engineer, and the two "wops." The observer and a wireless operator use a camera from time to time to "shoot" cloud formations, and the other "wop" also operates the radar instrument, which is mainly of value to the navigator when he is flying over strange country with no landmarks to guide him.

These officers and men of Coastal Command Met. Service have missed much of the limelight focused on the operational air crews, but it is entirely due to their steady, perhaps rather monotonous, routine work (including that of those behind the scenes doing the dullest job of all—taking down figures), that vital data have been provided, without which our major air operations would have been impossible.

In peace, as in war, this work must go ahead. Weather will always be a factor of the greatest consequence to civil aviation, shipping, agriculture, and—directly and indirectly—to all of man's enterprises.



The crew of a Flying Fortress on meteorological work study the map of their route. The flight will be one of six hours duration.

An 8ft. Wooden Canoe

Constructional Details of a Serviceable Craft for Young People

By "HOBBYIST"

THE framework of a canvas canoe requires sound knowledge and woodwork experience to construct properly, then comes the difficulty of stretching the canvas over the framing in an expert manner, the cutting, tacking, stitching, waterproofing, etc. It is not everyone who feels like undertaking such a job, even though they have sufficient confidence in themselves. It is chiefly for this reason, therefore, that the light, all-wood canoe illustrated has been designed.

There is nothing elaborate about its construction. It is a simple, practical piece of work, and inexpensive, having a length of 8ft., with a beam of 22ins. and a hull 11ins. deep. The canoe is suitable for most boys aged from 12 to 14 years, and as it has watertight compartments fore and aft there is no likelihood of it sinking should it ever capsize in rough waters.

The canoe is a flat-bottomed craft intended for shallow lakes, ponds and waterways. It is enamel-finished and makes a handsome little craft. Details of paddles are provided, and these—like the canoe itself—can be made cheaply from deal boards.

Fig. 1.—The finished canoe.

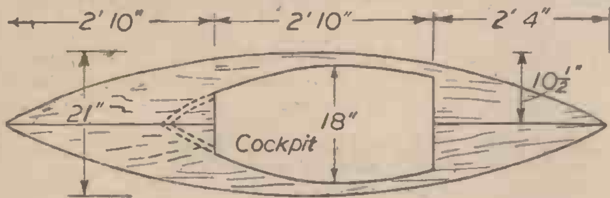


Fig. 2.—Shape and dimensions of deck and bottom.

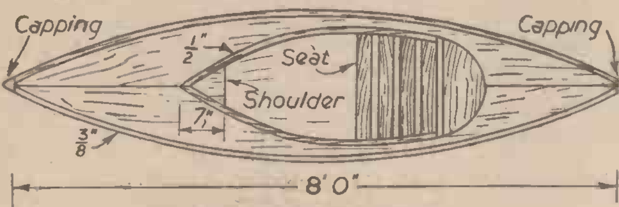


Fig. 3.—Plan of the canoe.

Bottom and Deck

To make the bottom, two 10⅜in. wide by ⅜in. thick prepared boards (shelving) are dowelled together. To make the joint waterproof, groove the edges (after setting out the position of the dowel holes and boring them with a ⅜in. bit) for a tongue of wood about 1in. wide by ¼in. thick. A plough-plane, fitted with a ¼in. wide cutter, is, of course, necessary here.

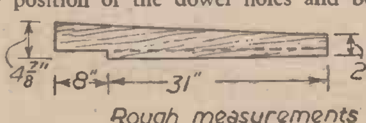


Fig. 6.—Coaming board.

The tongue-and-dowelled joint also applies to the deck (top) boards which, like the bottom boards, are 8ft. long. Having jointed the boards together, using waterproof glue or a thin oil paint as an adhesive, plane both sides with a smoothing plane. The outside shape, as shown at Fig. 2, is marked out, including the position of the two upright cross pieces forming the watertight compartments. Have the cockpit shape marked on the deck, but do not cut it out at the moment.

The shaping, incidentally, is best done with a pad-saw or keyhole saw.

Note that the stem and stern posts are recessed in the ends of the deck and bottom (see Fig. 9). The posts are best fitted when the cross pieces have been screwed to the bottom and braced, as shown at Figs. 4 and 5, following which the deck is attached, using paint and 2in. oval nails.

The inset at Fig. 9 shows an alternative post that may be used, which dispenses with capping pieces at the noses (bows). A suitable recess cut in the deck and bottom "locks" the posts not unlike a dovetail. You could, at this point, line the inside of the work with slips of ½in. square wood, keeping the slips flush with the shaped edges.

Hulls, Coaming and Seat

To facilitate bending, the hull boards (sides) must be extremely thin. It is a good idea to purchase one unplaned board 9ft. long by 11in. wide by 1in. thick and have it sawn in half, then planed to ⅜in. thick at a machine shop. The single board thus provides two thin hull boards 11in. wide. Pick a board free from knots (particularly "dead" knots) as much as possible.

Screw holes are bored and countersunk along the ends of the hull boards. Prior to attaching the ends to the stem or stern posts, give the interior of the work a coat of creosote, including the hulls, then coat all over again (at the joining edges) with thick oil paint or red lead paint.

It is better to use paint than glue, especially ordinary hot Scotch glue, the latter hardening too quickly and being easily affected with dampness.

At the moment, bend and screw down the hull boards by gradual stages. It is best, by the way, to attach one hull completely before attending to the other hull board.

Having attached the hulls, remove the screws singly and plug the holes with putty, then carefully screw the screws home again. Brass screws and copper nails are preferred, as these are not liable to rust like iron screws or nails, if used.

The Cockpit

Cut out the cockpit (by boring a hole for the entry of the keyhole saw blade) and trim it neatly (with a spokeshave) to shape. A pointed shoulder piece is attached to the deck for the coaming pieces (see Figs. 2 and 3), these being cut to the shape shown at Fig. 6. Cut them from ⅜in. or ½in. wood and attach

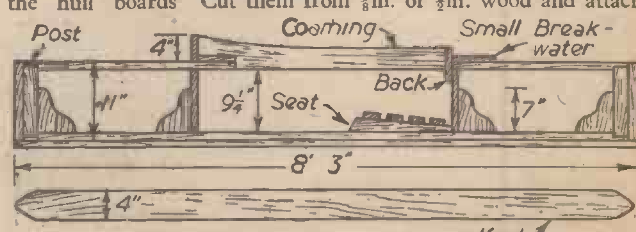


Fig. 4.—A sectional view, with hull board removed, and details of the keel.

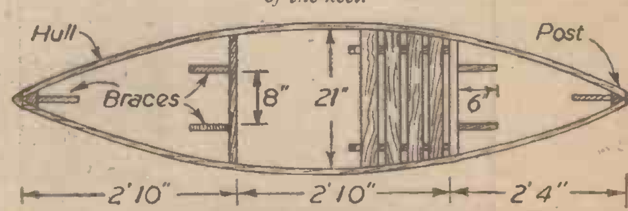


Fig. 5.—Plan view with deck removed to show interior.

to the cockpit edges with screws, the points of the coaming pieces being mitred beforehand.

The back piece also serves as a seat back (see Fig. 4). A semi-circular piece of wood is attached to the deck against the seat back, this acting as a small break-water; it is not an essential part of the canoe, but it adds to the appearance.

The seat is made from 2in. wide by ½in. or ⅝in. thick laths of wood, as shown at Fig. 7. A sloping seat is suggested in the side elevation at Fig. 4. Two supports are cut from ⅞in. stuff, with the laths nailed across. The seat should be fixed to the bottom of the canoe by screws, after which the keel of wood can be added to the underside, the length and width being shown at Fig. 4.

The Paddles

Some canoeists have a preference for a double-bladed paddle rather than a single-bladed one. Details are provided at Fig. 8 for both kinds, the single-bladed kind being cut to shape from a piece of ⅞in. wood 3ft. long by 8ins. wide.

Note how the handle shaft tapers in the width. The blade itself should taper towards the end and also be spokeshaved away at the edges, thereby making it streamlined. The handle is either rounded or kept square in section, with the sharpness removed from the edges. The paddle should be made smooth in every way. Deal has been suggested, but the best kind of wood to use in making the paddle is birch, beech, oak or ash. In fact, any hard wood is preferred to soft woods.

If desired, saw kerfs could be cut in the handle at the top. The idea is to "line" the handle much in the same way as a wood chisel. The kerfs give the hand a better, non-slip grip.

The double-bladed paddle can be made up like the one just described, using a piece of stuff 4ft. or 5ft. long by 8in. wide. You may prefer, however, to cut out circular blades from ¼in. birch plywood (if available) and fit them to a shaped handle as shown. The grain of the plywood should run crosswise and not vertical.

A strong paddle can be made from ⅜in. plywood (for blades) and 1¼in. thick ash (for the handle). Several coats of thin enamel paint will help to preserve the wood and keep it damp-proof.

Finish for the Canoe

The finish for the canoe consists of a coat of creosote, followed with a coat of lead paint, then two coats of enamel paint of attractive colour, such as bright green or else dark blue (royal blue), with the interior a brown colour or bright red. The paddle is coloured the same as the exterior of the canoe.

Naturally, the more coats of paint applied to the work, the more waterproof it becomes. Oil paint is excellent as a foundation paint and finishing paint.

The completed canoe will be found to be somewhat awkward to shift from place to place. A pair of large pram wheels, complete with axle, fitted in a temporary manner to the stem or stern of the canoe, will be found invaluable.

The wheels, if easily removed from the axle, can be stored in the canoe, together with the axle, for use whenever needed.

Although constructed entirely from wood, the canoe will be found comparatively light and very buoyant, and being flat-bottomed, it will float in comparatively shallow waters.

CUTTING LIST

	Long.	Wide.	Thick.
4 deck and bottom boards ..	8ft.	10¾in.	⅞in.
1 hull board ..	9ft.	11in.	1in.
1 keel piece ..	8ft. 3in.	4in.	⅝in.
2 coaming pieces	3ft. 4in.	5in.	⅜in.
1 seat back ..	1ft. 6in.	4in.	⅜in.
2 cross pieces ..	1ft. 8in.	9¼in.	⅞in.
6 braces	7in.	6in.	⅞in.
2 nose posts ..	11in.	2in.	2in.
2 capping pieces	1ft.	1in.	⅞in.
4 seat laths ..	1ft. 9in.	2in.	⅝in.
2 seat supports ..	1ft. 1in.	2in.	⅞in.
1 paddle piece ..	3ft.	8in.	⅞in.

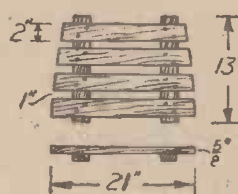


Fig. 7.—Seat.

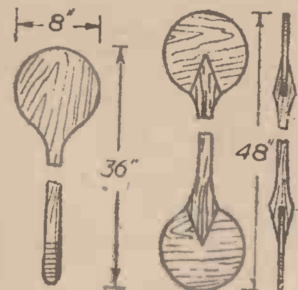


Fig. 8.—Paddle details.

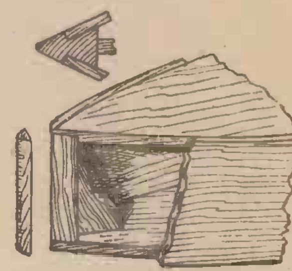
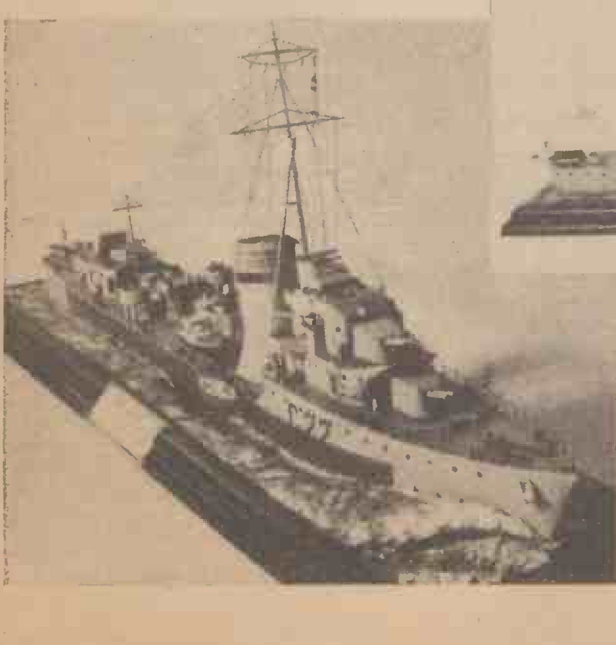


Fig. 9.—Constructional detail of the nose.

NOTE.—Other small parts not mentioned above can be cut from waste wood. Sizes stated are not nett.

A Fine Model Destroyer



This scale model of the destroyer "Jackal" was built by Seaman A. H. Baker. The "Jackal" was launched on October 25th, 1938. On May 11th, 1942, she was damaged in an air attack in the Eastern Mediterranean. She was taken in tow, but had to be sunk by our own forces, as it was impossible to get her into harbour. Mr. Baker decided to make this model in his spare time, as two of his shipmates were survivors from the ship, and supplied him with particulars of her structure.

The Foundations of Thermodynamics—6

Scale of Temperature : Fundamental Interval : Temperature Variations

By R. L. MAUGHAN, M.Sc., F.Inst.P.

(*Continued from page* 219, *March*, 1946)

IT has been seen how a study of the first and second laws of thermodynamics led Rudolf Clausius to the discovery in 1854 of a thermal property of matter which he called entropy, and how a change in the value of this quantity for a given substance can be calculated in terms of a heat-temperature ratio when, and only when, the change in the physical state of the substance takes place as a thermodynamically reversible process. When the state of the substance alters irreversibly, the entropy change associated with it has a value, not always easy to calculate, which is greater than the heat-temperature ratio. This fact is formally expressed by the inequality $S_B - S_A > \int_A^B \frac{dQ}{T}$, where A and B refer to points in the plane of a pressure-volume diagram which define the initial and end states of the substance, S and Q refer to quantities of entropy and heat respectively, and T to a degree of temperature on the absolute scale.

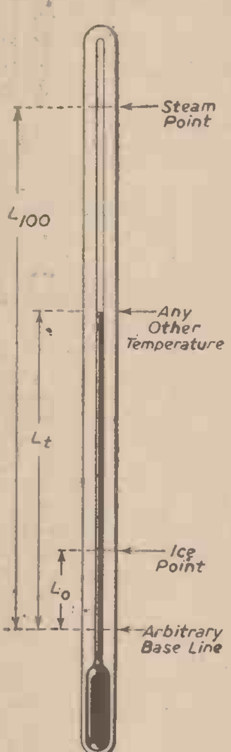


Fig. 26. — Liquid-in-glass thermometer.

In a substance or system of substances which is isolated in the energy sense from its surroundings, so that it cannot be subjected to external influences, the quantity dQ in the above formula denoting an amount of energy supplied to or withdrawn from the system by its surroundings in the form of heat, becomes zero, and the inequality takes the form $S_B - S_A > 0$, or $S_A < S_B$. This indicates that the entropy value of any isolated system always increases when the system undergoes an irreversible change of condition, and continues to increase as long as the condition is changing. By the doctrine of conservation of energy, the universe as a whole can be classed in this manner as an isolated system, since in accordance with that doctrine no energy can be removed from or added to the amount already present in it. It is also known from experiment and observation that physical conditions in the universe are always changing, and further that these changes are thermodynamically irreversible. Reversible phenomena are known in nature, as for example in the previously mentioned thermoelectric effects discovered by Peltier and by Thomson, but as each of them is inevitably accompanied by certain irreversible effects (e.g., the generation of "Joule heat" by the passage of an electric current in a conductor), the phenomenon as a whole is characterised as an irreversible one. If the relation $S_B > S_A$ is therefore referred to all the changes in progress at any specified time everywhere in the universe, it proves that the entropy total for the universe is always increasing. This conclusion was reached in 1854 by Clausius, who used it to sum up the main laws of thermodynamics in the classical line "the energy of the universe is constant, the entropy of the universe strives towards a maximum."

William Thomson, working independently of Clausius and along slightly different lines, arrived at the same conclusion two years earlier, in 1852, but expressed it in a different and rather more sensational manner. Thomson had examined in some detail the properties of the quantity Q/T, without using any particular title to describe it, and had established a relation between it and the energy which is unavailable in a cycle of work for transformation into energy of the desired kind. This relation takes the form, as was shown in Part 5 of this article, of an equation $Q_2 = \frac{Q_1}{T_1} \cdot T_2$, for a reversible process, where Q_2 represents the heat which cannot be converted into work, Q_1 the total heat supplied, T_1 the temperature at which it is supplied, and T_2 the lower temperature which, as Sadi Carnot had shown almost thirty years previously, must be available if there is to be any conversion at all of heat into work. Thomson saw from this equation that as all natural processes caused the quantity which is measured by Q/T, and which Clausius afterwards called entropy, to increase in magnitude, and also that as a result of the collected transformations of heat into work everywhere in progress the pooling of the unused heat caused the lowest available temperature left for use in future transformations to rise gradually, the amount of unavailable energy was, for these two scores, increasing steadily. He summarised these findings by proclaiming that because the total energy present in the universe in all its forms is, in accordance with the principle of conservation of energy, unalterable in amount, and because the fraction of it still available for conversion into mechanical power is hourly becoming less and less, the passage of time must eventually bring about the heat-death of the universe, after which there can be no more transformations of energy from one sort into another.

Scale of Temperature

The work in the province of thermodynamics for which Thomson is probably most famed is his creation of an absolute thermodynamic scale of temperature. Temperature is a word used in the physical sense to describe an intensity of hotness, and the purpose of a scale of temperature is to represent any given intensity of hotness uniquely and reliably by a pure number. Before the introduction of the thermodynamic scale, all measurements of temperature were quoted in terms of some physical property of matter, such as the length of a column of liquid enclosed in a glass tube, but because of small differences shown by different substances in their rates of variation of the selected property (as, for example, in the rates of expansion of mercury, alcohol or sulphuric acid enclosed in glass), no two temperature scales based upon properties of matter were found to agree exactly. It became the aim of scientists, therefore, to arrive at a conception of temperature which was absolute in the sense that it was free from the peculiarities of any particular property of matter, and this purpose was achieved by Thomson in 1848. His scale is defined in a manner which makes it independent of the behaviour of any material body, but when it is used as a practical means of measuring real temperatures, recourse must once more be made to one of the older scales based upon the properties of a real substance.

In order to establish one of these older types of scale, some physical property of

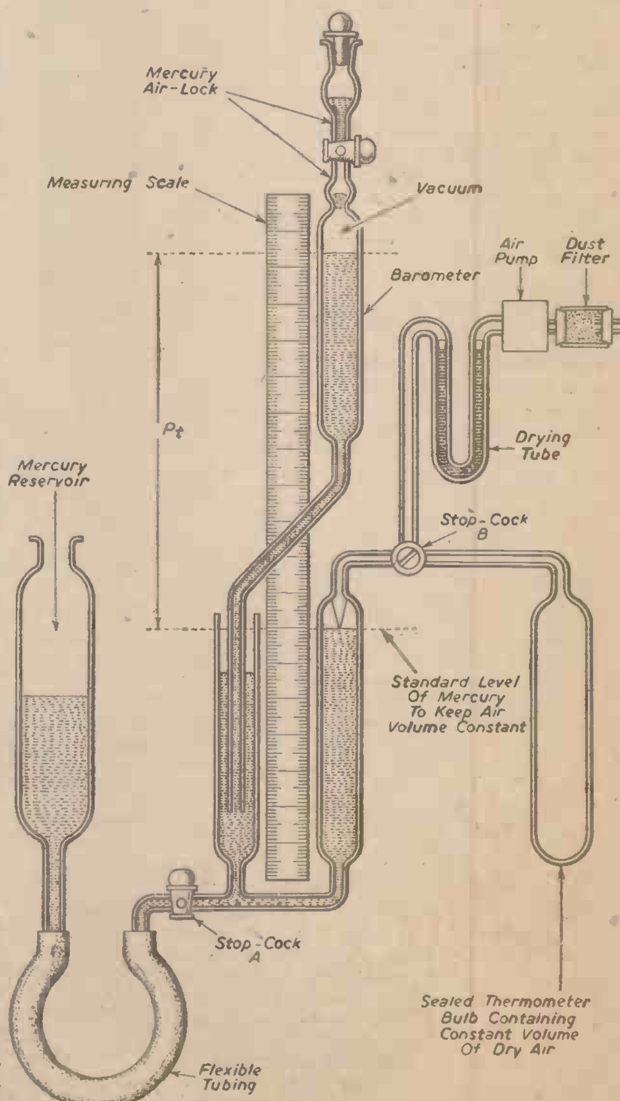


Fig. 27.—Constant volume air thermometer.

matter is first of all selected which varies uniquely with hotness. A great number of such properties presents itself to scientists, among them being the length of a column of liquid in a narrow glass vessel, the volume of a given mass of gas kept at a constant pressure, the pressure of a given mass of gas at constant volume, the saturation vapour pressure of a liquid, the electrical resistance of a metal of specified shape and size, the electromotive force of a thermocircuit, the velocity of sound in a gas, the pitch of a note from a vibrating tuning fork, the solubility of a liquid for a solid, the elasticity of a metal, the viscosity of a gas or liquid, the surface tension of a liquid, the magnetic moment of a magnet, the refractive index of a transparent liquid, and the intensity and quality of the electromagnetic radiations from a hot body. Not all of these are suitable thermometric properties; some give too small a response to a temperature change, others would present considerable technical difficulties in the design and successful operation of a practical thermometer based on them.

After making the selection of a suitable property, its magnitude is measured at any two arbitrarily chosen standard temperatures which are referred to as the "fixed points." As these standards should be easily and accurately reproducible, and readily accessible to all who desire to consult them, and should mark off a range of temperature commonly encountered in ordinary experience, the fixed points which are usually chosen are the melting point of ice under normal pressure, and the boiling point of water under normal pressure. The ice-point was proposed by Robert Hooke at Oxford in 1664, and the steam-point by Huygens in 1665. Other more curious standards, suggested in the early days of thermometry, included the temperature of melting butter and the temperature of a dairy cow, though these, perhaps, may not appear too curious when it is recalled that the fundamental unit of mechanical power, the horse-power, which is still in general use, was proposed by James Watt after a study of the performance of dray horses at a London brewery.

"Fundamental Interval"

The range of temperature between the two fixed points is described as the "fundamental interval" of the scale, and its subdivision into a specified number of units or degrees determines the nature of the scale. Any fundamental interval which contains one hundred units is classed as a centigrade or Celsius scale after its inventor Anders Celsius, a Swedish astronomer who introduced it in 1742. Some years earlier, Gabriel Fahrenheit, a physicist of Danzig, had proposed the scale which contains 180 degrees in its fundamental interval and whose zero is 32 Fahrenheit degrees below the ice-point. It is recorded that Fahrenheit chose this value for his zero as it was the lowest temperature reached in Danzig in the winter of 1709. A third class of temperature scale, no longer in such wide use as those of Celsius and Fahrenheit, was proposed in the early part of the 18th century by Antoine de Reaumur, and has its fundamental interval divided into 80 degrees numbered from a zero at the ice-point.

After the selection of the fixed points and the division of the fundamental interval into a definite number of units, the scale becomes completely defined by a ruling that equal intervals of temperature shall correspond to equal changes in the magnitude of the chosen property of matter. This makes temperature a linear function of the magnitude of the particular property on which the scale is based, and since the various properties of matter do not exhibit the same rates of temperature variation, no two scales based upon the behaviour of substances agree completely. The pure number which represents a degree of temperature is readily calculated from this arbitrarily imposed linear law. If the magnitude of the selected property is denoted by the symbol F, then its linear variation with temperature is expressed by the equation $F_t = F_o.(1 + k.t)$, where F_o, F_t denote respectively its magnitude at the ice-point and at any other temperature which is to be associated with the number t, and where k is the temperature coefficient of variation of F. If the scale is of the centigrade type, with its zero at the ice-point, a particular case of this formula is obtained by substituting 100 for the symbol t, giving $F_{100} = F_o.(1 + k.100)$, and by eliminating the constant quantity k from these two equations, the number t is given by $t = \frac{(F_t - F_o)}{F_{100} - F_o} \times 100$. The fact that F is present to the same power in the numerator and denominator of the right hand side of this equation makes t a pure number, no matter what particular physical units F may happen to possess.

Thermometers

To use this formula to calculate a temperature number, a suitable instrument, the thermometer, is required to measure the magnitude of the physical property at the ice-point, the steam-point, and the unknown temperature. In the familiar liquid-in-glass type of thermometer (Fig. 26), the particular property to be measured is the length of the liquid column in any convenient units of length, above any chosen level in the bore of the tube. The temperature in degrees centigrade is then calculated from the formula $t = \frac{(L_t - L_o) \times 100}{L_{100} - L_o}$. This type of thermometer is compact, portable, easy to manipulate, and swift in its response to a temperature fluctuation, but is restricted in its use to the relatively small temperature range in which the thermometric substance preserves its liquid state, and is liable to errors and complications due to non-uniformity of bore in relation to the closeness of the orders of magnitude of the thermal expansion coefficients of the glass envelope and the liquid contained in it. The need for a material which preserves its fluid condition over a greater range of temperature, and whose expansion coefficient is of a much higher order than that of the solid walls of the confining vessel, gave rise to the design of the gas thermometer, in its two variations, the constant volume, and the constant pressure types.

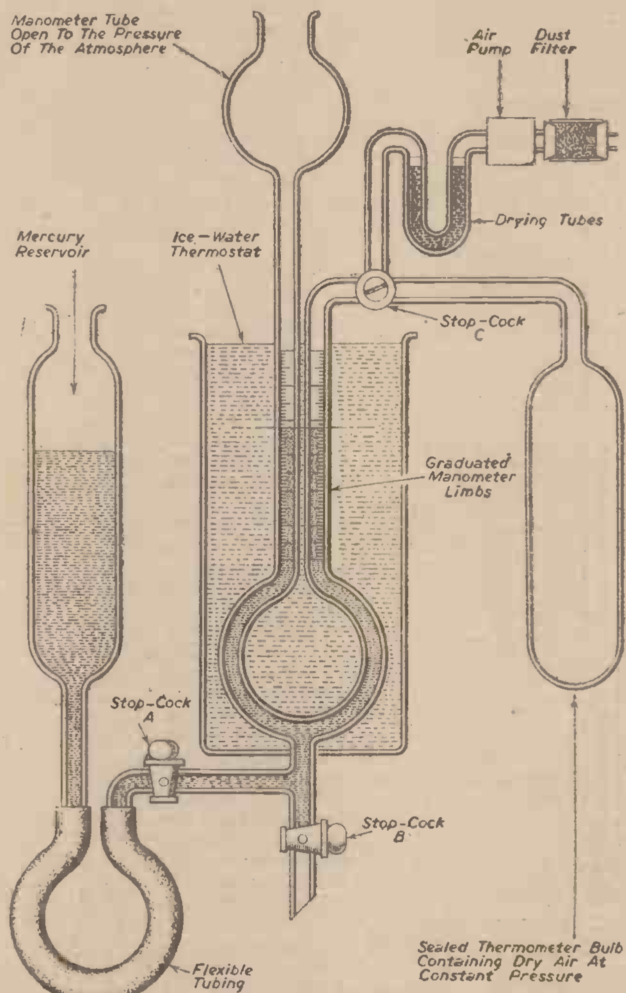


Fig. 28.—Constant pressure air thermometer.

The constant volume air thermometer is illustrated in Fig. 27. A quantity of dry, clean air is pumped through drying tubes and dust filter into the sealed thermometer bulb and dead space of the capillary tube which connects it to the mercury tubes. A three-way stop-cock B cuts off drying tubes and air pump after a sufficient quantity of air has been introduced into the apparatus, leaving the air bulb and mercury bulbs in permanent communication. As the air bulb is immersed in turn in melting ice, in the vapour of distilled water boiling under normal pressure, and in the space whose temperature is to be estimated, the volume of this air is kept constant by opening stop-cock A and adjusting the height of the mercury reservoir in order to keep the mercury at a standard level marked by a V indicator. The corresponding air pressure P_t, registered in centimetres of mercury, is obtained by consulting the barometer incorporated in the apparatus. The required temperature number t is then calculated in centigrade degrees on the constant volume air scale by substituting the measured values P_t, P_{100}, P_o in the formula

$$t = \frac{(P_t - P_o) \times 100}{P_{100} - P_o}.$$

The constant pressure air thermometer is illustrated in Fig. 28. In a manner similar to that used in the constant volume air thermometer, a charge of clean, dry air is introduced into the sealed thermometer bulb, and is then kept at the constant pressure of the atmosphere (which in general can be assumed to be steady for the duration of the experiment), while the air bulb is immersed in turn in ice-water, steam at normal pressure, and in the space whose temperature is required. The various volumes occupied by the air at these successive temperatures are indicated on the graduated limb of the manometer which is in communication with the air bulb. Constancy of pressure is indicated by equal mercury levels in the two manometer limbs, and is arranged by removing mercury through the stop-cock B or adding it as required by opening stop-cock A and adjusting the height of the mercury reservoir. The temperature number t is calculated from the formula $t=\frac{(V_t-V_o)\times 100}{V_{100}-V_o}$, where V denotes the volume of the charge of air.

Temperature Variations

The linear relation between temperature as registered in degrees centigrade on a gas scale, and the corresponding property of the gas (its pressure at constant volume, or its volume at constant pressure), is shown in Fig. 29, where the equation to the straight line can be written as $V_t=V_o(1+A.t)$, or $P_t=P_o(1+B.t)$, according as it refers to the constant pressure or constant volume instrument respectively. If different masses of air are subjected to temperature variations in these two types of thermometer, a family of linear graphs is obtained with a common point of intersection, as shown in Fig. 29.

Constant Coefficients

The common point of intersection marks the temperature at which the pressure or the volume of the gas would vanish, provided the substance were still in a gaseous condition, and still governed by the laws expressed in the above linear equations. This fact suggests a suitable absolute zero of temperature on the gas scale, the temperature at which the gas and its pressure effects just disappear, which is located below the ice-point at a number of degrees equal to 1/A on the constant pressure scale, and 1/B on the constant volume scale, where A and B are the constant coefficients contained in the above two linear equations. Experimental determinations of A and B have shown that they are both numerically equal to 1/273.13, which places a single absolute zero of temperature common to all gas thermometers at a level of 273.13 centigrade degrees below the melting point of ice.

(To be concluded)

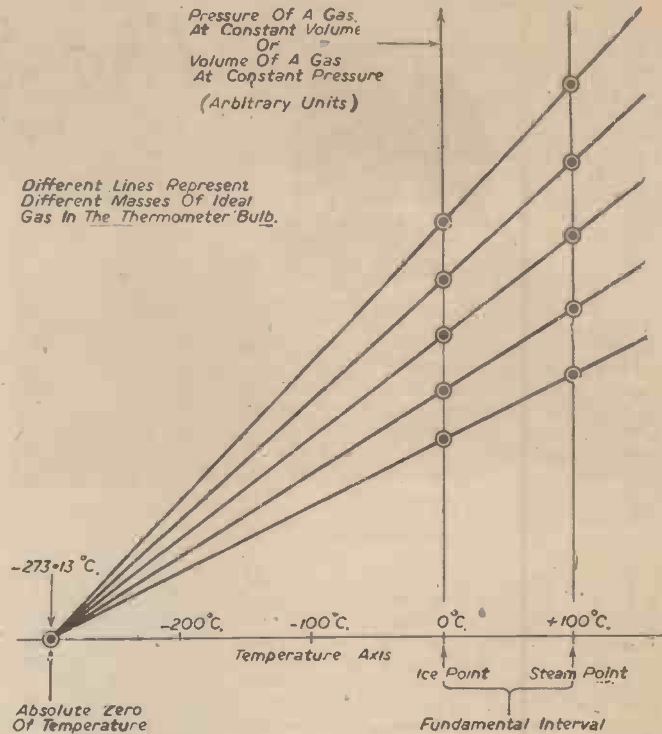
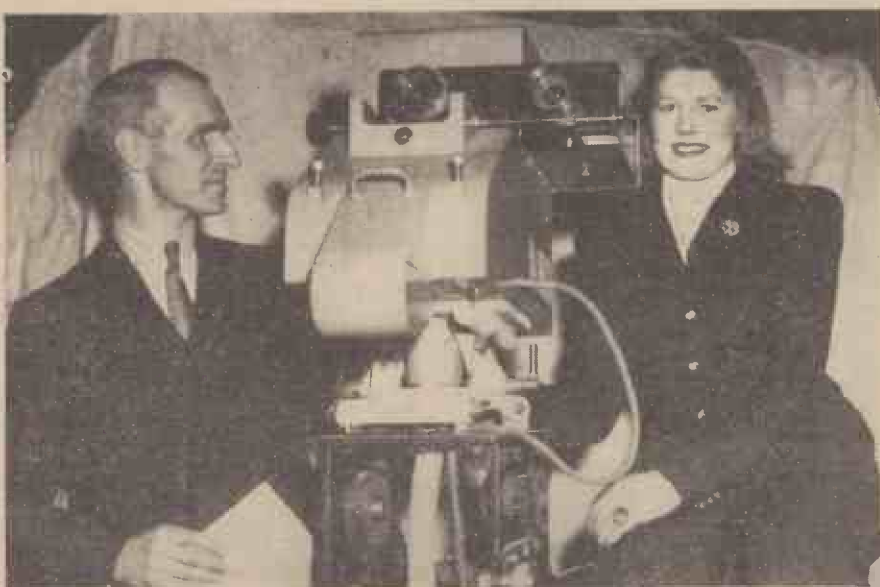


Fig. 29. — Graphical relation between pressure or volume of a gas and temperature as recorded on the Ideal Gas Scale.

Preparing for Television



Programme director Cecil Madden, and announcer Miss Jasmine Bligh, are here seen with a television camera at Alexandra Palace.

THE B.B.C. are going ahead with plans for the resumed television service, and meanwhile the radio industry has scheduled 100,000 new television receivers for production. Furthermore, several firms which supplied the 20,000 pre-war television sets which have lain idle since 1939 are planning to give full assistance in the overhaul of these sets. The date of the first official programme is not yet announced.

Test Transmissions

The transmission of a still pattern from the London Television Station at Alexandra Palace started on February 1st. Transmissions are being made on weekdays from 11.30 a.m. to 12.30 p.m. and from 4 p.m. to 5.30 p.m., and consist of a tuning note and interval signal on the sound channel of 41.5 mc/s (7.23 metres) and a still pattern of a black cross on a white background on the vision channel of 45 m/cs (6.67 metres).

Overhauling Studio Apparatus

The still pattern, which can be produced without the use of studio cameras and apparatus, enables the B.B.C. to carry on the work of overhauling the studio vision apparatus at Alexandra Palace without interruption from the tests, and at the same time provides a test signal suitable for the use of the radio trade.

(Below). Mr. J. F. Cartwright at the vision control panel with Mr. Douglas Birkenshaw, the chief engineer.

One of the special aerial arrays on which enemy aircraft were detected by means of radar.

The Story of Radar—6

Finding the Bomber Target : "Gee H" : Blind Bombing : Navigation

(*Continued from page* 207, *March issue.*)

MEANWHILE the centimetre technique had also been applied to radiolocation devices on the ground. The first centimetric "coastal watching" set for the detection of ships had been constructed at T.R.E., and had so impressed Admiralty experts that they decided to send scientists from the Admiralty Signals Establishment (A.S.E.) and Naval officers to study the new technique with all its advantages.

The culmination of the first stage of development work on centimetric ground radiolocation was a fighter-direction station on the South Coast of England; the success of this station followed largely from the intimate collaboration between the fighter pilots and the personnel operating the station. The pilots gained complete confidence in the directions given to them by means of this equipment, and on their "days off" they visited the G.C.I. Station to watch the control of an operation and hear the directions given to their own comrades who were fighting.

Long before this first centimetric G.C.I. station was superseded a series of Fighter Direction Stations had been equipped and were in successful operation during 1943. Our R.A.F. fighter wings were thus provided with an immense tactical advantage over the enemy. Gradually the enemy zone of operations was forced back into France; eventually modifications had to be introduced to fit higher power transmitters—the enemy had been driven right back out of range of our fighter-direction equipment! These modifications were hurried forward and all were complete by March, 1944, when the Luftwaffe was beginning to be "on the run."

D-Day and After

The organisation of ground-controller's equipment and fighter aircraft fitted with air-interception devices into a tactical weapon was thus accomplished in ample time for its use in the invasion of Europe. The part played by G.C.I. during the latter half of 1944 and the first half of 1945 must await the full story of the final overthrow of the enemy's European power, but our rapid progress from Normandy to the Rhine necessitated several "crash" programmes of modifications to meet the needs of our ever-lengthening lines of offence, while the later operations of a somewhat different type required yet other changes and developments.

Now that the European War is won, the needs of transport over vast distances, and in the tropical conditions of much of the Far East, have posed further problems, the solution of which will not have ceased to be valuable when peace-time applications of G.C.I. to civil aviation become all-important.

Although the Gee system gave highly accurate navigation over Western Germany, the degree of accuracy was not sufficient to achieve blind bombing. It became clear that if blind bombing of targets other than towns by large numbers of aircraft was to be achieved, a system more accurate than Gee must be devised. The bombing of towns was to be provided for by H_2S. The very precise marking of small targets, however, was to be carried out by Oboe. Neither of these systems, however, was capable of providing blind bombing of several tactical targets simultaneously by a considerable number of aircraft. Out of this need the Gee H system was evolved.

The H principle consists of measuring, with great precision, the range of an aircraft from two fixed ground beacons. In contrast with Oboe, where ranges are measured on the ground, in the H system the ranges are measured in the aircraft. The number of aircraft which can use the system is limited only by the power-handling capacity of the beacons. A transmitter in the aircraft sends out a pulse. This is received by each of the ground beacons and returned on a different frequency to the aircraft. The time taken for this process gives a precise measurement of the two ranges, the delays in the beacons having previously been accurately ascertained.

When the range of the aircraft from the two fixed ground beacons has been accurately determined, its position is, of course, fixed. In addition to knowing its position, however, an aircraft requires to know its ground speed, both in magnitude and direction, before it can so release its bombs blindly as to hit the target. The direction of flight is obtained through the aircraft flying along that circle of constant range from one of the beacons which passes through the target. The ground speed is determined by measuring the rate of change of the range from the other beacon. The accuracy of bombing depends, of course, on the position of the target relative to the two beacons, and it can be easily seen that this accuracy decreases as the angle of intersection of the two constant range circles through the target decreases. It was found that, under favourable conditions, bombs could be dropped blind so that most of them fell within a few hundred yards of the target, and when pattern bombing in formation was used, very good concentrations were achieved.

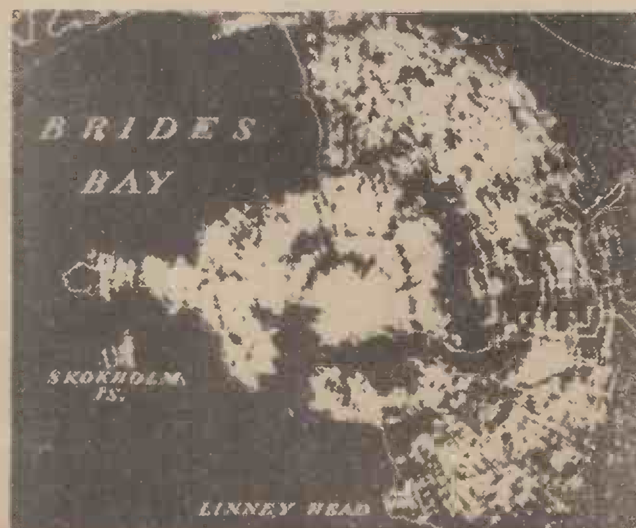
A single pair of ground stations which gave cover for blind bombing of targets in the Ruhr was set up in the autumn of 1943, but the system was not used to any great extent until early in 1944, by which time additional ground beacons had been set up along the South Coast. Gee H really came into its own when the intensive bombing of targets in France and the Low Countries, prior to the invasion, was started early in 1944. It was then used extensively by the American Eighth Air Force, who developed a technique of leading formations of aircraft by single Gee H aircraft.

After D-Day Gee H was used extensively with great effect against flying-bomb sites and many other tactical targets on the Continent. In particular, it was used successfully by No. 2 Group of the 2nd Tactical Air Force. One of the most spectacular achievements by this group in a single operation was the complete destruction of the headquarters of the 21st Panzer Division a few days after D-Day. As the fighting on the Continent advanced and the German Air Force was little in evidence, it became possible for heavy bombers of Bomber Command to fly by day against targets on the Continent. Gee H then began to be used extensively by these aircraft for this type of mission.

Accurate Blind Bombing and Target Marking

It was not long after the crushing defeat of the German Air Force in the "Battle of Britain" that British scientists turned their attention to the possibility of using radar, fresh from its success as a defensive weapon, to bring the growing might of Bomber Command effectively to bear upon Germany. Early in 1941, when work on Gee was already well under way, it was realised that there was a real need for a system which could not only hit a large town, but could pin-point targets such as factories and military installations even under adverse flying conditions.

In order to meet this need for accuracy it was obvious that full use must be made of the range measurement which is at once the essential and the most precise part of any radar measurement, and so a scheme was worked out which fixed the position of a bomber by range measurements from two



A radar map of the south-west tip of Wales as shown at night on the cathode-ray tube of the H_2S apparatus on an R.A.F. aircraft.

suitably placed ground radar stations. In this system, known as Oboe, it was planned that all the control of the operation should be done from the ground and that the aircraft equipment should be as simple and automatic as possible, in a later stage of development it might in fact be possible to dispatch the aircraft with no crew whatever.

The system as developed in 1941-1942 consisted of two suitably placed ground radar stations A and B, which obtained responding pulses from the Oboe-controlled aircraft. Ground station A, known as the tracking or "cat" station, defined a narrow track at constant range from the station by sending signals in the form of dots and dashes to the pilot. He was thus guided towards the chosen target. In early models the amplitude of these signals, dots or dashes, told the pilot how far he was from the track. In later versions of Oboe rate-aiding principles were applied and the amplitude of the signals then told the pilot not when he was on track, but when his heading was correct, i.e., accurately towards the target. The ground station B, known as the releasing or "mouse" station, measured the ground speed of the aircraft as it approached the target along the track and sent a signal to the bomb aimer to tell him when to press the bomb release switch (on some aircraft it was arranged that the signal itself released the bombs).

In order to try out the system as early as possible, the first Oboe (Mark I) was produced, using carrier frequencies in the 1½ metre band. It was planned that if these trials were successful a scheme (Mark II) suitable for operational use and using a wavelength of a few centimetres would be produced. The trials of the Mark I system in May, 1942, using a bombing range in the Bristol Channel, were so successful that the Air Ministry made an immediate request for the Mark I system to be built in an operational form, with a view to attacking the Ruhr area. The relative ease of jamming the 200 mc/s system was well known, but it was decided that the system would be well worth while building even if it only lasted three weeks!

In the middle of 1942 a device which proved a milestone in the annals of Bomber Command was produced, the marker bomb or target indicator. Oboe dropped the first of these on a range in Southern England at night in a trial watched by many Air Ministry and Bomber Command officers, and immediately the possibility of using Oboe in conjunction with the main force of Bomber Command instead of with a specialised squadron, became apparent. For the attack on the Ruhr, Oboe Mark I ground stations were hand-built and set up at Dover and Cromer. Two stations, each of which could work as tracking or releasing stations, were installed on each site so that two aircraft could be controlled simultaneously. A squadron of Mosquitoes was fitted with the responders and special pulse-communication receivers and training began in September, 1942. In December, 1942, the first trial bombing raid was made on the Ruhr, four Mosquitoes flying at 28,000ft. on a wild winter night. The aircraft navigated themselves to some point on the circular track about 50 miles from the target by means of Gee. Oboe control then took over and the pilot was given signals to guide him along the curved track. Signals were given from the mouse stations to tell the bomb aimer when he was approaching the target, and finally a signal was sent which accurately defined the release point for the bomb.

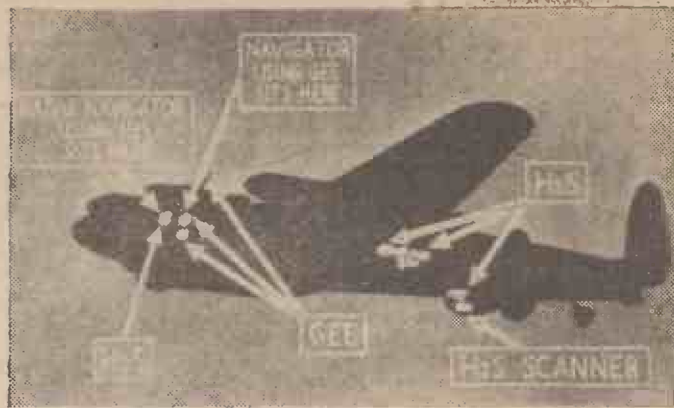


Diagram indicating the positions of various radar apparatus on an R.A.F. night-flying bomber.

In February, 1943, small marking raids were started with a backing-up force of less than 40 bombers, but by March so much confidence was placed in the system that the 12 Oboe Mosquitoes were dropping their target indicators to mark the aiming point for 860 bombers on Dusseldorf. Then followed the whole series of devastating raids on the Ruhr in which Essen, Dortmund, Cologne, Duisberg, Wuppertal, etc., were all attacked.

The Germans had started jamming Oboe Mark I in October, 1943, but by taking suitable anti-jamming measures the system was kept operational until November, 1944. The risk that had been taken on the 1½ metre system had been justified in that all suitable targets within range had been wiped out.

In December, 1943, operations were commenced on an experimental system on centimetres where freedom from jamming was expected.

Much of the actual centimetre equipment used in the Mark II project was developed jointly by British and American scientists working together in the same laboratory in England. The outcome of this joint effort was that America was able to supply all the centimetre airborne transmitters and special transmitting valves required for use both by Bomber Command and by the U.S. Ninth Air Force. Similarly, all the receivers for both Air Forces were produced in England. The accuracy of the system was further improved and mobile stations were installed on the south coast of England with a view to enabling Bomber Command to support the forthcoming invasion. These Mark II mobile stations, together with the coverage provided by the Mark I fixed stations, were used continuously for precision bombing and small marking attacks on tactical targets—railway yards, airfields, radar stations, etc., and later on dozens of "flying-bomb" sites in Northern France.

Diagram indicating how radar operates on a warship. Aircraft have been caught in the radar beam. The two small inverted V's on the right in the circle indicate the two aeroplanes, as seen by the radar operator. The "hump" on the left is the radar transmission signal.

In the early hours of the morning of June 6th, 1944, 50 Oboe-equipped Mosquitoes dropped five target indicators on each of 10 coastal defence batteries on the German held coast between Cherbourg and Caen. Immediately 100 Lancasters hovering near each target aimed 500 tons of bombs at each cluster of indicators and the invasion attack began. During the following weeks Oboe was used consistently by night and day for marking tactical targets so that Bomber Command could be brought to the aid of the armies in the field—in many cases the targets, such as Caen, were but a mile from our front line troops.

In a few months, 24 Oboe mobile ground stations were in operation on the Continent, moving forward as the armies moved and controlling not only Pathfinder Mosquitoes of Bomber Command, but also Pathfinder Marauders of the Ninth American Air Force, 36 of which were fitted with Oboe. In some months as many as 70 per cent of the bombs dropped by the Ninth U.S.A.A.F. were dropped blind, using this method.

Navigation and Finding the Target—H_2S

When it became possible to transmit and receive signals on a wavelength of a few centimetres instead of 1½ metres, which had hitherto been the shortest usable wavelength, a completely new range of radar equipment became possible. The radar systems would now be capable of working to much finer limits both in the amount of detail and the accuracy of the information available, because of the narrower beams and sharper pulses which could be produced on centimetre wavelengths.

In the autumn of 1941, when many of the early difficulties had been solved, the comparative failure of our bombing effort against Germany was strongly in the minds of the workers at T.R.E. and effort was transferred from AI to the problem of producing a blind-bombing sight. It was appreciated that the new AI system, with very little modification, might be usable as a blind-bombing device. The beam of radiation which normally searched the sky for hostile aircraft could be made to search the ground for towns, factories, etc., which one would expect to stand out as "targets" on the display against a weaker background from the open country. That such a method of detecting towns was possible had been demonstrated previously using a system working on a wavelength of 1½ metres, but on this wavelength only very isolated towns could be located due to the overlapping of the responses from hills and woods included in the "illumination" by the broad beam. Beyond recording this as a factor to be further investigated and possibly exploited, nothing had been done. In November, 1941, a trial flight with an AI aircraft in which the aerial had been adapted for downward looking showed immediate promise in that during a flight from the base at Christchurch to Wolverhampton, a series of " targets " were seen on the radar display and it was possible later to correlate these with specific objects on the ground. After this early success, work was immediately put in hand to re-design the AI aerial system specifically for the purpose of scanning the ground and to build up a system whereby the navigator in a bomber could have presented to him on a screen, a radar map of the terrain over which he was flying. On this map large built-up areas or other man-made objects, such as factories, would show up as high lights, due to the radar echoes from these objects being very strong, stretches of water, lakes, rivers, etc., would be left completely black, since water reflects little or no radiation back towards the aircraft, and open country, sending back a random assortment of weak echoes, would appear as an indefinite grey background. This map would be independent of cloud and weather conditions and would allow accurate navigation over any part of Germany (or any other part of the world which was not barren waste or ocean).

Homing Device

The decision to install this new aid soon followed, production on a superlative scale of speed and priority was the greatest of all the " crash programmes " of radar production, but it was vital to keep the enemy in the dark about the purpose of this novel device, even when he had some evidence that new fittings were appearing in our aircraft. So it was to be known as a " homing device." The initials BN for blind navigation by which it had been known were thought too suggestive and a name which could give nothing away H_2S was suggested and H_2S it remained!

Although this was an attempt at a navigational aid and blind bomb-sight of completely new design and the first results were of necessity crude, the need of Bomber Command was so urgent that as early as July, 1942, only seven months after the first preliminary flight trial, the production of units for fitting into heavy bombers was initiated.

H_2S is, then, the " gen box " with a scanner which projects a fine beam of radiation ahead, scans the landscape by illuminating every point in turn over a wide area, and paints (and continually repaints) a map on the PPI tube. In the map the objects which send specially strong echoes back to the set, such as hangars and big buildings generally, appear as bright spots, the water areas which do not turn the energy back towards the sender, but reflect it optically away from the source appear black. So the PPI displays a rather special kind of radar map, in which slant range and bearing is correct for all the identifiable radar landmarks. The fidelity of the first H_2S map was not sufficient for the operator to identify a town from its shape or the presence of distinguishable objects in the town, but only to give an approximate size of the town. The navigator had, therefore, to keep a continuous DR plot to know which towns were showing on his H_2S display. When it came to the actual bombing run, the operator had to estimate the position of Aiming Point on this radar map from the general shape of the town response and if possible obtain a check from prominent small objects on the outskirts. It must not be thought that the development of this aid was all as simple as it has been made to sound, for in addition to the difficulties of establishing a reliable airborne equipment using the new techniques of centimetre waves, the problem of controlling the radiation within fine limits to obtain a uniform picture was considerable. The contrast between town and country is not very great and the picture obtained was very liable to be what a photographer would describe as under- or over-exposed. The H_2S picture was very liable to show under-exposed areas of gaps; and hours of patient experimenting in the air and on the ground to get the correct grading of radiation at all angles from the scanner aerial were necessary. So serious was this that early attempts in America to repeat British results led the experimenters there to despair of making it a practical system. In the end, however, as the technique was progressively improved, there was no doubt that a practical " gen box " was really being evolved.

The development of H_2S was not accomplished without sad loss of life, the first heavy bomber installed crashed on an experimental flight and all the crew and five of the pioneer experimenters were killed.

Pathfinder Technique

Simultaneously, with the development of H_2S, Bomber Command were developing their pathfinder technique and although H_2S was finally produced for the main bomber force, it was possible to achieve great results from the first production models fitted to pathfinder aircraft.

Hamburg was the first target attacked by H_2S on the night of January 30th-31st, 1943, this under appalling flying conditions. Within a few days H_2S raids on Cologne, Turin and Hamburg demonstrated the wide range of a bomber force using this equipment. Navigators, by means of H_2S were able to maintain accurate track and timing, locate their targets without difficulty and avoid defended areas en route.

However, as the centimetre technique developed and experience in the Service showed the need for improvements, modifications were made to the first design, so that the map became a more faithful reproduction of the ground beneath the aircraft and smaller objects were painted distinctly on the screen.

Air Research for Surface Ships (A.S.V.)

The A.O. C.-in-C., Coastal Command, was a frequent visitor to Bawdsey Research Station, an appreciative observer and a stimulating and constructive critic, with a lively enthusiasm. Over the coffee cups in the Bawdsey mess he interrupted a discussion on airborne radiolocation for the night fighter to inquire whether help could be given to the reconnaissance aircraft of Coastal Command in their search for surface ships. No Bawdsey man would admit that radiolocation was inapplicable to searching for anything above the surface from anything else above the surface, and so ASV was born of AI. The custodian of AI development, undertook to develop ASV also. Aided by his group, he made rapid progress in experiments in which the team amassed a very creditable log of flying hours in their airborne laboratory. On September 3rd, 1937—an unrecognised pre-anniversary—the airborne equipment for ship research, ASV, found H.M.S. *Rodney* and H.M.S. *Courageous*, without visual aid and with little knowledge of their time-table, at five miles range, and in the course of shadowing trials on the next day " saw " aircraft being flown off from *Courageous*.

Of all the R.D.F. equipments subsidiary to the main CH-CHL stations, ASV paid the earliest dividends. The 1½ metre equipment, fundamentally similar to the AI set, but less restricted by not being part of a complex operational network, was used with great success by the R.A.F. against enemy shipping and submarines in the second year of the War. The first recorded " kill " was a submarine on February 10th, 1941; the ASV aircraft concerned was a Whitley.

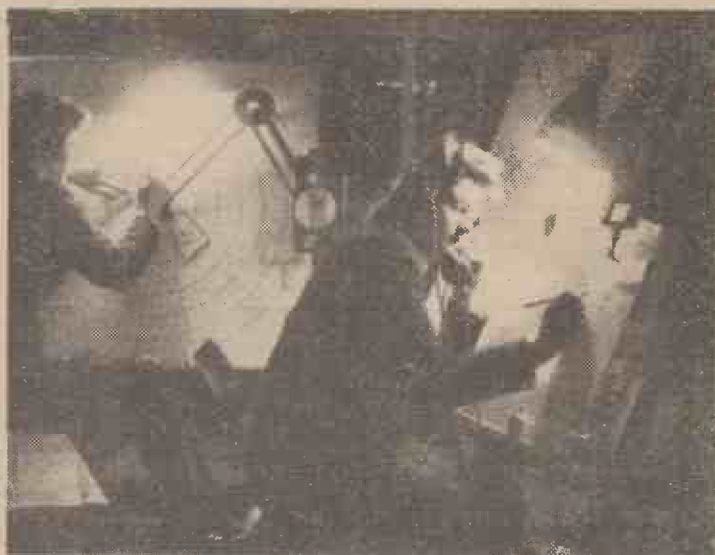
Later, the Sunderlands and Catalinas in their multitude ranged the seas, with successes, such as the finding of the *Bismarck*, to their credit.

" Leigh-light " Operations

The story of ASV development goes into the centimetre wave region about the same time as AI, but for the slightly different reason that the shorter wavelength enables more precise discrimination of targets to be achieved than could even be possible on 1½ metres, except by using a large aerial array, excluded by aerodynamic considerations. No account of ASV would be complete unless it included some details of the " Leigh-light " Wellington and its transitory, but heartening, success against U-boats at the peak of our worst shipping losses in 1942. The breathing-space so gained was of incalculable value to the Allies and enabled us to face the still more disastrous losses of early 1943 in the hopeful knowledge that we were forging another ASV which would practically drive the U-boat from the seas a few months later. The Battle of the Bay of Biscay may be understood from the following notes:

The capture of the French West Coast ports by the Germans in 1940 enabled them to establish submarine bases on the edge of the Atlantic. The Bay of Biscay then became a " transit area," i.e., an area through which the U-boats passed to and from their bases, but which was not primarily their operational area. For many reasons which need not concern us here, such an area is potentially a very good one for anti-submarine work; and in the case of the Bay, since it was within reasonable range of aircraft based in the United Kingdom, a violent and lengthy aircraft versus submarine battle soon developed.

(To be continued)



To further develop the use of radar in the British Navy schools are being set up all over the country, and the illustration shows two Wrens undergoing training in one of the schools.

Shannon Electricity Scheme

A Far-reaching Programme for Eire to Supply Electricity and Piped Water to Every Irish Rural Home

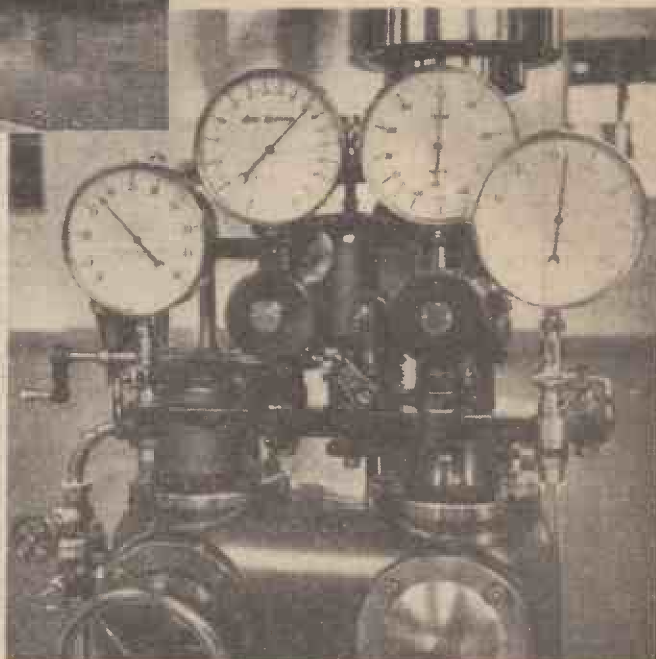
Exterior view of the power station, showing in the background the lock through which traffic using the Shannon must pass.

IF only electricity and piped water could be laid on to every farmhouse and every cottage on Britain's countryside. This is an ideal about which people have long talked and dreamed. Across the Irish Channel, in Eire, they have just started on a programme of construction—the money is voted and the contracts are being placed—that will make the dream come true as far as Eire is concerned.

"A public electricity supply is already available to 95 per cent. of the total Irish population resident in cities, small towns and villages. It is now a question of bringing the supply to the farm community, who in Eire live in dwellings situated on the individual farms."

This passage, taken from a report which the Irish Electricity Supply Board presented last summer to the Government in Dublin, sums up the far-reaching programme on which Eire has now embarked—a programme destined to give every Irish rural home not only electricity but, also, piped water.

The scheme involves spending some £20,000,000, and an additional £3,000,000 will go in harnessing the River Erne in County Donegal, a few miles from where that delectable river enters the sea between Ballyshannon and the popular seaside resort of Bundoran.



(*Above.*) *Four single dials tell the engineers all they want to know to enable them to keep the immense plant working smoothly and without hitch.*

(*Left.*) *Potential transformers controlling the voltage of the transmission lines at the exit from the power station.*

It was in 1925 that engineers put a dam across Ireland's longest river, diverting its waters to make them flow through great turbines installed at Ardnacrusha, near Limerick. The turbines in turn drove dynamos; and the resulting electric current was taken on overhead lines all across Ireland from Limerick to Dublin and from Cork to Sligo, say, from Bristol to London and from Southampton to Liverpool, giving all Ireland electricity, made without burning any fuel at all.

That was the Shannon scheme, for which T. A. McLaughlin, an engineer and present member of the Electricity Supply Board, was responsible.

Exhibition of German Aero Developments

AN interesting and instructive exhibition of German Aeronautical Developments is now being held under the auspices of the Ministry of Education at the Science Museum, South Kensington. The exhibition is admission free and is open on weekdays from 10 a.m. to 6 p.m. and Sundays from 2.30 p.m. to 6 p.m. It will be open for three months. The authorities felt that it was of the utmost importance that students and technicians as well as the general public should have an opportunity of a close-up inspection of what the German aircraft industry achieved. Although, operationally, enemy aeronautical development was at all important times one step behind our own, the Minister of Education felt that it would be of considerable educational value to display German aircraft and equipment to give a true overall picture of aeronautical development.

The exhibits include a number of typical German military aircraft, including a jet-propelled fighter, flying bomb, the gyro-kite for use with U-boats, a piloted V1, a V2-rocket, and radio controlled rocket weapons. Many components and photographs are exhibited, showing to the general public for the first time full details of enemy aeronautical development.

The exhibition coincides with the post-war re-opening of the Science Museum, where exhibits relating to atomic energy, X-rays and the quartz crystal clock are to be seen.

The Mechanics of Meteorology—5

Valley Winds : Depressions : Anticyclones

By G. A. T. BURDETT

(*Continued from page 215, March issue*)

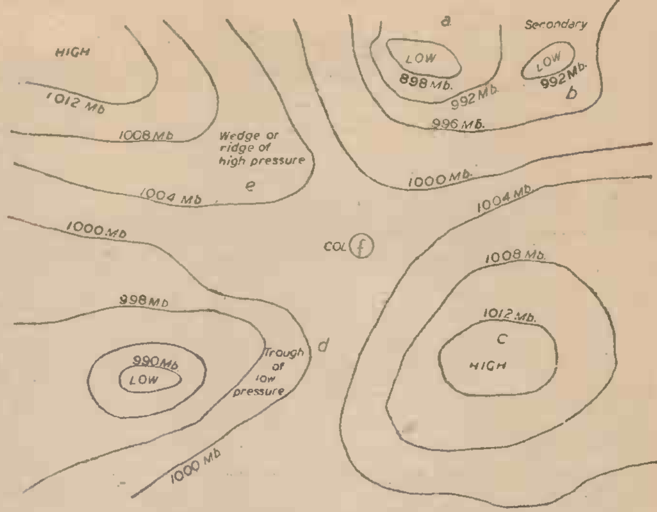


Fig. 34.—*Types of isobar systems.*

VALLEYS in general tend to concentrate the wind, which results in a wind force which exceeds the velocity of the general wind. Since these winds can only blow along the valley in either of two directions, a small change in the general wind direction will cause a valley wind to reverse its direction. It is for this reason that the valley wind must be considered a local wind, since it bears very little relation to the general wind direction. It can, of course, be likened to a stream which flows down the hillside and then flows along the valley between the hills.

Gustiness

Wind gusts are usually present over land and rarely extend to heights above a few hundred feet. They are caused by obstacles on the ground, such as trees, buildings, cliffs and hills. These obstacles tend to break up the general wind in a similar manner to the piers of bridges which cause eddies in the water. For example, a west wind which has a general velocity of 25 m.p.h. will, owing to obstacles, gust between 5 and 35 m.p.h., and will vary considerably in direction. A west wind of 25 m.p.h. may, therefore, cause a south wind to blow down a street north to south in direction at a velocity of 35 m.p.h.

Effect of Wind During Passing of Fronts

It will be seen later that anticyclones and depressions are never stationary, but move across the face of the earth. These, particularly the depressions or lows (regions of low pressure), which move at high speeds, cause a rapid change in pressure distribution.

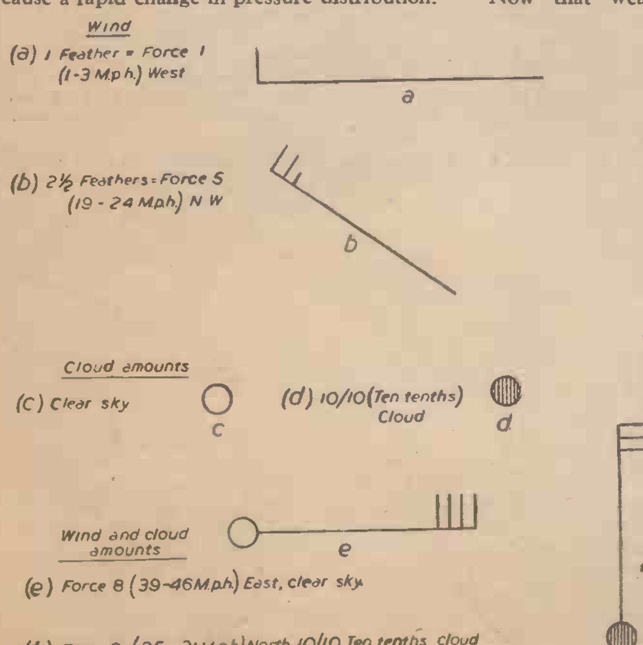


Fig. 33.—Beaufort wind and cloud symbols used on a weather map.

It was shown above that the wind about a high and a low flows in opposite directions. Thus the movement of these will cause a rapid change in wind direction at the places over which they pass.

These winds usually cancel out, or in any event alter the direction of local winds. It is these winds—the general winds—which chiefly concern the meteorologist, since the observation of these changes plays a large part in weather forecasting.

Wind Indications on a Weather Map

We saw earlier that for simplicity of observation and recording the Beaufort wind force was used. As this number will give only the wind speed, it is of little use alone for the purpose of compiling a weather map.

Fig. 33 illustrates an arrow shown on a weather map to indicate the wind speed and direction. The arrow points the direction to which the wind is blowing, while the feather indicates the Beaufort scale number. Half a feather is equal to one step in the Beaufort scale, and a full feather two steps. Used in conjunction with the wind force and direction symbol is the cloud amount symbol, Fig. 33 (c) (d).

For instance, Fig. 33(e) would mean that an east wind of 39-46 m.p.h. (surface wind) is blowing, while the sky is clear.

Pressure Distribution and Frontal Systems

Now that weather forecasts are again broadcast on the radio, the terms depressions, anticyclones, ridge of high pressure, trough of low pressure, and so on, are once more frequently referred to.

To many these somewhat technical terms mean little, if anything at all.

These terms are, however, employed daily by meteorologists as part of their professional jargon, and since to understand the terms is to begin to understand meteorology, they will now be defined.

Each of these terms refers to the pressure distribution at the times and places named in the forecast.

For example, "a depression is centred over Northern Ireland and is moving at a speed of approximately 25 miles per hour in a northeasterly direction," simply means that over that area a region of low atmospheric pressure is centred and is travelling in the direction named.

There are a number of types of pressure distribution, of which six of the more important are described below.

(a) Depression or low.
(b) Secondary depression.
(c) Anticyclone or high.
(d) Trough of low pressure.
(e) Wedge or ridge of high pressure.
(f) Col.

Depression or Low

A depression is a region where the atmospheric pressure is low, and therefore "low" is a common name given to a depression. From Fig. 34a it will be seen that a low represents a number of almost parallel closed isobars having the region of lowest pressure in the centre.

The total area of a depression varies considerably, some being known to have diameters of more than a thousand miles. Their speed of travel also varies, but over Great Britain this is usually in the order of 25 m.p.h. in a north-easterly direction. More often than not they are formed over the Atlantic Ocean and travel via Great Britain towards Scandinavia.

Secondary Depression

Depressions usually appear in families. There is the parent or primary depression about which are formed one or more secondary.

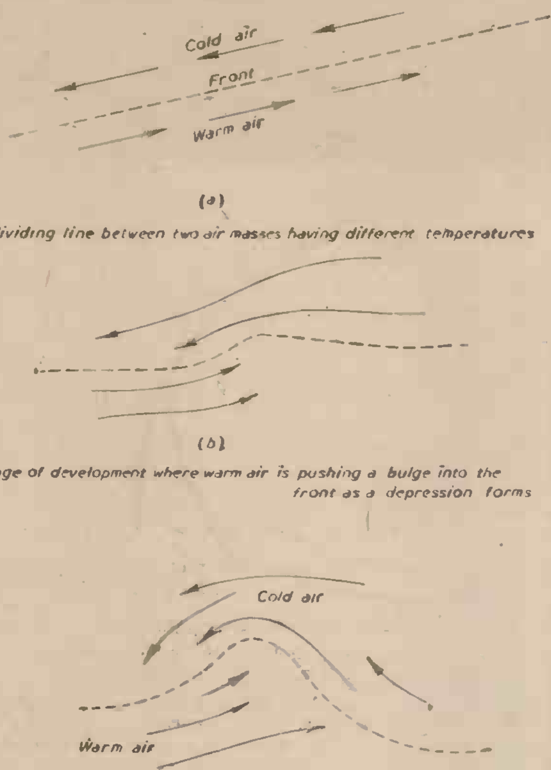
Secondary depressions bear all the characteristics of the primary, and also travel in a north-easterly direction, but they travel at greater speed and revolve usually in an anticlockwise direction round the primary. On occasion the secondary depression will develop into a primary after its "parent" has dispersed, and no fixed rules can be laid down. Fig. 34b illustrates a secondary depression.

Anticyclone, or High

The anticyclone is, in effect, the converse of the depression. It comprises a region of high pressure with the area of highest pressure in the centre, Fig. 34c.

The term anticyclone has been derived from its contemporary the depression, since the scientific name for the latter is a cyclone, but this is rarely used now. The term "high," being self-explanatory, is a popular name by which the anticyclone is often known.

Anticyclones do not travel at the same speed as depressions. In fact, they move very slowly and are often stationary over an area for days, and maybe weeks.



(a)
Front or dividing line between two air masses having different temperatures

(b)
Second stage of development where warm air is pushing a bulge into the front as a depression forms

(c)
Front stage in depression where bulge is enlarged

Fig. 35.—Further stage in depression where bulge is enlarged.

Trough of Low Pressure

A trough of low pressure, Fig. 34d, is a V-shaped depression where the isobars form a sharp bend. These are very similar to the contour lines on a map depicting a valley.

Wedge or Ridge of High Pressure

A wedge of high pressure is the converse to the trough and is usually shaped like an inverted V. See Fig. 34e.

Col

A col is the region of low pressure between two anticyclones. Fig. 34f.

It was shown in Article IV that the wind travels round an anticyclone in a clockwise direction. Therefore the col is the place where the two sets of wind from different anticyclones meet in different directions.

A col rarely lasts for a long period, since the region of low pressure provides a path for the passage of a depression, which will disperse it.

Weather Conditions

As the various forms of pressure distribution outlined above dictate to a considerable extent the type of weather which may be expected where they appear over an area, we will now examine weather connected with them.

Depression

When a depression is passing through, a period of bad weather may be expected.

Over the region of low pressure there are considerable rising currents of warm, moist air. The air is then cooled to its dew point, cloud is formed, and rain or precipitation follows. The wind is usually very violent.

A depression usually lasts from one to two days, but sometimes has a life of five days or more, after which it gradually breaks up and disperses.

At this stage the depression, which is the most important "weather factor," has only been dealt with in general terms. In view of its importance further reference will be made to it when dealing with frontal systems and weather maps.

Anticyclone

In summer fine weather may be expected during an anticyclone. During the day the wind is almost absent, there is much sunshine, and the temperature is high. At night the sky will be clear, but, as mentioned earlier, the conditions are usually favourable for the formation of radiation fog or ground mist.

In winter weather conditions vary, since there are two types of anticyclone.

(1) Those being fine, but cold, weather with the ground frost or fog at night.

(2) Those where the sky is continually overcast, with sheets of low stratocumulus cloud. Conditions of this nature are often termed "anticyclonic gloom."

This gloom is due largely to the existence of an inversion. An inversion, as was explained to some length earlier in this series, is an inversion of air temperature with increase in altitude. Where normally the temperature of the atmosphere decreases with altitude at the rate of approximately 1 deg. F. for each 300 ft., with an inversion it will instead increase for the first 1,000 to 2,000ft.

It is at the limit of the inversion that the cloud will form, and over large towns and industrial areas this cloud is mixed with smoke and dust, so forming a lid over the area which shuts out much of the daylight.

Trough of Low Pressure

The weather consistent with a trough of low pressure is, in common with all low-pressure systems, rather bad.

Over the British Isles the "trough line" is usually a line of occlusion (see later section on frontal systems).

Now the line of occlusion may have either warm-front or cold-front characteristics.

If it has warm-front characteristics there will be continuous rain with low cloud, both in front and at the trough of low pressure. When the trough has passed the weather is milder and wind usually veers from south-westerly or westerly.

Should the trough have cold-front characteristics, and these are more common, the weather will be very squally, with heavy showers, and the temperature will fall rapidly as the wind veers as above.

As mentioned previously, a wedge of high pressure usually appears between two depressions. Therefore the first depression will pass over, followed by the wedge which is again quickly followed by a further depression. Fair weather with light winds may be expected in the wedge, but this rarely lasts long.

Where bright weather quickly follows a depression, a wedge of high pressure may be expected; and one may be practically certain that bad weather is again not far behind with the approach of the second depression.

Col

The col, it will be remembered, is a region between two anticyclones. Since, however, fine weather often appears with anticyclones, the col will not make much difference to the prevailing weather.

On the other hand, the two anticyclones may have different characteristics, particularly as regards temperature and relative humidity.

This difference, in summer time, will give rise to an upward rush of air streams which cause thunderstorms. When fine weather suddenly breaks up with thunderstorms, the presence of a col may be the cause. With the slow advance of another anticyclone, a further period of fair weather is, however, probable.

In winter time the rising of the masses of air of different relative humidity will usually give rise to the formation of mixing fogs.

Generally, however, cols rarely last for long periods, and although they cannot be entirely neglected, they bear little real importance in the general weather "picture."

Frontal Systems

We saw earlier in this series that the structure of an air mass, and the weather which accompanies it, depends upon the history of the mass. Air which has travelled considerable distances over the ocean will be moist, while that from over large areas of land will be comparatively dry.

This may be further expanded by stating that air from the equatorial regions will be warm, while that from the North Pole (in the Northern Hemisphere) will be cold. Generally speaking, therefore, over the British Isles two masses of air may appear, polar and tropical.

Now these two air masses will not readily mix. The masses are divided by distinct lines, known as fronts. On one side we find cold polar and on the other side warm tropical air, Fig. 35a.

To analyse further we now get polar and tropical air masses.

Polar Air Masses

The general characteristics of these are, cold and dry cause considerable upward and downward currents of air (convection), squalls and gusts.

The weather accompanying these is gener-

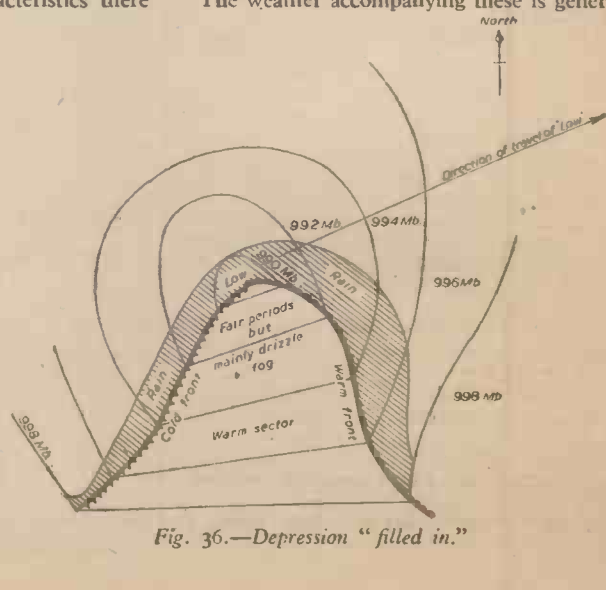


Fig. 36.—Depression "filled in."

ally fair and cloudy, with a risk of thunder. Cumulus, the fine-weather cloud, will also form.

Polar air masses may be of two types, maritime or continental.

Maritime polar masses come from the Greenland-Iceland area, and are therefore moist and cold and give rise to cumulus cloud and showers.

Continental polar masses come from North Russia and Siberia in the summer and from Eastern Europe and Siberia in the winter. They are very dry, therefore, giving few, if any, showers. In winter they are very cold, but in summer may be quite warm. As is well known, a warm, easterly, dry wind is quite common during the summer months, and is no other than the movement of the polar air mass.

Tropical Air Masses

Tropical air masses, on the other hand, are warm and moist, and have little air circulation (convection). Accompanying them is fine and cloudless weather during the summer, but mist, fog and drizzle in the winter.

The maritime tropical masses usually come from the Mediterranean in the summer and from the tropical Atlantic in the winter. They are always very moist, and give rise to considerable fog, particularly in winter. Often during the summer, like the polar maritime air masses, they cause cumulus cloud to form, giving off showers with a risk of thunder.

Continental tropical masses usually come from South-east Europe in the summer and from North Africa in the winter. They are dryer than maritime air and are less liable to cause fog. During the summer, when the land is hot, the weather is usually hot and dry and the skies are clear.

Development of a Depression

The cold polar air which is found on the north side of a "front," Fig. 35a, usually flows in a north-east to a south-west direction. The warm tropical air, on the other hand, flows in the opposite direction. The dividing line between these "passing" air masses is, of course, the front.

Now this air movement is not stable, and a number of disturbances occur.

The warm air, being lighter, tends to rise and cause a bulge in the front. At the same time the heavier cold air also causes another bulge in a southerly direction, Fig. 35b.

The warm-air bulge then develops and causes the cold air to swing back over the warm bulge, Fig. 35c.

We then get (Fig. 36) a sector filled with warm tropical air which is surrounded by the cold air to the north of the front.

A fully developed depression has now formed which, as pointed out earlier, travels in a north-easterly direction.

It will now be seen clearly that when at the beginning of the warm sector, we get a warm front which is immediately followed by the warm sector. Following this, upon reaching the rear portion of the polar air we get a cold front.

The growth of the depression will have caused a redistribution of the atmospheric pressure in the area. These changes are illustrated in Fig. 36, where the isobars have been "filled in."

From this it will be seen that the wind, instead of being in two directions as before the depression formed, is now varying considerably. These wind changes are those which are also present when a depression is passing over an area.

Since the air in the various sectors of a depression has travelled long distances over the ocean from the south-west, it will have a high relative humidity. Therefore, as it rises over the cold air along the front, it will, upon cooling, soon reach its dew point temperature and cloud will form. The cloud in the warm sector is dense nimbostratus.

As, however, the warm light air ascends, other "frontal" clouds will form. These are altostratus, cirrostratus and cirrus, and comprise the four clouds of the warm front system.

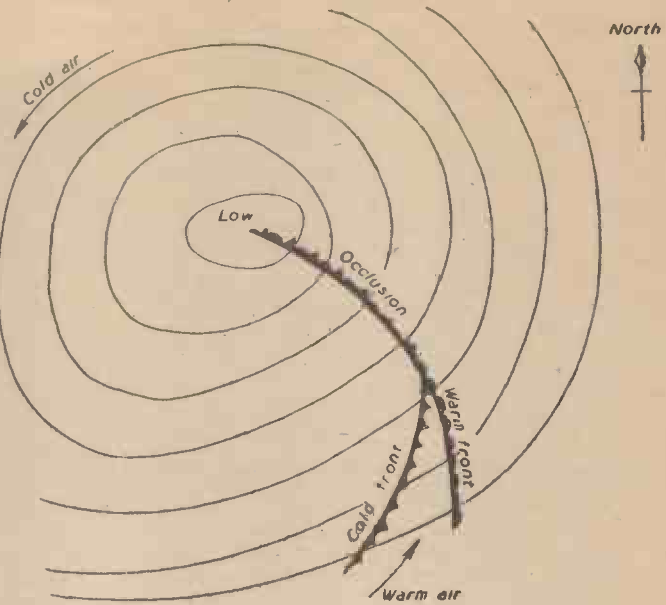


Fig. 38.—Occlusion forming.

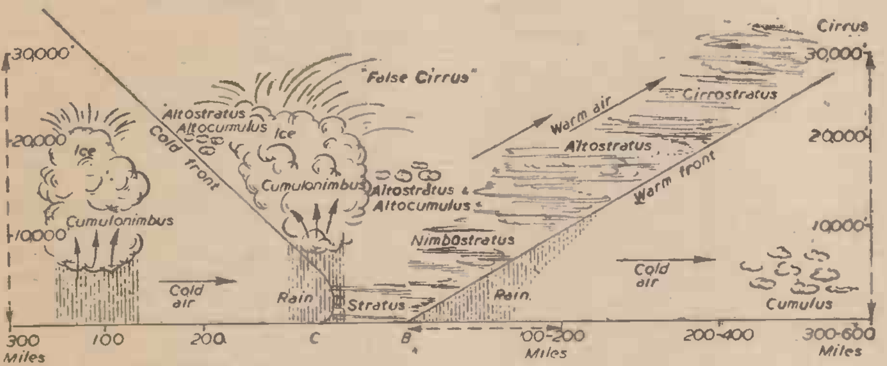


Fig. 37.—Cold and warm fronts showing warm sector (vertical section).

The general character of a warm front will be more readily appreciated by studying its vertical section, Fig. 37.

It will be seen that the warm front extends to approximately 500 miles.

The observer will first of all notice the patches and wisps of cirrus cloud at a height of about 25,000ft. This will be accompanied by a steady fall in the barometer pressure (due to the approach of the low). As the front passes over, thicker cirrostratus will arrive and give the appearance of a halo over the sun or moon.

This cloud will be followed by the strato-cumulus cloud, and the sun will have a watery appearance. The barometer fall is then arrested. The wind, which at first will have been south-easterly and of moderate strength, will now veer towards the south and decrease in speed. Although rain begins to fall from the altostratus cloud, which is now about 15,000ft. thick, most of it usually evaporates before reaching the ground (e.g., it is termed "spitting with rain").

FRONTAL CHARACTERISTICS

Element	In advance	At the passage	In the rear
WARM FRONT			
Pressure	Steady fall	Fall arrested	Little change or slow fall
Wind	Backing and increasing	Veer and decrease	Steady direction
Temperature	Steady or slow rise	Rise but not very sudden	Little change
Humidity	Gradual rise	Rapid rise	Little change. Maybe saturated
Cloud	Ci, Cs, As, Ns, in succession. Fs, Fc, below As and Ns	Low Ns and Fs	St or Sc may persist
Weather	Continuous rain or snow	Precipitation almost or completely stops	Fair or drizzle or intermittent slight rain
Visibility	Very good except in rain	Poor, often mist or fog	Usually poor—mist or fog may persist
COLD FRONT			
Pressure	Fall	Sudden rise	Rise continues more slowly
Wind	Backing and increasing becoming squally	Sudden veer and heavy squall	Backing a little after squall, then fairly steady veering further in later squalls
Temperature	Steady, but fall in pre-frontal rain	Sudden fall	Little change. Variable in showers
Humidity	Little change	Sudden fall	Variable in showers but generally low
Cloud	Ac, As, then heavy Cb	Cb with Fs, Fc or Ns very low	Lifting rapidly followed by As, Ac. Later further Cu or Cb
Weather	Usually some rain, perhaps thunder	Heavy rain, perhaps thunder and hail	Heavy rain for usually short period. Sometimes more persistent. Then fine followed by further showers
Visibility	Poor, perhaps fog	Temporary deterioration followed by rapid improvement	Very good

As —Altostratus Ns —Nimbostratus St —Stratus Ac —Altocumulus
Ci —Cirrus Fs —Fractostratus Sc —Stratocumulus Cu —Cumulus
Cs —Cirrostratus Fc —Fractocumulus Cb —Cumulonimbus

Following this, we get the nimbostratus, or the rain cloud. As will be seen from the figure, there will be much precipitation in the form of continuous rain, snow or sleet for the last 250 miles.

The Warm Sector

When the warm sector, part B, reaches the observer, the sky will begin to clear, leaving patches of strata-cumulus and stratus cloud. The wind then veers to the south-west, increasing in speed. The air is warm and muggy, and it will probably be foggy, while the barometer will remain steady or will fall slightly, since we are now in the steady of the low.

Cold Front

At the cold front we find the comparatively dry polar air. Since this air is heavier, it will push up the warm moist air. These rapidly rising warm-air currents will cause cumulonimbus (the thundercloud) to form.

As the cold front reaches the observer he will soon notice the development of the cumulonimbus cloud, and thunderstorms may occur. The barometer then begins to rise suddenly, and the wind veers suddenly and squalls to a westerly and, finally, a north-westerly direction as the cold front passes through. During this period the temperature will be lower.

The accompanying table shows all the frontal characteristics which are typical.

Occluded Front

Depressions usually form over the Atlantic. Upon reaching the British Isles they are well developed. Rarely are they in the form just described, which is separated warm and cold front.

Instead, they have become occluded or filled up. This is due to the following reasons.

The cold air behind the warm section travels at a greater speed than that at front. This means that the rear cold air, or the cold front, overtakes the warm front and undercuts the warm air.

Fig. 38 illustrates a typical occluded depression which appears over the British Isles. The effect is as of a giant zip fastener, the edges of which are the cold and warm fronts respectively. As these fronts become occluded (the zip is fastened) the gap (the warm section) disappears and the depression breaks up.

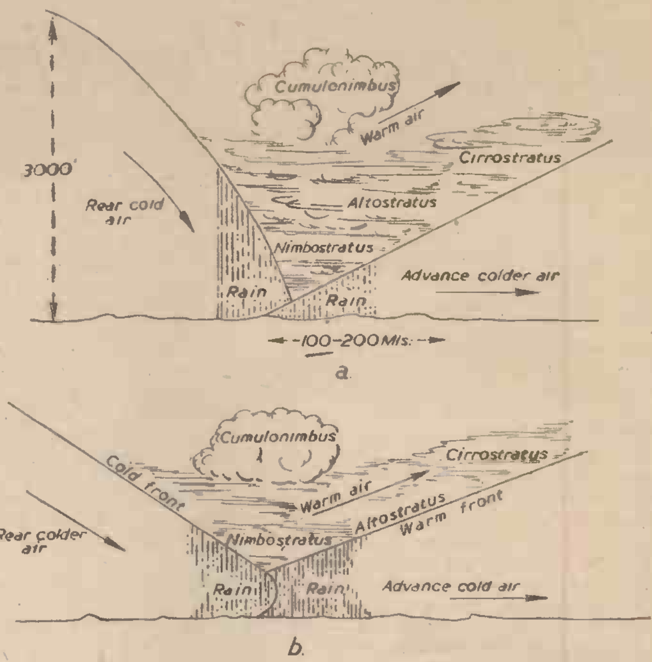


Fig. 39.—(a) Warm front occlusion ; (b) Cold front occlusion.

There are two forms of occluded front, the warm front occlusion and the cold front occlusion. The appearance of either depends upon the relative temperature of the two masses of cold air. If the rear air is warmer it will rise over the advance air, and we get the warm front occlusion (Fig. 39a).

When the advance air is warm the rear air will undercut and appear as a cold front occlusion (Fig. 39b). The main sector is shorter, but cumulonimbus cloud will appear in the warm sector and give rise to thunderstorms.

(To be concluded.)

Notes and News

Johnson's Photographic Competition

MESSRS. JOHNSON AND SONS, of Hendon, have recently issued a list of prizewinners in their November Photographic Competition, which closed on November 30th, 1945.

Two first prizes of £5 each are awarded to: Mr. A. C. Hind, 79, Hartland Drive, Edgware, Middlesex, and Mr. F. Macey, 82, Sycamore Avenue, Cleadon Park Estate, S. Shields.

Three second prizes of £2 each are awarded to: Miss B. Wagstaff, 1, 21, Northwood Hall, Hornsey Lane, N.6; Mr. A. Panes, Frampton Cotterell, nr. Bristol; and Mr. F. J. Palmer, "Redcot," South View Road, Marlow, Bucks.

In addition, there are awards of ten third prizes of £1 each, 20 fourth prizes of 10s. each, and 25 consolation prizes.

New Diesel-electric Locomotives

TWO diesel-electric locomotives have recently been operating on the French railway between Paris and Dijon. Each locomotive has two permanently coupled sections, which are carried on three axles and two trailing bogies. In the centre part of each section there are two four-stroke airless-injection engines having an output of 1,050 h.p. These engines are coupled to generators which supply three double-armature motors which drive the axles through gearing. The auxiliary circuits are fed from a 110-kW. direct-current generator, which is driven from a separate diesel engine.

North Wales Slate Quarry

MOST things in North Wales seem to be made of slate. The chapel where people worship sometimes has slate on its outside walls, and is certainly roofed with slate. Garden fences are sometimes made of slate, tall slivers stuck into the ground and held together at the top with strong wire. Gate posts are made of slate, so are some of the walls, bridges, paving-stones, doorsteps, mantelpieces, sinks and cisterns. Much of the slate comes from the mountains of North Wales, where the Penrhyn slate quarry lies. It is the largest in the world—an enormous excavation a mile and a quarter long, three-quarters of a mile wide and a quarter-mile deep.

Slates have been taken from Penrhyn Quarry for hundreds of years. Historians say the 13th-century Conway and Cærnarvon castles were originally roofed with slate.

Slate from Penrhyn Quarry is obtained in all colours: red, blue, purple, grey and green. It is completely proof against acid, weather and water, and its durability is testified by the original slate roof on St. Asaph Cathedral, in excellent condition after 250 years.

A train of slate from one of the galleries in the quarry takes the blocks, trimmed after blasting, to the dressing shed, where they are sawn into the required shapes, and split.

Lucas' "Freelite" Wind-driven Lighting Plant

Descriptive Details and Notes on Installation and Operation

Fig. 1.—The complete wind-driven lighting plant.

THE Lucas "Freelite" wind-driven dynamo lighting plant provides the ideal solution to the lighting problem in bungalows, sports pavilions, farm buildings or, in fact, any buildings which are remote from an electric supply and where the small lighting demand does not warrant the cost of an engine-driven electric plant.

These lighting sets have been designed and are manufactured as the result of several years' experience—a large number are in operation in many parts of the world.

Description of the Plant

Briefly, the plant comprises a 12-volt dynamo directly coupled to a twin-blade propeller, which together with the headstock, tail, etc., are mounted on a wooden mast or steel tower (Fig. 1). The dynamo generates electricity by being rotated by the propeller which derives its power from the wind.

The dynamo armature is mounted on large ball-bearings, and the twin-blade propeller is designed so that it will operate in light breezes. The dynamo charges a storage battery which supplies current for six lighting points—three of 30 candle power and three of 6 candle power.

The battery consists of two units of the type fitted on cars for lighting and starting. As these batteries are designed for the strenuous conditions of road service, it will be realised that they are capable of giving a very long life when used as a stationary battery supplying a comparatively small lighting load.

The plant includes all components necessary for making the installation and for providing six lighting points. The bulb holders are provided with special adaptors, which enable ordinary motor car bulbs to be used.

Advantages of the Plant

(1) The cheapest method of obtaining electric light — the initial cost is low. There are no running costs, as the supply of energy is provided by the wind. (2) The plant requires the minimum of attention to keep it in good working order. There is no engine requiring fuelling and starting up. The plant can be left in operation unattended for many days, making it the ideal equipment for bungalows and cottages used at week-ends and holidays only. (3) The plant gives safe and silent operation. There is no engine smell or noise, and further, there is no risk of fire. (4) In addition to providing an electric supply for lighting, the equipment can be used for charging radio batteries, or for giving an extra charge to batteries fitted to cars, commercial vehicles or motor cycles. (5) The plant can easily be erected, if the instructions on installing are carefully carried out.

Installation

The site for the mast carrying the propeller and dynamo must be carefully chosen in order to get the best results. It is essential that the airflow is uninterrupted by trees, buildings or other high objects, otherwise the plant will not operate satisfactorily. In order to ensure a good clearance for the propeller over the average house top the mast must be at least 40ft. high—in general the higher the mast the better the performance of the equipment. The mast must not be mounted on the roof or fixed to the chimney of a building, as under these conditions the best results will not be obtained.

While the mast should be clear of buildings, the distance between it and the batteries should be kept as small as possible, and in no case must it exceed 50 yards.

The Mast (Wooden Type)

The most convenient form of wooden mast is one of square section, approximately 4in. by 4in. It must be tapered at the top to 3½in. by 3½in. to take the top of the mast fittings provided; the length of the taper must be 10in. (Fig. 2). A recess must be made at the top of the mast, as shown, in order to allow the sliding member of the furling mechanism to move freely.

Before fitting the headgear on the mast grease the tubular portion of the stand on which the furling mechanism operates. In addition the headgear must be arranged so that the location for the tail is in line with the dynamo; this will ensure that the jaws of the furling lever will locate over the flange on the stand.

When securing the fittings to the top of the mast the square plate in the headgear must fit squarely on the top of the mast, in order to prevent water gaining ingress to the end grain of the timber. Knock the square metal band over the tapering legs of the fittings as far as possible, to secure the headgear in position.

The two steel steps must be bolted to the mast 36 to 40in. below the top of the mast. Connect the eight guy wires as illustrated in Fig. 3. Four guys must be brought up through grooves in the steps and fastened through holes in the legs of the stand, while the other four must be wrapped round the steps as shown.

Deck spikes or other suitable fittings such as are used on telegraph poles may be used as steps, and these should be fitted at intervals of about 18in. on alternate sides of the mast before erecting.

The best method of erecting the mast is to sink a hard wooden post of the same or slightly larger section than the mast firmly into the ground. This post must project at least 2ft. 6in. above the surface of the ground. Fit one bolt through the bottom of the mast and the post. By this means it is possible to assemble the complete headgear, with the exception of the propeller, on the

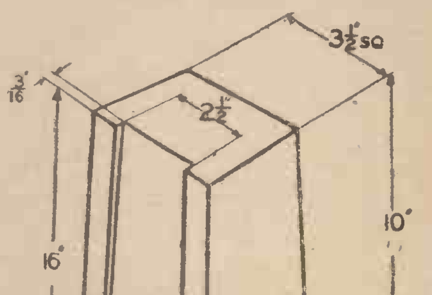


Fig. 2.—Top of the wooden mast, showing tapered end.

ground, and then, by using the bolt at the bottom of the mast as a hinge, to erect the mast by pulling on some guy wires, while the other guys are used to steady and manipulate it. When this is completed, ensure that the mast is vertical by means of a plumb line and then fasten the guy wires firmly to suitable anchorage points.

When fitting the dynamo in its bracket (Fig. 4), see that it is positioned according to the instructions given on the plate fitted on the yoke. The distance from the inner face of the driving end bracket to the near side of the clamping ring must be $3\frac{1}{2}$in.-$3\frac{5}{8}$in. Some dynamos are provided with two pegs on the underside of the yoke. The clamping ring must locate between those pegs.

It is essential to duplicate the main guy wires—that is, use two wires from each corner to the same anchorage point on the ground—also, if desired, additional wires may be fitted half-way down the mast. Finally, fit the remaining bolt at the base of the mast to complete the erection.

The Furling Handle

The furling handle must be screwed to the mast at a convenient height on the same side as the slide on the headgear. Drill a hole a foot below this and drive in the spike holding the furling handle spring.

Wiring the Dynamo

Remove the negative cable terminal from the plate near the top of the headgear and solder into it the end of a length of 7/.064 cable. Carefully clean the terminal and plate to ensure that a good connection will be made, then replace the terminal and securely tighten the bolt. The cable must be run down the side of the mast, supported by means of staples. On reaching the bottom of the mast the cable must be carried along fencing or on wooden stakes driven into the ground and connected to the terminal marked "—D" on the instrument panel at the house or building to be illuminated.

As a protection against lightning a lead must be connected to the negative lead from the dynamo at the bottom of the mast and

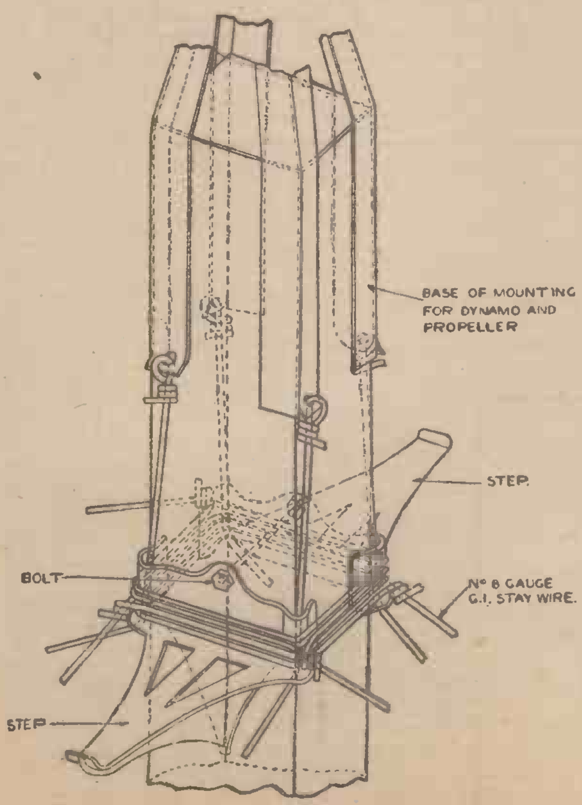


Fig. 3.—Method of attaching steps and guy wires.

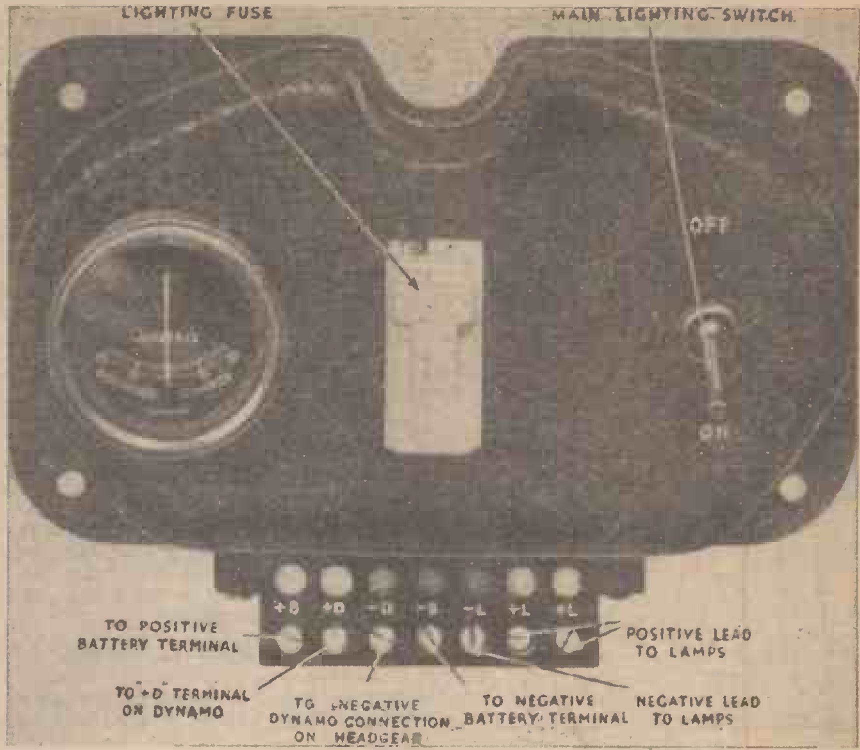


Fig. 5.—The instrument board.

properly "earthed." The join in the lead must be well insulated with tape.

A lead is provided for connecting the dynamo negative terminal to the bolt on the fixing band. These connections must be made tight.

The positive cable (7/.064) must be soldered into the connector on the wire in the centre of the headgear and supported by means of insulators down the opposite side of the mast. This cable must be carried in the same way to the instrument panel and connected to the terminal marked "+D." The cables must be protected from the weather and from damage as much as possible. Fit the rubber caps over the dynamo terminals as shown, in order to prevent the ingress of moisture. During the erection of the dynamo there is always the possibility of its finish being scratched. It is recommended, when the installation of the dynamo is complete, that it is given a coat of rust-resisting paint as a protection against weather.

The Tail

When fitting do not push the tail right home, but allow a clearance of about half an inch to ensure that the tail can move freely. Secure the tail by tightening the two clamping bolts. The rubber bushes must be fitted in position between the small flanged end of the tail and the corresponding flange on the headgear. Apply a little graphite to the rubber bushes in order to assist the tail to move freely.

The Propeller

The propeller must not be fitted until the whole of the erection, installation and wiring is completed and the batteries connected. The efficiency of the plant depends on the propeller, and great care must be taken when handling it. Propellers are carefully balanced and set before leaving the works, and if altered, even very slightly, their efficiency will be decreased.

After the whole installation is finished fit the propeller on the dynamo spindle, with the concave or hollow side facing the wind, and securely tighten and pin the nut; also replace the brass cap which protects the nut and pin. Always handle the propeller by the centre—never by the tips. The propeller must be kept tight on the spindle, and when fitting the propeller see that the tail is in the furled position.

Instrument Board

The instrument board (Fig. 5) must be firmly mounted in an upright position in the house and all connections must be clean and tight. Care must be taken that it is not mounted in an exposed position.

Batteries

The batteries must be housed in a cool and well-ventilated position, either in or close to the house, where they will be readily accessible. It is important that the batteries are as near as possible to the lights in order to prevent high voltage drop in the cables with consequent poor illumination. The two batteries must be connected in series, that is, the negative terminal of one battery must be connected to the positive terminal of the other, with the connector provided. The remaining positive terminal must be connected by a length of 7/.064 cable to the terminal marked "+B" on the instrument panel, the negative battery terminal must be connected to the terminal marked "—B."

Wiring

As this is a low voltage system, heavy feeders of 7/.044 stranded copper wire must be run above the ceilings in the various rooms to be served with light, in order that the full battery voltage may be maintained at the more distant points.

When it is necessary to have one cable crossing another see that they do not touch, but loop one over the other.

1/.064 cable must be used to supply the various rooms by tapping the positive and

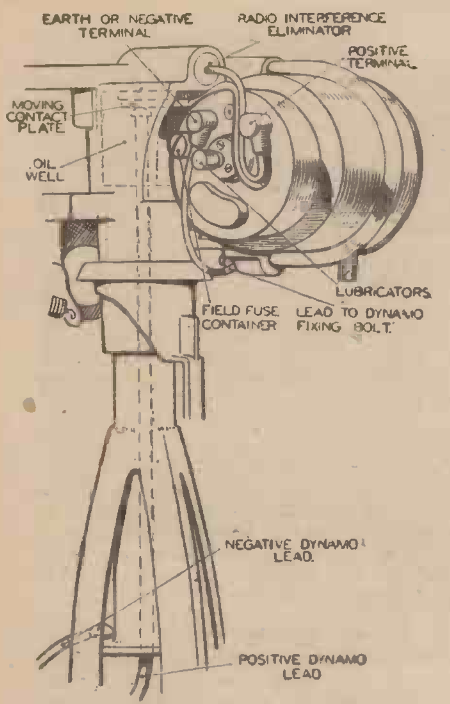


Fig. 4.—Showing how the dynamo is fitted in place.

negative feeders nearest to them, taking care to solder and tape all joints. Heavy twin flex (40/36) must be used from the ceiling roses to the lamp holders.

Lubrication

Fill the oil well on the headgear with car engine oil, also thoroughly soak the wool waste and spin the whole head around several times to ensure that the rotating contact in the head is making good connection with the top of the stand and also to ensure that the headgear is free to turn in the wind. The equipment requires very little attention, but it should be given an occasional inspection in order that it may give the best results.

Maintenance

Do not allow the plant to run with the batteries disconnected, or serious damage may result. Do not allow the plant to run should the dynamo fail to charge. Furl the tail until the trouble is rectified.

Batteries

The following are the most important maintenance points :

1. Keep the acid level with the top of the separators.
2. Add only distilled water, never tap water.
3. Test the condition of the batteries by taking readings of the specific gravity of the acid with a hydrometer.
4. Keep the terminals spanner-tight and smeared with Vaseline.
5. Furl the tail only when attending to the headgear, except in the event of trouble, or if the batteries are overcharged.
6. Keep the tops of the batteries clean and dry.
7. Never allow the batteries to remain in a discharged condition, or serious damage will result.

Topping Up

At least once a month remove the vent plugs in the top of the batteries and examine the level of the acid solution. If necessary add distilled water, which can be obtained at all chemists, and most garages, to bring the level of the acid solution up to the top of the separators. If acid solution has been spilled it must be replaced by a diluted sulphuric acid solution of the same specific gravity as the electrolyte in the cell to which it is to be added. When examining the cells, naked lights must not be held near the vents on account of the possible danger of igniting the gas coming from the plates.

Measuring the State of Charge of the Batteries

If at any time it is desired to know the state of charge of the battery, it can be found by means of an instrument known as a hydrometer.

Before measuring the specific gravity of the acid solution by means of the hydrometer, see that the acid is at its correct level. The readings for each cell should be approximately the same.

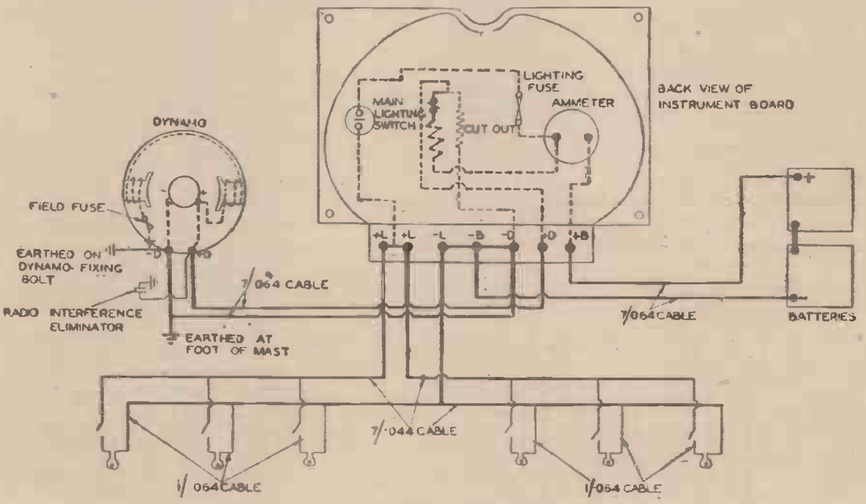


Fig. 6.—Wiring diagram.

The specific gravity readings and their indications at 60 deg. F. are as follows :

1.285–1.300	..	Fully charged.
1.210	..	half discharged.
below 1.150	..	fully discharged.

For temperatures above 60 deg. F. .002 must be added to the reading for every 5 deg. rise, i.e., at 70 deg. F. the fully charged reading should be 1.289–1.304. For temperatures below 60 deg. F. deduct .002 for every 5 deg. fall.

If the specific gravity of the electrolyte falls to between 1.150 and 1.210 economise in the use of the lights until the state of the battery improves.

Dynamo

The dynamo is provided with a grease cap at each end ; about every three months give the caps two turns. When empty, the lubricators must be refilled with a good quality high melting point grease.

Periodically, inspect the two carbon brushes and see that they press firmly on the commutator, and move freely in their holders. Dynamo brushes should be replaced before they are completely worn, in order to avoid interruption of service. A brush is worn out when the spring no longer presses it on to the commutator but comes against a stop instead.

The surface of the commutator must be kept clean and free from brush dust, etc. ; neglect of this precaution will result in the commutator becoming blackened, causing sparking to occur at the brushes and consequently shortening the life of the machine. The best way to clean the commutator is to insert a fine duster, held by means of a suitably shaped piece of wood, against the commutator surface, slowly rotating the armature at the same time.

Dynamo Field Fuse

A fuse is connected in the dynamo field circuit and will blow in the event of anything being wrong in the charging circuit, e.g., the batteries becoming disconnected from the dynamo due to a broken or loose connection at the dynamo and battery terminals. The fuse is housed under the knurled thimble which is screwed into the commutator end plate of the dynamo. The inner end of the fuse is supported by a flat bronze clip, and this must press firmly against the end of the fuse, as a poor contact will cause faulty operation. If found to be loose bend the spring towards the end plate of the dynamo, care being taken that it does not touch the end plate.

Should this fuse blow, indicated by no charge reading being given on the ammeter

SPECIFICATION

The plant consists of the following components :
Twelve-volt Dynamo, armature mounted on ball-bearings.
Twin-blade propeller.
Top of mast mounting for dynamo, fittings for propeller and top step fitting.
Tail and furling equipment.
Batteries. (Two 6-volt 130 ampere hour units, complete with cable connectors.)
Instrument board, incorporating cut-out, main lighting switch fuse, ammeter and distribution box.
Six lighting switches.
Twelve porcelain insulators.
Six lamp holders and adaptors.
Three bulbs, Lucas No. 4, 12 volt, 24 watts.
Three bulbs, Lucas No. 209, 12 volt, 6 watts.
To provide an even greater storage capacity, two extra 6-volt 130 ampere hour batteries may be used.
The lengths of the cable required for wiring the plant will, of course, depend on the distances between the various units. The following size cables are recommended and can be supplied as follows :
Cable between dynamo, batteries and instrument board—Size 7/.064.
House wiring (mains or feeders)—Size 7/.044.
House wiring (tappings to switches and ceiling roses)—Size 1/.064.
In order to complete the installation the following items are required which it is generally more convenient to obtain locally.
Wooden mast, approximately 4in. by 4in.—40ft. high.
Fixing post and bolts to secure mast.
Guy wire—No. 8 gauge, galvanised iron.
Fixings for anchoring guys.
Deck spikes or other suitable fittings for steps up mast.

HOW TO LOCATE AND REMEDY TROUBLE.

(1) LIGHTING

Symptoms.	Possible Causes.	Remedy.
Lamps do not light.	Lighting fuse blown.	Rectify cause of trouble, probably a short circuit in the wiring or at a bulb holder. Replace fuse wire.
	Broken or loose connection in lighting circuit.	Examine connections from instrument board to lighting points. Tighten loose connections or replace broken lead.
	Battery in low state of charge.	See below.
Lamps give poor light, or light when switched on and gradually fade out.	Battery in low state of charge.	See below.

(2) DYNAMO

Symptoms.	Possible Causes.	Remedy.
Battery in low state of charge.	Dynamo not charging, indicated by ammeter not showing charge reading when the dynamo is being driven at a considerable speed with no lights in use. Due to: Broken or loose connection in charging circuit causing field fuse to blow.	Examine charging circuit wiring. Tighten loose connections or replace broken lead. Particularly examine battery connections. Fit replacement fuse.
	Commutator greasy or dirty.	Clean with soft rag moistened with petrol.
	Dynamo giving low or intermittent output, indicated by ammeter giving low or intermittent charge reading when dynamo is being driven at a considerable speed. Due to: Loose connection in dynamo circuit.	Examine charging circuit wiring. Tighten loose connections or replace broken lead. Particularly examine battery connections.
	Commutator or brushes greasy.	Clean with a cloth moistened with petrol.
	Brushes worn, not fitted correctly, or wrong type.	Replace worn brushes. See that brushes "bed" correctly.
	Dynamo not charging due to the headgear binding and preventing the propeller from facing the wind.	Lubricate by filling the oil well into the rotating head with good grade motor-car engine oil.

when the dynamo is running during daytime with no lights in use, the propeller will race and the plant must be furled at once in order to prevent damage. The cause of the blown fuse must be ascertained before it is replaced. The most likely causes are: a disconnected battery or a loose or broken connection in the charging circuit. The replacement fuse must be the same size as originally fitted (6 amp. cartridge type).

The Cut-out

Connected between the dynamo and battery is the cut-out (Fig. 6)—an automatic switch which acts as a "valve" allowing the flow of current from the dynamo to the battery only. It closes when the dynamo is running fast enough to charge the battery, and opens when the dynamo speed is low, thus preventing current flowing from the battery through the dynamo windings. The cut-out is accurately set before leaving the works, and no adjustment should be necessary. Should the cut-out points become dirty or blackened they may be cleaned with very fine emery cloth.

If the cut-out chatters, and the ammeter needle oscillates violently, the trouble may be due to unsteady action of the dynamo caused by a worn or sticking brush, or a loose connection at the dynamo or in the instrument panel.

Furling

When furling the tail, detach the spring and allow the furling handle to move slowly in an upwards direction to the full extent of its travel. Do not allow the handle to spring into the furled position.

The furling mechanism must be operated at fairly frequent intervals in order to ensure that it is functioning satisfactorily, and that the headgear revolves freely, otherwise the propeller may not pull into the wind.

Propeller

See that the propeller nut is kept tight at all times.

When removing the propeller never hit the threaded end of the dynamo spindle, but wedge the propeller off by driving something such as a screwdriver in behind it.

Lighting Fuse

In the centre of the instrument panel is a 15 amp. fuse connected in the main lighting circuit, and its function is to protect the wiring in the house. Should this fuse blow, the cause of the trouble, such as a short circuit at a lamp holder, must be rectified before replacing the fuse wire.

Top of Mast Fittings

About every 12 months the head should be raised an inch or two and the dynamo moved forward so that the rotating contact can be withdrawn and inspected for wear. An indication of the height of the contact can be gained from the clearance between the top of the furling flange and the upper jaw of the furling bell-crank lever on the head. If the contact should wear, the head will drop slightly and the clearance will disappear.

The oil well in the rotating head must be filled with motor-car engine oil every three months, or more often if necessary.

Radio Interference Eliminator

Immediately above the rotating positive contact is the wireless interference eliminator which is built into the head. The positive connection from the eliminator is by a flexible wire to the positive terminal on the dynamo.

The negative connection is made by a flexible lead pressing against the metal of the head casting. A rubber stopper holds the eliminator in position, and also renders it weatherproof.

It will be understood that various parts for this lighting plant are difficult to obtain at the present time, but they are likely to be available later. Readers requiring further information are advised to communicate with Messrs. Joseph Lucas, Limited, Gt. King Street, Birmingham.

New Bristol Aero Engines

AN announcement by the Bristol Aeroplane Company last year indicated that the company then had under development air-cooled radial sleeve-valve engines which might confidently be expected to cover the 2,000-3,000 b.h.p. range in the near future. One of the engines concerned is the Bristol Centaurus CE. 22 SM.

This is an 18-cylinder, air-cooled radial, sleeve-valve engine of 3,270 cu. in. (53.6 litres) capacity, the bore and stroke being 5¾in. × 7in.

It is a forward development of the Centaurus XVIII and 57 series as fitted to the Hawker Sea Fury, Bristol Brigand and Fairey Spearfish, and it is the prototype of the Centaurus 130 which will power the Airspeed Ambassador and other civil transport aircraft.

The Centaurus 57 has a maximum power rating, on 100 octane 130 grade petrol, of 2,475 b.h.p. for take-off, 2,560 b.h.p. at 4,250 ft. and 2,300 b.h.p. at 17,000ft. When using the methanol-water injection device, the take-off power is increased to 2,800 b.h.p., and a corresponding increase is available for emergency level flight.

The Centaurus CE. 22 SM. as exhibited is being type-tested initially at a rating corresponding to that of the 57, but is designed for immediate development to 3,500 b.h.p. Development testing has, in fact, already been carried out at powers substantially in excess of 3,000 b.h.p.

The CE. 22 SM. has a single-stage two-speed supercharger, with twin lateral air intakes carrying the fuel spray nozzles which are fed by the Hobson/RAE fuel injector mounted at the lower rear end of the engine. The Centaurus 130 will have a single-speed supercharger of similar general arrangement, but the two-speed version will also be available; whilst the engine is designed to facilitate the application of other developments in supercharging and fuel systems.

The propeller reduction gear is suitable for reversing propellers.

The engine mounting can be either rigid or of the flexible type, according to the aircraft constructor's requirements.

As with preceding types, the latest Centaurus will be available in the form of a complete low-drag power plant with all cowling and ancillary equipment.

The Bristol Hercules HE.20 SM.

This is a 14-cylinder, air-cooled radial, sleeve-valve engine of 2,360 cu. in. (38.7 litres) capacity, the bore and stroke being 5¾in. × 6½in.

The HE.20 SM is being type-tested initially with a take-off rating of 2,000 b.h.p., but tests at more than 2,500 b.h.p. have already been carried out, and the engine is intended for immediate development over this range of output.

The new engine has a single-stage, two-speed supercharger with a single down-draught intake carrying a Hobson/RAE fuel injector, which is equipped for methanol-water injection.

Rocket Propulsion

War Developments—the Field Rocket Projectile

By K. W. GATLAND

(*Continued from page 211, March issue.*)

HAVING related the achievements of private individuals and research organisations unconnected with governments, let us now investigate the innumerable military rockets which saw service during World War 2.

Mention has already been made of the fact that in the years leading to the outbreak of hostilities the Allied Governments—and the British Government in particular—remained apathetic of the research that was then undergoing open and rapid development at the hands of the amateur rocket societies.

We have seen, too, how the newly formed National Socialist Government, in 1934, instituted a purge on Germany's privately established rocket groups, confiscating their records and throwing into concentration camps all those technicians who refused to co-operate in formulating the rocket to the Nazi plan.

In the closely-guarded rocket laboratories, workshops, and testing grounds that resulted from the ascension of the National Socialists, the fruits of years of painstaking research by honest and well-meaning technicians—whose aims were none more sinister than the outcome of the meteorological sounding rocket and the rocket mail carrier—were minutely investigated. Upon their work, in fact, was largely built the military research programme, which many years later had its result in Peenemunde—the Baltic research station. There, as is now well known, originated the V-2; power units for innumerable rocket interceptors, remotely controlled air to air, ground to air, air to ship, winged "flak" rockets and projectiles; and many others to come, had the war not ended when it did.

When war came to Britain the followers of "Blimp" were eventually swept aside, and pursuing the path of the pre-war amateurs the Government war rockets slowly but surely evolved, as also did similar rockets in Russia and the U.S.A.

Classification of Types

The developments of the war have been so numerous and varied that, to avoid confusion, it will be necessary to abandon the accustomed sequence and to detail each type of rocket device separately from first to the most recent.

There are nine main types of rocket weapons and devices, and it will be most convenient to deal with them in the following order: (a) field projectiles; (b) aircraft firing projectiles (R.P.); (c) ground to air "flak" projectiles; (d) air to ship "flak" projectiles; (e) ground to air "flak" projectiles (manned); (f) long-range projectiles; (g) assisted take-off accelerators (A.T.O.), and (h) rocket propelled aircraft.

The Field Rocket Projectile

Undoubtedly, the points of greatest significance about the field rocket projectile are its light weight, its portability, and the ease with which it is constructed with a minimum of skilled labour. A similar calibre gun, on the other hand, would be appreciably weighty, difficult to manœuvre, and require for its building special materials, a large variety of complex shaping machines, and highly skilled forgers and machinists.

The rocket has one disadvantage: it can only be considered accurate at close range. With present methods of stability and control—in cases where the latter exists—the rocket projectile is hopelessly inferior to the orthodox shell over distances of more than half a mile. This must not be taken to infer that it will always be so. Much hope is held in the development of radio-acoustic "self-directing" devices for use against vehicles, ships, and aircraft. The "Schmetterling"—Germany's V-3—was to have been acoustically homed into bombers. The designer of this unique air weapon, Professor Wagner of Junkers, in fact, considered the weapon to be so effective that he predicted the destruction of one Allied bomber for every missile that the Germans launched.

The small close-range rocket, however, lacks nothing. It is sufficiently accurate for anti-tank use, and is easily transported and operated in difficult country, in many cases single-handed, requiring little more than a simple tube for its launching. One of the German rocket projectors, in fact, was named the "stove-pipe," so great was the resemblance to common stove-piping. Again, compare the gun with its complex rifling, breech and firing mechanism, its great weight and relative immobility.

In a multiple launching arrangement the rocket has, too, become a valuable barrage weapon. Who will forget the sight of fiery trailed "flak" rockets arcing up into the night sky at the first approach of Nazi bombers or V-1s? The British Z-batteries went into full-scale action in 1943; but had *serious* work started on their production—really, a simple matter for the right people—even at as late a time as 1939, who knows how much damage, death and suffering might have been averted from our cities and towns, so poorly defended at the time of the "blitz"? The rocket-projectors, so simple and effective an answer, arrived too late to stem the main attacks of the Luftwaffe—*yet almost identical projectors had been in use for firing amateur research rockets years before the war, both in Britain and America.*

It has been openly admitted that the development of the Z-battery involved seven years of research. A useful comparison is the Russian launcher and projectile with which "Stormovik" IL-2 aircraft so successfully turned the Nazi "spearheads" at Stalingrad. This projector, which was among the first rocket weapons to be used in the war, was officially reported to have been developed and produced *within twelve weeks*. It is well known, also, that the Soviet forces used multiple land projectors at Stalingrad.

The least that can be said of the British development is that it gives added emphasis to the need for a central pool of rocket data and literature, from which Government technicians and amateurs alike could draw information. As we have had cause to mention earlier, much original work has been done with rockets, but much more has been duplication.

The "Katusha"

The "Katusha" was actually the first rocket weapon of the war, being itself a development of a multiple rocket device which had been employed by the Russians against the Turks as long past as 1830.

It was used with disastrous effect on the Nazi forces at Stalingrad, where it was considered to have been a key weapon in the city's defence. The projectiles, which were fired in quick succession from batteries of launching ramps, burned "solid" propellant, had an overall length of between 5 or 6ft. and a weight (including explosive head) of about 50lb. Their burning time was less than two seconds.

Another Russian weapon in use at about the same time was a small-calibre anti-tank projector which fired 30 armour-piercing rocket shells simultaneously. The launching tubes were mounted in five rows of six on a light carriage and set to discharge the rockets over a fairly wide area. It was, of course, ideal against massed tank formations.

First German Field Rocket

The Germans first employed rockets in the field on the Russian Front.

They were initially used as smoke curtain projectiles, although it was not long after that explosive and incendiary rocket carriers made their appearance.

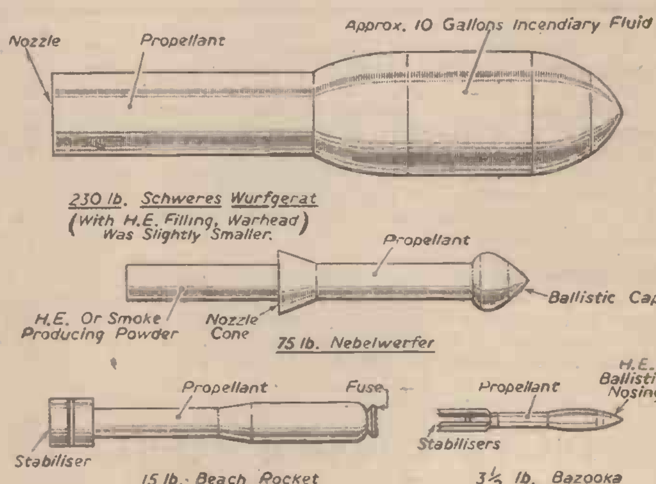


Fig. 61.—Four of the most prominent field rockets used during the war. (Scale .05in. = 1.0in. approx.)

Later it was announced that Rommel was employing anti-tank rockets in Libya, and this type was also used by the retreating German armies in Tunisia and Italy.

The Schweres Wurfgerat

The chemical and incendiary rockets developed by the Germans were of two main types. First the large rockets of 12¼in. and 10in. calibre, which were employed in the Schweres Wurfgerat (heavy throwing engine). The former was an incendiary carrier, while the latter contained high explosive, and both types had an effective range of 2,000 yards.

A unique feature of this projector was that the transit case was also the launching rack, from which the rockets were fired at any desired elevation.

At first, however, they were launched singly, but eventually cases were assembled together in two layers of three to form a six-ramp projector, and the complete set-up mounted on a gun-carriage. Ignition was achieved electrically by successively firing squibs.

The projectiles used in this launcher, as we have already observed, were of two classes. Both, however, were to the same basic design, although the head of the explosive rocket was slightly smaller than the one having an incendiary filling. The warhead of the 12½in. calibre type contained a little more than 10 gallons of incendiary fluid.

Attached behind the warhead was a propellant tube of smaller calibre which housed a double-base powder, somewhat similar to cordite. Stability was achieved by axial rotation caused by offset exhaust apertures in the base-plate.

The total weights were 180lb. and 230lb. respectively.

The Schweres Wurfgerat was largely used in Italy, and, mounted on motor-trucks, it was employed to quell risings of Polish patriots in Warsaw. Towards the close of the European war, however, several of these projectors were captured by the Czechs and used effectively against Nazi forces surrounded in some Channel ports.

Nebelwerfer 41

The second main rocket type was smaller, being of 6in. and 8in. calibre, and used in the Nebelwerfer 41 (Smoke-thrower Model, 1941). In this device the projectiles were launched from steel tubes, which were mounted in groups of six on small gun-carriages. Firing was accomplished electrically, with a delay of one second between each round.

Unlike the projectiles of the Schweres Wurfgerat, the propellant in the 6in. calibre type was housed in the rocket head, exhaust being made through 24 tangential nozzles in a conical centre-section. The explosive, or smoke-producing powder, was contained within a tubular tail-section.

Stability was, of course, effected by axial rotation, but was in part due to the placing of the centre of reaction forward of the centre of gravity.

The nozzle cone had a diameter of 6in.; the propellant and rear tubes slightly less. The rocket's overall length was 3ft. 6in.

A sheet steel ballistic nosing was also fitted, and it is of interest to note that its maximum cross-sectional diameter was greater than that of the propellant tube. This, presumably, was chiefly intended to stabilise the rocket while in the launching tube, the nozzle cone having about the same dimension.

It has already been mentioned that the nose form is the essential feature for consideration at near-sonic and super-sonic velocities. This is because of the compressibility region that is built up at the front of the body, which takes the form of hyperbolic sound waves and constitutes the main drag. Because of this and other practical considerations, such as explosive capacity, balance, etc., little account has been given to maintaining a smooth body line aft of the nosing in the majority of war projectiles. For a more detailed account of compressibility phenomena, the reader is referred to an earlier article in this series, PRACTICAL MECHANICS, January, 1946, pp. 133-135.

The smoke-curtain projectile was the first of the type to be used in action, and weighed slightly less than 75 lbs. The Germans later employed the rocket fitted with a modified aft container of explosive in place of the smoke-producing powder. The latter were used at Stalingrad and Veliki to supplement field howitzers, and had a range of about 7,000 yards and an average velocity of 1,000 feet per second. They weighed approximately the same as the smoke-producing rockets.

The 8in. calibre model had a more orthodox appearance. The explosive was contained in the nose, and the propellant at the rear. Stability was again obtained by body rotation, exhaust being made through off-set holes in the base-plate of the propellant tube.

It weighed 200 pounds, and was credited with a range of approximately 9,000 yards.

British and U.S. Developments

A development of the Z-battery projector (which will be detailed in a later article) was employed during the decisive El Alamein battle in order to concentrate a great fire power against the German Army, which was then going all out for a break-through into Egypt.

It is significant to note that while the Germans apparently favoured rockets stabilised by axial rotation, the British and

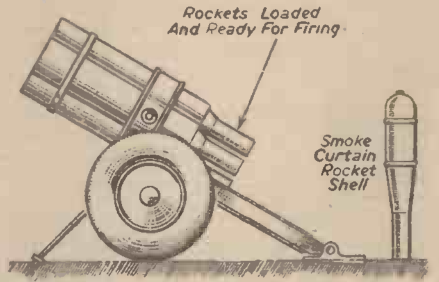


Fig. 62.—The Nebelwerfer: a six-barrelled rocket projector mounted on a wheeled chassis.

American rockets were un-rotating and stabilised by fins. There is no doubt that both systems have disadvantages, and one that is most noticeable is a pronounced tendency for finned projectiles to turn into the wind. Conversely, there is a small loss of propulsive efficiency in causing body rotation.

The principal single-unit anti-tank projectors were, of course, the American "Bazooka" and the German "Panzer Fist." These were the lightest projectors used during the war, and both could be fired single-handed, although they were generally operated by a team of two.

First, because it was by far the most significant, the "Bazooka"—officially known as "Rocket Launcher, A.T.M. 1." Apart from the Russian "Katusha," it was undoubtedly the most important field rocket of the war and saw large-scale service in Europe as well as in the Far East.

The "Bazooka" was essentially a close-hand weapon—300 yards was its limiting range. It was developed to the specification for a light, easily transported rocket projector having the fire power of a large calibre gun and capable of being operated by, at most, two men. How the requirement was met is now past history, but it is as well to recall that this and similar rocket weapons were decisive instruments in the final overthrow of the Axis.

As previously mentioned, the projector was operated by a two-man team—the launcher, who carried the 12 lb. firing tube, and the loader, who had care of the projectiles, which he carried in a special compartmented canvas bag.

The launching tube, open at both ends, was about 4ft. 2in. long and less than 3in. in diameter. A shoulder stock was fitted to the tube, and this contained two ordinary dry-cell flashlight batteries used in the ignition of the projectile. Launching was initiated by a normal type trigger placed forward of the stock. A hand grip was also attached close to the mouth.

Preparatory to loading, the launcher assumed a "one knee down position," having the projector over his right shoulder, into which the stock fitted snugly. The projectile was then inserted into the aft end of the open tube by the loader, who catched it with a wire retaining device to prevent it from slipping out backwards. He would then step to the side of the projector and move a small contact switch from "Safe" to "Fire," finally tapping the launcher on the shoulder to signal readiness for firing.

The loader would, of course, take due care that he was well to the side and clear of the rearward blast effect of the projectile when it was eventually fired.

The launcher, having sighted his target, depressed the firing trigger, and with a blast of flame rearward from the tube, the projectile sped rapidly towards its objective. The projectile was so designed that it ceased firing before emerging from the tube, and thus the launching crew were not affected in the slightest by flame or blast. There was little or no recoil.

Although the missile's striking velocity was quite low, it had great penetrative ability. This was because the explosive was detonated on impact, with the result that a hole was blown through the armour plate and the interior of the tank filled with blast, which was generally fatal to all within.

The projectile of the "Bazooka" was about 20in. long, had a maximum diameter of 2½in., and an approximate weight of 3½lb. It was stabilised in flight by six fixed sheet-metal fins.

The explosive was contained within a ballistic nosing, and around this was fitted a thin band of copper, necessary for the ignition circuit. A wire connected the battery, trigger switch and contact box, and through the moveable contact arm the current was transmitted to the copper band on the projectile. A further connection was made from the band to an electrical ignition squib, fixed within the nozzle of the propellant chamber. The other end of the wire attached to the squib was grounded to the projector.

German Anti-tank Weapons

The German counterpart of the "Bazooka" was the "Panzerfaust" ("Panzer Fist").

It was hardly comparable, however, for its effective range was little more than 50 yards. Although not the main German rocket weapon for the purpose, it was, nevertheless, supplied in quantity to the Volksturm for delaying tanks.

The principal anti-tank projector was much larger, having a tube of about 6ft. in length and 6in. diameter. Unlike the "Bazooka," a heavy metal shield was fitted to the launching tube in order to guard the crew from blast and flame. A hole in the shield, in which was mounted a frame sight, enabled the launcher to direct his fire in conjunction with a second sight on the muzzle of the tube.

Although the weapon was rather heavy and had to be supported during firing, it was claimed that it could be carried by one man. In principle, both these German weapons were similar to the "Bazooka."

Rocket Projector Boats

The next important development was the rocket-firing boat. These craft were used to support troops in landing operations and, as such, no apology is offered for including them under the head of "Field Projectile."

The rocket-boats first went into action during the British invasion of Sicily, much to the consternation of the defending troops. Their value once proved, they were later adopted by the U.S. Navy, and figured prominently on D-Day during the assault upon the European continent. Similar boats were used in the landings on Walcheren, and also in the Pacific, where they materially assisted in the invasion of the Philippines, Iwojima and Okinawa.

The vessels originally employed for projecting rockets were ordinary tank-landing craft.

The projectors were mounted in the fore of the vessel and, prior to firing, all but one of the crew had to retreat below decks in order to evade the terrific blast. The operator was specially clad.

These steel rocket-boats carried hundreds of explosive rockets, which were fired in overlapping salvos from the fixed projectors in which they were stowed. They were launched at about 50 to 60 degrees, about a dozen or more at a time.

Other launching systems were later developed in which the rockets were able to be fired individually or in rapid succession. Each projector consisted of a double pile of six rockets so placed that the bottom one of each pile was in the firing position on the launching rails. The rockets were fired successively by electrical impulse and, as the first shot away, the whole pile dropped down so that the next rocket entered the firing position and was launched, whereupon a further rocket entered for firing, and so on, until all were expended. These projectors were mounted in groups of four along the sides of the ship. In certain instances, two sets of launchers were mounted on lorries for use on land.

The projectiles used in these launching systems weighed 15lb. The explosive head had a diameter of 4½in. to which was attached a cordite-filled propellant tube of 3in. diameter. A 4½in. diameter circular stabiliser was fitted at the extreme rear.

A 5in. projectile was later developed, as well as one of even larger calibre, but details of these are, unfortunately, lacking.

The value of the rocket-firing ship was, of course, in that it enabled a weight of fire to be directed comparable with that of a modern battleship. It was not a weapon of great accuracy, however, but was, nevertheless, ideal from the point of view of laying concentrated fire on relatively large areas.

(To be continued)

The Gloster Meteor IV

Constructional Details of this Record-breaking Aircraft

Front view of the Gloster Meteor jet-propelled aircraft.

THE Meteor IV—a twin-engined, jet-propelled, single-seater fighter—is a low wing monoplane of all-metal construction, with tricycle alighting gear and two Rolls-Royce Derwent Series V engines.

The whole aircraft is built on a "unit" system, thus:

- Fuselage nose.
- Front fuselage (with nose wheel, pilot's cabin and magazine bay).
- Centre section (with the centre plane aerofoils, the two undercarriage units, the two nacelles and fuel tank bay).
- Outer planes (each with ailerons and detachable tip).
- Rear fuselage (complete with tail portion, which includes the lower fin).
- Tail unit (consisting of upper fin, upper and lower rudders, tail plane, and two "half-elevators").

The fuselage nose houses the gun camera and nose-wheel mounting structure, and is otherwise a fairing which has special side panels to resist the gun blast.

Solid Bulkheads

The basis of the front fuselage structure is two fore-and-aft vertical diaphragms and three solid bulkheads. The nose-wheel mounting structure is on the first or nose-wheel bulkhead. The internal structure is sealed between the nose-wheel bulkhead and the seat bulkhead to form a pressure cabin on later aircraft. The third or front spar bulkhead is used to bolt to a similar bulkhead in the centre section. The centre section and the rear fuselage are of semi-monocoque construction; and two rearmost frames of the rear fuselage are extended upwards to form posts for the lower fin and to give attachment points for the tail plane and upper fin.

The main plane is a two-spar, stressed-skin structure. The centre section spars are spaced by six major ribs, interspaced with lighter skin ribs. Each engine nacelle is built of two main frames attached towards the outer ends of the spars. The two undercarriage bays, the upper and lower air brakes and the flaps are all between the nacelles and the "centre fuselage." The outer planes, which are joined to the centre section at both spars, have plate and lattice type ribs. The internally mass-balanced ailerons are all-metal structures with automatic balance tabs. The outer plane tip is detachable for production and replacement reasons.

The components of the tail unit are of stressed-skin construction. The high tail plane, necessitated by the jet from the propelling nozzles, splits the rudder into two parts. Trimming tabs are fitted to each "half-elevator" and to the lower portion of the rudder.

Hydraulic Undercarriage

The hydraulically operated, levered-suspension tricycle alighting gear consists of two independent undercarriage units which retract inboard and a nose-wheel unit which retracts rearwards, the wheel itself being housed between the rudder pedals in the front fuselage. In addition to the normal electrical indicators, there is a mechanical downlock indicator for the nose-wheel unit, showing just forward of the windscreen.

The stick-type control column has a hinged spade grip, and the rudder pedals have parallel action. Trimming tabs are operated by normal-type hand wheels.

Power Units

While the earlier Marks of Gloster Meteor aircraft were fitted with Rolls-Royce Welland jet-propulsion engines, the later Marks are fitted with Rolls-Royce Derwent engines. This engine was a record breaker from the outset, in that it was designed and the first engine was on test within a period of three and a half months, developing no less than 2,000 lb. thrust at 16,500 r.p.m.

Each engine is mounted between two centre section ribs using trunnion-type side mountings, one of which is free to float sideways to allow for expansion.

The engine is steadied at the rear by a "diamond" bracing, which again will allow for expansions. The generator (port nacelle), the hydraulic pump (starboard nacelle) and the vacuum pumps (both nacelles) are driven by auxiliaries—drive gearboxes, each mounted on the front spar in front of its respective engine, and from which it is driven by an extension shaft. The self-sealing fuel tank is divided by a transverse diaphragm; each compartment normally feeds one engine, but there is an interconnecting balance cock which is normally closed. The feed to the burners is maintained by external electric (tank mounted) and engine-driven pumps.

A central drop fuel tank is carried beneath the centre section as required. The oil system for each engine is self-contained, there being no airframe oil tank. The engine-driven hydraulic pump operates the alighting gear, flaps and air brakes. An emergency hand pump will operate all services.

The pneumatic system operates the gun cocking gear and the undercarriage brakes; there is no nose-wheel braking. There are two air containers in the rear fuselage; no compressor is fitted.

Power for the electrical system is supplied by a 24-volt, 1,500-watt, engine-driven generator on the port engine, charging two 12-volt accumulators. An electrical remote control two-way radio is mounted in the rear fuselage. Beam approach and I.F.F. installations are also fitted.

Armament

The armament consists of four 20 mm. belt-fed Hispano guns mounted in the outer structure of the front fuselage and fired electrically by a selective "wobble" button on the spade grip. The four ammunition tanks (one for each gun) are in a magazine bay, immediately behind the pilot, with ready access for re-arming. A gun camera is mounted in the fuselage nose fairing, and the control for this camera is incorporated in the gun button and may be used without the guns if required.

Other equipment includes a combined cabin pressurising and heating system, a gun heating system, windscreen de-icing and de-misting and an oxygen system.

Meteors are now being fitted with full photographic equipment and are being tropicalised.

THE WORLD OF MODELS

By "MOTILUS"

Three Scale Model Liners

Fig. 1.—The cross-Channel steamer "Anglia" in steam on the lake.

IN the course of my travels recently in the West of England I had the pleasure of meeting Mr. George H. Charlton, a retired official, who before the war was in the civil government of Shanghai. He is now sixty-five years of age, and started the hobby of model-making some twelve years ago when he was living in the North Foreland district.

His special interest is the building of scale model ships, and the three models I had the pleasure of examining were the *Anglia*, a typical cross-Channel passenger steamer, ⅛in. to the foot, and the R.M.S. *Queen Mary* and R.M.S. *Queen Elizabeth*, both to the same scale of $^1/_{32}$in. to the foot.

Simple Steam Plant

The basis of his motive power for the models was the steam plant, which I consider was never fully appreciated by amateur model shipbuilders before the war, and this was the plant shown in two sizes in the 1934/5 and 1936 catalogues of Bassett-Lowke, Ltd., but on making inquiry I understand it was withdrawn from sale owing to the lack of demand, but that there is a possibility it may be reintroduced now their post-war range, with certain modifications, is being considered.

The "Anglia"

The hull of the *Anglia*, which took about three years in all to construct, is a scale model of the White Star Line motor ship *Georgic*, by Bassett-Lowke, Ltd.—length 1 metre, beam 5¾in. and depth about 4in. At the scale of ⅛in. equals 1 ft., this hull has been adapted to that of a cross-Channel steamer 315ft. long, with 44ft. beam and draught to loaded water line of 16ft.

The steam power plant in this case is the larger size "launch engine" double-acting piston valve engine, copper water-tube boiler, spirit-lamp with automatic safety feed, and displacement lubricator. The boiler is arranged to exhaust steam to two funnels. The boat is fitted with brass keel with rudder attached, propeller shaft and screw by Bassett-Lowke. The deck fittings, anchors, anchor cable, ventilator cowls, port and starboard lights, the Welin quadrant davits and all rail stanchions were also supplied by this firm. All the other deck fittings, boats, derricks, masts, deckhouses and funnels were made by Mr. Charlton. The decks and deckhouses are of $^1/_{16}$in. plywood, and all are properly cambered.

As to the performance of the ship, she has the additional stability of about 12oz. of lead as inside ballast, disposed of as experience has shown, when needed.

With the boiler two-thirds full of water

Fig. 3.—Close-up of the "Anglia" with funnels and deckhouses removed.

and the methylated spirit lamp full, a continuous run of 35 to 40 minutes can be secured at a steady reasonable pace and with a steam pressure of no more than 25 pounds per square inch. The boiler is built to work in safety up to 50 pounds per square inch.

Non-stop Runs

The two boats I saw demonstrated on the model yachting lake at Torquay were the *Queen Mary* and the *Queen Elizabeth*, and both these vessels did non-stop runs of between 40 and 45 minutes at what appeared to be a scale rate of speed for the prototypes. The day was cold, but the water quite calm with no breeze, and I consider the model ships gave an excellent performance for their size.

The "Queen Mary"

The *Queen Mary*, which is a scale model except as regards depth ($^1/_{32}$in. to 1ft.—that is, 1,018ft. long equalling 31$^{13}/_{16}$in.

Fig. 2.—The three model steamboats built by Mr. George H. Charlton, which are featured in this article.

and beam 118ft., equalling $3\frac{11}{16}$in). The depth is 4in., the hull being built of $\frac{1}{8}$in. thick light cedar planks—on the bread and butter principle, each layer glued and dowelled to the one beneath. The keel is of brass $\frac{3}{8}$in. deep, $\frac{5}{16}$in. wide.

She is powered by the smaller size Bassett-Lowke steam plant—launch engine, water-tube boiler and safety spirit-lamp—and exhaust steam up one funnel only. She is driven by a Bassett-Lowke scale model three-blade brass propeller—$1\frac{1}{2}$in. diameter.

In the water the ship is about $\frac{1}{4}$in. lower than the true water line according to the scale, the amount of keel and ballast necessary to secure stability in a hull only $3\frac{11}{16}$in. wide being responsible for this. An additional $\frac{1}{4}$in. of beam and a slightly fuller stem form would obviate this defect; and this has been proved in the later hull of the *Queen Elizabeth*, which has a great reserve of buoyancy.

Run of 45 Minutes

On one filling of the spirit-lamp and boiler two-thirds full, a continuous run of 45 minutes has been attained frequently—the boiler providing a constant and quite adequate supply of steam to drive the engine and ship at a really fast pace and with most realistic effect. In spite of the narrowness of the hull, no difficulty is experienced in keeping the methylated spirit-asbestos-wick-lamp burning brightly. The water and steam consumption are ridiculously small, and the little engine is efficient and powerful. A displacement lubricator (built into the steam pipe) ensures adequate oiling of the cylinder, and the owner has fitted a simple "drip-feed" lubricator for the crankshaft.

These weights in connection with this model make a set of interesting comparisons.

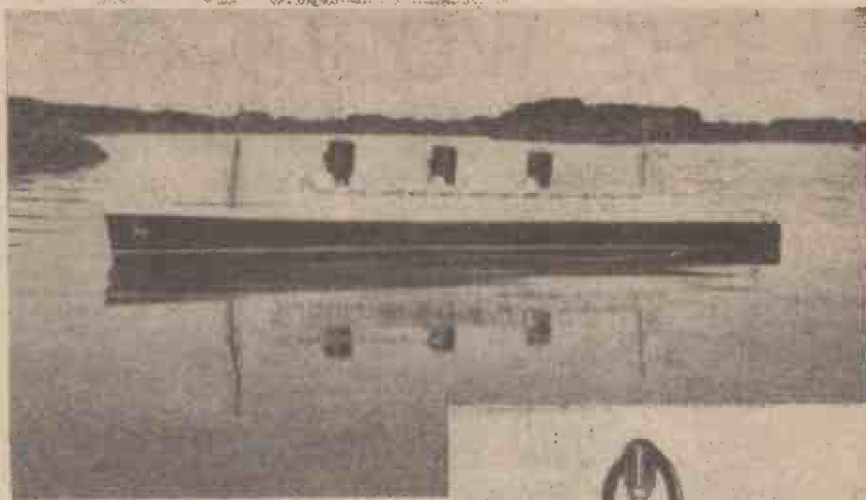


Fig. 5.—The "Queen Mary" in steam on the lake.

depth is $4\frac{3}{8}$in. This, as I mentioned before, makes a much more seaworthy and stable hull than actually the scale measurements would give, and allows more internal space for the steam plant. This and the brass keel are the same as for the *Queen Mary*, and are interchangeable, serving both hulls. The *Queen Elizabeth*, owing to the different spacing of her funnels—two as against three of the *Queen Mary*—requires a longer propeller shaft, and the disposition of the boiler, so that the exhaust steam passes up the forward funnel, whereas in the *Queen Mary* it passes up the centre one of the three funnels.

Fig. 4.—A close-up of the special "Fiddle" type steam-launch engine used for all these models.

Mr. Charlton writes that quite recently he has made some excellent runs with the *Queen Mary*, and has attained a 50 minutes' non-stop run on one filling of water and methylated spirit, at the cost of four-fifths of a penny!

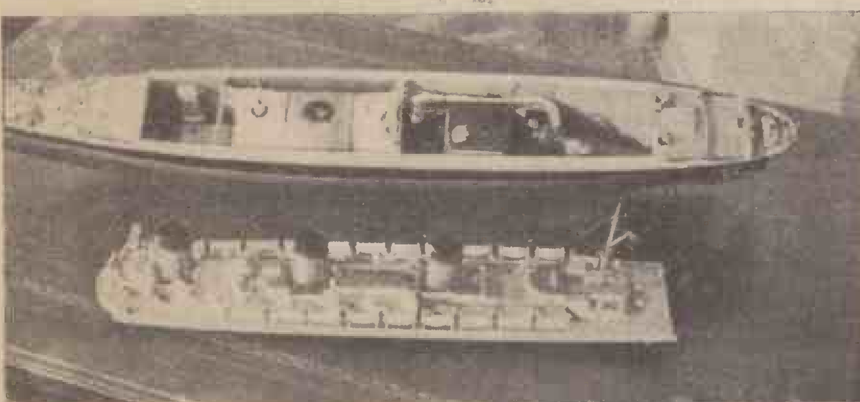


Fig. 6.—Close-up of the "Queen Mary" with the whole of the deck and the superstructure removed showing the layout of the plant.

	lb.	oz.
Cedar wood hull with rudder, propeller and brass propeller shaft	2	13
Complete steam plant on its steel tray	2	4
Brass keel and 7 screws	1	12
1 piece extra brass ballast ..		3
Total	7	0

The "Queen Elizabeth"

Now to describe the *Queen Elizabeth*, which is actually not yet completed in her deck arrangement. Her all-in weight is 9lb. 6oz., and she will steam for just as long as the *Queen Mary*, but not at quite such a speed, owing to her beamier and fuller hull form.

Her hull is carved from a solid block of straight-grained spruce—a good, light aeroplane wood. Her length, 1,030ft. (12ft. more than the *Queen Mary*), equals $32\frac{3}{16}$in. Her beam has been made 10ft. more than true scale, i.e., 128ft. equals 4in., and her

Fig. 7.—Mr. Charlton starting the "Queen Elizabeth" off on her voyage on the Torquay boating lake.

Letters from Readers

Telescope Lenses

SIR,—With reference to an inquiry in the February issue concerning telescope lenses I had a half plate camera and thought I could make a telescope from the front lens, but as you state in your reply you get the image upside down. I tried everything until I came to the eyepiece of a pair of focusing spectacles, which used to be sold at 5s. per pair. I now have a fine telescope.—H. BURT (Bridport).

A Fine-mesh Strainer

SIR,—The following idea which has been well tried out is for an efficient and quickly made fine-mesh strainer, for paints, etc., and may be of interest to other readers. To make the device obtain a small sheet of fine brass wire mesh from an ironmonger's shop, a lever lid tin, such as a treacle or paint tin, and two lids which each fit the tin.

Turn the tin upside down and cut out the base with a can-opener.

Now, with a small pair of shears or sharp chisel, cut a large round hole in each of the lids, to within about ¼in. of the rim of the lid.

Cut a disc out of the wire mesh so that it fits neatly inside one of the prepared lids, and then place the second lid inside the first and clamp the two lids tightly together, with the wire mesh in between.

The strainer can now be inserted into the tin through the base, and pressed tightly into the lip of the tin from the inside.

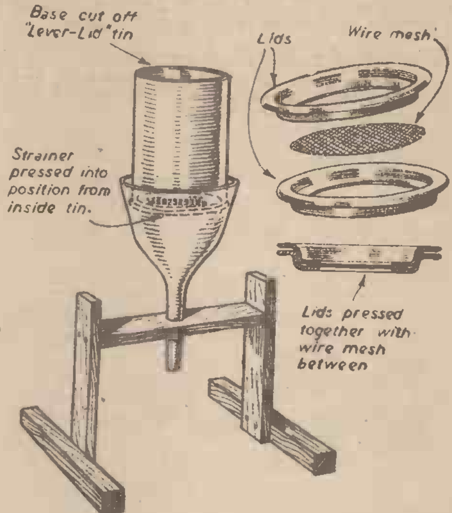
The advantage of this strainer is that it can be made very quickly and easily from readily obtainable materials.

As an addition to the above a tin funnel could be obtained the right size to fit the strainer, the funnel being held in position in a small wood frame, as shown in the sketch.—W. S. MOWFORTH (Hessle).

Transparent Plastics

SIR,—In the February, 1946, issue of PRACTICAL MECHANICS I notice an inquiry by J. A. Paul, of Kensington, regarding Perspex and Plexiglass.

He asks if it is possible to liquefy and mould these plastics. I would like to amplify your answer to this inquiry. It is true that you have to cement pieces together, but cellulose cement is not the correct solution. The best results will be obtained by using glacial acetic acid with a 5 per cent. proportion of Perspex filings to tone it down to a usable substance. The raw acid will burn and take off the top surface of the plastic. The solution should be used at a temperature of about 70 degs. C. as it has an exceedingly high freezing-point.



Details of a fine-mesh strainer, by W. S. Mowforth.

A perfectly transparent joint may be made with a little practice. It is necessary for the plastics to be as flat as possible and to be held tightly in a vice or such-like for two hours. Acetic acid is easily obtainable at any chemist.

Alternatives to acetic acid are chloroform or benzol, with the aforesaid Perspex filings.

It is, perhaps, needless to say that the plastics must be perfectly clear and unmarked before joining is attempted.—A. E. MANSFIELD (R.A.F.).

SIR,—In your February issue of PRACTICAL MECHANICS it was stated in answer to J. H. Paul (Kensington) that Perspex cannot be remoulded.

It may interest other readers to know that methyl methacylates have been used for a number of years in dentistry. It is bought in the form of a powder and liquid, known as the polymer and monomer. When mixed together they form a dough which is packed into a plaster of paris mould, made in two halves; these halves are pressed together, squeezing out any surplus. They are then clamped together and placed in water which is brought to the boil in not less than half an hour; it is then boiled for half an hour. After cooling, the mould can be opened and the object (in my case, a denture) can be polished, first with pumice and then with rouge.

Acrylate resins are made in a number of shades of pink and yellow, for the teeth also are now being made of plastic, being built up from a number of shades of yellow.

Transparent plastic is usually used in the palate behind the teeth.—H. T. SHEPHERD (Sydenham).

"Mystery of Magnetism"

SIR,—In the September, 1943, and the February, 1946, issues of PRACTICAL MECHANICS, I have noticed what I think is a mistake.

In the articles "Mystery of Magnetism," and "Annals of Electricity No. 9," you show the field due to a wire carrying a current to be radial to the wire. Perhaps you will explain this as I think the field is really in the form of concentric circles.—A. J. CLARKE (Hemel Hempstead).

[The author states: "With regard to the criticism of the photograph of the electro-magnetic field, I can well assure you that the said photograph is one of my own and a genuinely untouched one.

"I took this photograph by passing a very heavy current through the wire and by tapping the card. The iron filings arrange themselves concentrically for about 1/3rd inch around the wire (this can be seen in the photograph) and from thence radiate out in lines. This experiment can readily be repeated by critical readers. The whole matter seems to be a case of textbook theory not quite agreeing with observed practice."]

New Inventions

For Blunt Blades

A RAZOR strop having a front plate with a surface of soft leather and a back plate of a rough nature is not novel. But a sharpener of this description, for which a British patent has been applied, is affirmed to surpass its forerunners.

This strop is furnished with two strips of leather secured to opposite sides of a block. The strips are impregnated with abrasive material, one strip being treated with a substance of a coarser nature than the other.

Preferably, the abrasive material is in powdered form and is forced into the smooth side of the strips, which have been previously furrowed by means of a comb with sharp teeth. The furrows are arranged close together.

It is advisable to mix the abrasive material with an adhesive or an animal or fish oil.

Non-skid Tread

THE pneumatic tyre is the subject of a recent application for a patent in this country. In this instance, the efforts of the inventor have principally been directed to make a non-skid tread which will surpass its forerunners.

The tyre in question has a number of transverse projections on the tread surface. Each projection comprises a longitudinal portion of a spiral element. This portion represents at least one half of a complete turn or twist, being formed with or united to the tread in such a manner that a spiral edge is adapted to engage the ground.

The resulting grip should prevent many a slip 'twixt the wheel and the road or field.

Typewriter Improvement

AN interesting device contrived to improve the typewriter is the invention of a Maltese.

In operating a typewriter, or type selecting or forming machine, it is often necessary to repeat a single symbol or mark; for example, when the operator underlines or cancels parts of the document. The customary practice of tapping the appropriate key several times is tedious.

According to the improved invention, there is means to work the keys in a repeat manner by a single driving movement of a member common to all of the keys from which single symbol repetition line printing is desired.

OUR COVER SUBJECT

THE illustration on our front cover this month shows the interior of the power station of the Shannon Electricity Scheme. The three turbo-alternators have a combined horse-power of 120,000. Further particulars of this scheme are given on page 245 in this issue.

QUERIES and ENQUIRIES

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

Blackening Pewter

WOULD you please let me know if there is a process of blackening pewter either chemically or electrically? The blackening must not be affected by water or oils.—J. E. Johnson (Nottingham).

BOIL together for ten minutes about equal parts of sulphur and slaked lime. Filter the resulting yellow liquid and brush it on to the pewter which is required to be blackened.

Alternatively, obtain 1oz. of sodium sulphide from a photographic dealer and dissolve this in a quart of warm water. The pewter articles, on immersion in or treatment with this liquid, will turn black, and the black surface film so formed will be insoluble in oil or water.

Purifying River Water

WILL you please give me some information with regard to purifying the water drawn from a river (for household purposes) through pump and a ½in. pipe? Also, would any charge be made for drawing the water from the river?—W. H. Dryhurst (Birmingham).

YOU can take water from a river, provided that you do not in any way interfere with its free flow, or provided that you do not divert the stream or river in any way. There may, of course, be local by-laws affecting the position, but we hardly think that any authority would interfere with your taking river water for household purposes.

We are afraid that we cannot give you exact details as to the manner of purifying the river water which you propose to avail yourself of, since there may be varying local contaminations of the water, due to industrial effluents. In the absence of any of these special contaminating effluents, your best plan is to pump the water into an upper tank and to allow it to trickle slowly through a bed of clean sand and fine, sharp grit to a lower tank, from which it can be drawn off for use.

The supply of filtered water in the lower tank should regularly be chlorinated in order to eliminate bacterial contamination. This is best done by bubbling a small quantity of chlorine gas into the water, but, in your case, you could obtain a fair degree of sterilisation by scattering about a couple of saltspoonfuls of fresh chloride of lime into every 40 gallons of water, and by allowing the treated water to stand for 12 hours before using it.

The filtering bed may comprise a cylindrical drum having small stones at the bottom, over which is placed a layer of coarse grit, then fine grit and finally sand. All this material must, of course, have been very carefully cleaned beforehand, and it would be a good thing if all such material could be completely sterilised by boiling in water for ten minutes or so before being placed in position. The incorporation of a proportion (say 10 per cent) of charcoal in the filter bed is advantageous, since charcoal is very effective in absorbing and retaining deleterious organic matters.

The filter bed will, naturally, have to be either renewed or cleaned and re-sterilised every so often, the intervals depending upon the initial purity of the water and the amount of water which is passed through the bed.

Messrs. Sofnol, Ltd., Greenwich, London, S.E., may be able to assist you in the provision of chemical testing outfits for ensuring the required purity of the water.

Iso-propyl Alcohol

COULD you please let me know if Iso-propyl alcohol is suitable for microscopy, and if it can be procured without a licence? I have been advised to use industrial methylated spirit, but there seems to be a great many obstacles to obtaining same.—W. Clark (Paisley).

ISO-PROPYL alcohol is quite suitable for use in place of ordinary ethyl alcohol for microscopy, and many other technical purposes. It can be obtained without licence or restriction, and it costs about 3s. 6d. per lb., whereas ordinary alcohol, owing to the heavy excise duty imposed on it, is about twelve times as expensive. It can be obtained from Messrs. A. Boake, Roberts & Co., Ltd., Stratford, London, E., or from any laboratory furnisher, such as Messrs. Griffin & Tatlock, Ltd., of Glasgow. As ordinarily sold, its "strength" is of the order of at least 99 per cent iso-propyl alcohol. Industrial methylated spirit is not available to private users, and, even so, it is not as suitable to microscopy work as is iso-propyl alcohol.

Converting D.C. Motor for A.C. Working

I HAVE a small D.C. motor, 24 volt, 9-18 watts, shunt-wound, and speed about 3,500 r.p.m.

I wish to use it on a milk whisk to work from the mains, which is 250 volt A.C., 50 cycles, and also be able to regulate its speed.

Would you please tell me if this is possible, and how I can do it without having to alter the windings of the motor?—E. F. Waller (Forest Hill).

WE are afraid it will not be practicable to run the motor from the A.C. mains without considerable alteration. If the field-iron system is not fully laminated the motor would, in any event, be liable to overheat on prolonged running from A.C. supply. Subject to this possibility, the field windings could be rewound and the motor run in series with a resistance from the mains, with tappings for speed control. We do not advise this method, however, and consider the better plan would be to rewind the fields and supply the motor through a step-down transformer at 24 volts A.C.

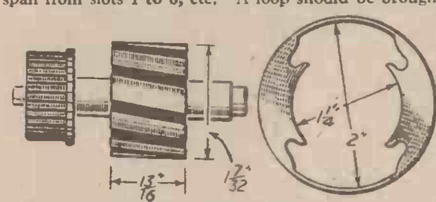
If the armature has upwards of about 16 commutator segments the field windings and armature could be rewound for operation direct from the A.C. mains.

Windings for Small Armature

I HAVE a small electric motor, the field and armature sizes being as indicated in the accompanying sketch. I wish to wind it for 230 v. A.C. The armature is a 11-pole type, with a 22-pole commutator. Can you give me the size of wire required, number of turns and method of winding?—L. G. Howard (Wall Heath).

WE suggest you wind each field pole with 700 turns of 35 s.w.g. enamelled wire, the two coils being connected in series with each other, so as to create poles of opposite magnetic polarity, and in series with the armature.

The armature should have 11 coils, each with 250 turns of 41 s.w.g. S.S.C. enamelled wire, and a coil span from slots 1 to 6, etc. A loop should be brought out from the centre of each coil for connecting to the commutator. With the armature placed so that the centres of slots 1 and 6 are equidistant from the centre of one pole face, number the commutator segment which then lies under the nearest brush, number 2. All numbering is clockwise at the commutator end.



Details of armature and field magnet for a small electric motor (L. G. Howard).

For reversible operation connect the start of the coil in slots 1 and 6 to segment 1, the loop to 2, and finish off the coil to segment 3. Connect the start of the coil in slots 2 and 7 to segment 3, loop to 4, finish to 5, and so on. For fixed clockwise rotation at the commutator end, add 2 to the numbers of commutator segments quoted above for the coil connections, and for fixed counter-clockwise rotation, subtract 2. You do not state whether the field iron system is fully laminated; if not, the motor is likely to overheat with prolonged running on A.C.

Bonding Compound

CAN you please give me any information regarding a "glue" used for bonding metal to metal in place of rivets, used as far as I know on American aircraft? I wish to know the following details, if possible:

(1) If heat is applied, at what pressure?
(2) Is the process suitable for bonding metal to wood?
(3) Is it possible to obtain supplies in this country?

—R. Gerard (Torquay).

NO information has yet been published in this country respecting the details of recent American constructional technique. Hence, the specific bonding compound about which you inquire will definitely not be available over here.

The nature of the cement, we surmise, will be to a large extent governed by its use. Ordinary gelatine dissolved in water so as to make a 5 per cent solution has sufficient strength to be used as a bond for thin, flat metal sheets, and the same material would also be suitable for bonding a thin sheet of metal to wood.

On the other hand, stronger bonding agents can be made by the use of rubber latex containing about 5 or 6 per cent of finely ground silica, this compound being allowed to set under slight pressure. Until recently, the sales of latex have been very rigidly controlled in this country, and, as yet, we have no information that they are not still strictly controlled. However, if you will write to Revertex Sales Company, Ltd., Upper Thames Street, London, E.C.4, who are suppliers of this commodity, you will be able to gather the very latest information concerning it.

Restoring Gilding on a Clock

I HAVE a French gilt and ormolu clock and pair of ornaments. The gilding is somewhat tarnished, and I should like to restore it. Gold paint would spoil it, and gold leaf does not appear to be practicable, on account of the intricacies of the moulding. Can you tell me how the gilding was originally done, and how to renew it?—S. C. Mills (Southport).

THE gilding of your clock and ornaments (if it *is* actual gilding—which is often not the case) has been effected either electrolytically (i.e., by electroplating) or by the application of genuine gold powder or gold leaf. The third method of gilding by rubbing with a gold-mercury amalgam and afterwards heating to red heat would not be applicable in this instance.

We agree that the application of ordinary "gold paint" would spoil the effect of the real gold. Hence, if you want to re-gild the parts, the only thing you can do is to smear them over with a little egg-white diluted with water, and then apply genuine gold leaf or genuine gold powder, both of which are exceedingly costly, in view of the present enhanced market value of fine gold. Even so, this application of gold might not leave the surfaces as smooth as you desired, and then would have to be burnished by rubbing them over with a small burnishing tool, preferably of agate.

It seems to us that your best plan is to rub pure benzene over the gilded parts by means of a camel-hair brush, and then to wipe the parts carefully with a soft cloth. This treatment will remove accumulations of dirt, thus revealing the true gold surface underneath.

Photographic "Bas-relief"

WILL you please deal with the following query? I wish to reproduce (in papier mâché or similar substance) a small photo in relief from a mould similar to those used in lead toy making. Is it a feasible proposition to make a mould by printing the negative down on sensitised zinc or other metal, and then etch away by acid, using a resist to stop out where etching is unwanted, or should I fail through underbiting? Will you tell me how a mould maker goes about his job to get a faithful copy of his subject?—A. G. Smith (New Milton).

YOUR suggested process of printing on sensitised zinc would give you a "hard" reproduction of the photograph on that metal, but you would not be able to use this as a mould for the reason that the moulded composition would be incapable of being withdrawn from it. Also, all the half-tones would be lost.

You will have to proceed via the technique of the photographic "bas-relief" or raised-image photograph which was once very popular in Victorian days. The process is rather tedious and difficult, but it is described in most dictionaries of photographs. Briefly, it is as follows:

An ounce of pure gelatine is soaked in 3½ ozs. of water until it swells up. Then the liquid is heated until the gelatine dissolves. Finally about 1 drachm of glycerine is added to the liquid. This liquid is then poured on to glass or metal plates and allowed to dry out and set thereon. These coated plates will keep indefinitely. They are sensitised by soaking for 15 minutes in a 6 per cent solution of ammonium (or potassium bichromate) and dry in the dark. A sensitised plate is exposed under a negative until it gives a detailed image in brown, the time taken for this exposure being about the same as that required to give a print on ordinary P.O.P. or self-toning paper. The exposed plate is carefully soaked in water. A relief is thereby produced, and the plate can then be moulded with plaster or with a waxy composition upon which an electrotype can be made.

We presume that you are familiar with the process of electrotyping. If not, you will find a description of it in almost any book of electrical technique, particularly those dealing with electro deposition and plating.

Some moulders, who do not wish to use the electrotyping process, make a model of their subject in clay or modelling wax. From this they make a plaster cast which is afterwards employed as a mould.

Photo Engraving

I WISH to reproduce photographs, by etching, on zinc (or copper). Will you please say how I can sensitise the metal, and what acid to use for etching? Also, what "resist" solution must be used to stop the acid acting on parts not to be etched?

Can you recommend me any books dealing with "Process" and "Line" block making?—A. G. Smith (New Milton).

W. K. BURTON'S "Practical Guide to Photographic and Photo-mechanical Printing" is an excellent volume for your purpose, but we believe that it has now gone out of print. However, an inquiry to Messrs. W. & G. Foyle, Ltd., Charing Cross Road, London, W.C.2, or to Messrs. Wallace Heaton, Ltd., New Bond Street, London, W.1, will put you in possession of this information, and may possibly bring you the titles of other works on photo-mechanical printing and block making.

The process of photo-engraving, even in its simplest form of line-block making, is a lengthy process, which we can only describe briefly within the confines of a single reply.

A polished zinc plate is coated with egg-albumen containing about 3 per cent of ammonium bichromate. After setting, it is placed in a special printing frame in contact with a negative made on a "process plate," in which it is exposed to sunlight or to the light of an electric arc lamp. The effect of exposure is to insolubilise the albumen.

After exposure, the zinc plate is covered with a thin film of a greasy ink. It is then placed in a dish of cold water and rubbed with a pad of cotton wool. This dissolves out the soluble parts, leaving the ink-stained insoluble portions. The plate is then dried, and the ink made tacky by slightly warming the plate. At this stage, either resin or bitumen powder is rolled on to the plate. The plate is then placed in a bath of dilute nitric or hydrochloric acid to eat into the bared portions of the metal, the tops and sides of the insoluble coating being protected by the resin or bitumen coating. After the etching has gone on sufficiently, the "bitumenised" resist is cleaned off, leaving the illustration or figure engraved in the metal.

In place of egg-albumen, gelatine solution plus bichromate may also be used as the light sensitive coating. Even glue may be used for this purpose.

The process is not an easy one. It takes much skill and experience to produce a good line-engraved block or a "half tone."

An article on the subject, giving details of the necessary plant, was published in PRACTICAL MECHANICS for November, 1945.

You will find brief descriptions of all types of block making in photographic dictionaries, such as E. J. Wall's popular "Dictionary of Photography."

Car Polishes

CAN you inform me how to make a really first-class motor-car polish?

I have been using a good one, but it has a tendency to make the colour to come off on to the cleaning cloth.—A. G. Watts (Chiswick).

CAR polishes of the non-wax type usually consist of a mixture of 1 part paraffin and 3 parts water, to which is added sufficient finest-grade whiting to make the liquid milky on shaking. The liquid must be well shaken before use and applied with a soft cloth. It will not remove the colour.

Wax polishes are of two kinds: (a) emulsified waxes; (b) oil-wax pastes.

Wax emulsions are difficult to make, and require special plant. In nearly every case, also, their method of manufacture is secret, but, essentially, it consists in adding emulsifying agents (such as triethanolamine) to the melted wax or mixtures of waxes, and then by pouring into it boiling water in a slow, steady stream. It would be extremely difficult for you to make such material on a small scale.

Wax pastes are usually composed of a 50 : 50 mixture of beeswax and carnauba wax dissolved in about ten times its own weight of white spirit or some other solvent, the whole being perfumed with a "polish" perfume. Owing to the solvent action of the liquid ingredient of the paste, such polish is, at times, likely to remove colour from the car body, but it really should not have this effect, if the paste is sparingly applied and if the car surface has been well finished in the first place.

Polishing Bone

I HAVE a small piece of bone (about 6in. long and 1in. diameter) which I wish to polish and use as an ornament. Could you please advise me how to do this?—R. Saunders (Norwich).

A SIMPLE way of putting a polish on the piece of bone (if the bone surface is already fairly smooth) is to give it a very thin coating of varnish. You may, however, desire to have a "natural" polish on the bone without varnishing, in which case you will have to smooth the bone down with successive grades of fine glasspaper (i.e., beginning with the coarser grades and succeeding each grade with a finer one) until, at last, you get a perfectly smooth and semi-glossy surface on the bone. At this stage rub over the bone a cloth charged with damp chalk powder or whiting, and finally use whiting which has been forced through very fine cloth.

If you can mount the bone in a lathe and revolve it at a high speed you will find all the above operations very much simplified and quickened.

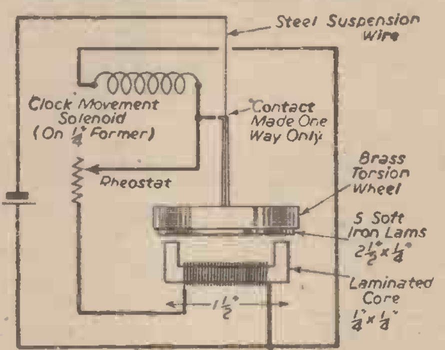
The final polish should be produced by means of chamois leather charged with the very finest possible whiting. Do not use jeweller's rouge (iron oxide) for polishing, since you will force some of its particles into the pores of the bone and so give it a more or less permanent pinkish appearance.

When you have obtained the desired polish we would advise that you give the bone surface a very light coating of a spirit varnish made by dissolving 1 part of bleached shellac in 3 parts of methylated spirit. This varnishing, of course, is not really necessary, but it will act as a "filler" for the pores of the bone and will go a long way towards preventing the bone surface from picking up dust and thereby becoming discoloured.

Coils for Electric Clock

I AM constructing an electric clock and find that the current consumption is excessive. I enclose details of the circuit and will be pleased if you can give me the necessary information as to the S.W.G. and number of turns to use for the minimum current consumption: (1) with a 4½ volt dry battery, and (2) with a 1½ volt dry battery.

Should I wire the coils in series? If you can also give me a general formula for other coils, or refer me to some literature on the subject, I shall be greatly obliged.—P. Pawsey (London, E.).



Circuit-diagram of an electric clock (P. Pawsey).

WE suggest the coils be connected in parallel as indicated in your sketch. For 4½ volt operation the solenoid coil should be wound with 1,000 turns of 32 S.W.G. enamelled wire and the torsion coil with 3,000 turns of 36 S.W.G. enamelled wire. For 1½ volt operation we suggest the solenoid coil should have 300 turns of 26 S.W.G. and the torsion coil 1,000 turns of 29 S.W.G. The strength of the torsion coil will, of course, depend on the length of air gap between the coil core and the laminations on the torsion wheel. It will also depend on the length of time during which the coil is energised, assuming this is small. The strength can be varied by means of a variable resistance, as shown in your sketch, or by feeding the coil from a lower voltage to reduce its strength.

The book "Electromagnets and Windings" by G. Windred (George Newnes, Ltd.) gives some useful information on electromagnetic calculations; but intermittently energised coils, such as you are using, are not easy to calculate, and are best wound on an experimental footing.

Electron Microscope

COULD you please enlighten me on the following subject: What is the principle of the electron microscope? Will it, in time, be made cheap enough so that it can be brought into the general laboratory? What is its present magnification power?—R. Stone (Wembley).

THE electron microscope works essentially on the principle that a beam or "pencil" of electrons may be used for the production of magnified images on a photographic plate instead of light rays. The electron microscope consists of an evacuated metal cylinder at the upper end of which is fixed a specially designed cathode-ray tube, which acts as an electron generator. The electrons are projected downwards through a very small opening and along the axis of a metal tube. The electron beams proceed through "focusing" coils, which may be said to represent the condenser and objective lens of an ordinary visual microscope. The preparation under examination is placed in the path of the rays, and, after passing through it, the electron beam is so guided that it impinges upon a fluorescent screen (which represents the eyepiece of an ordinary microscope) or, alternatively, on a photographic plate. It is upon the change of direction which is given to the electrons by the object under examination that the magnifying powers of the instrument depend.

The magnifying capabilities of the electron microscope are very great, since the flying electrons, being much smaller than light waves, can "feel" particles which ordinary light cannot detect. An electron microscope can give a magnification up to 20,000 times, and, perhaps, even more, compared with the 1,000 times magnification of an ordinary high-grade visual microscope.

There is no doubt that electron microscope construction will be cheapened. Nevertheless, the instrument is difficult to work, necessitates a knowledge of vacuum technique and electrical working, so that there is little hope of it ever becoming as common in ordinary laboratories as is the present-day ubiquitous visual microscope.

An illustrated article on the Electron Microscope appeared in the issue of PRACTICAL MECHANICS dated July, 1940.

A.C.-D.C. Converter

I HAVE a Delco-Remy car dynamo and wish to use it as an A.C.-D.C. converter. Is there any method of doing this without driving it with an electric motor? If so, will you kindly give me details of any alteration needed.—F. F. Lee (Beverley).

THE dynamo is not very suitable for use as an A.C. to D.C. converter without driving it by A.C. motor. There is one possible way in which it could be used, however, if you have a suitable D.C. supply available. Assuming the motor has two brushes only, you could fit two slip rings to the shaft, connecting these to points on the armature windings one pole pitch apart, these being fed with an A.C. voltage approximately 71 per cent of that required at the D.C. brushes. Such a machine would not be self-starting from the A.C. side but could be run up almost to synchronous speed as a D.C. motor from a battery, then the A.C. switch could be closed so that the machine would pull into step and continue to run as a synchronous converter.

Dead-black Finish on Metal

I AM building a multi-range test meter and would be very grateful if you would inform me how to obtain a "dull black finish" on my panel which is made of aluminium.

On the scale of the meter is a black finish, but it seems to have a slight gloss; it is made of brass. Also, how is the dull silver finish obtained?—L. Devins (Sligo).

(1) Dead-black finishes on aluminium and similar metals usually contain arsenic, a highly-poisonous material, for which reason we would advise you to use a proprietary preparation such as Johnson's "Dead Black," which material is simply brushed on to the metal in question. This preparation is obtainable from most large photographic dealers, or direct from Messrs. Johnson & Co., Ltd., Manufacturing Chemists, Hendon, London, N.W.4.

If, however, you still wish to blacken the metal chemically the procedure is as follows:

Caustic soda	1 part
Water	10 parts

Immerse the aluminium article for a minute or two in the above *warm* solution. Then wash it well in hot water and immerse it until blackened in the following solution:

Hydrochloric acid ..	10 parts
Sulphate of iron ..	1 part
White arsenic ..	1 part
Water	10 parts

Finally, rinse the blackened article most thoroughly in warm or hot water.

2. In your case, we think that the simplest method of getting a dull silver-like finish on aluminium would be to brush over the surface the following solution:

Caustic soda	1 part
Water	2 parts

Use the solution fairly hot. Allow it to act for about half a minute and then wash it off with plenty of hot water. Alternatively, you can immerse the entire article in the solution for the time stipulated.

Another formula which has been recommended for getting a dull silver finish on aluminium is the following:

Silver nitrate ..	6 grams
Potassium carbonate ..	6 grams
Sodium bicarbonate ..	6 parts
Potassium bichromate	1 part
Water	500 c.cs.

The aluminium object is immersed in this in the cold until the desired shade has been obtained. It is then withdrawn and thoroughly washed. We think, however, that the simple caustic soda treatment previously described will be quite satisfactory in your case.

Small Articles from Bone

I WANT to make some small articles from bone (fittings for musical instruments), since this material appears more suitable than most plastics, etc. Is it possible to use ordinary bones purchased from a butcher for this purpose, and if so, which bones are most suitable, and how should they be treated to obtain the proper hard material?—G. W. Wilson (Oban).

BONE fittings are not usually approved of by instrumentalists. They have not the peculiar soft feel of ivory. They are sometimes coarse-grained and they tend to yellow with use. It is now possible to obtain white plastic material for pianoforte key making, and we suggest that you might make inquiries to this end from a firm of piano accessory dealers such as Messrs. R. J. Goddard, Ltd., Tottenham Court Road, London.

You can, of course, use ordinary bone for this purpose, but the bone must be thoroughly degreased, and it is usually bleached by chloride of lime. It is then carefully smoothed down with white or light-coloured abrasives, such as tripoli powder, rottenstone, and finally by ordinary whitening. The flat "blade" bones are the most suitable for the purpose, but for small articles, fragments from ordinary round or "shank" bones will do quite as well.

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THE Cyclist

Editor: F. J. CAMM

VOL. XIV APRIL, 1946 No. 290

All letters should be addressed to the Editor, "THE CYCLIST," George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2.

Phone: Temple Bar 4363

Telegrams: Newnes, Rand. London

Comments of the Month — By F. J. C.

Road Traffic Signs

THE report of the departmental committee on traffic signs which was appointed in 1944, has recently been published. From it we learn that the Minister supports the conclusions which have been reached on the general principles to be followed in the erection of traffic signs, and *hopes* that all highway authorities will have regard to them when preparing schemes for the signposting of their areas. If the conclusions are sound, why hope? Why not compel highway authorities to adopt the suggestions made? The committee was appointed in 1943 by Lord Leathers, then Minister of Transport. It was under the chairmanship of Sir Frederick Cook, and it included nominees of associations representing road hauliers, commercial vehicle drivers, motorists, cyclists, pedestrians, representatives of Government departments, the police, and highway authority engineers.

The report lays down the general principles on which the committee considers a satisfactory system of traffic signs should be based. In essentials it accepts the existing system as developed from the report of a previous committee in 1933, but many recommendations are made for modifications and improvements which the experience of the intervening years has shown to be desirable.

Uniformity of Practice

THE committee attaches great importance to uniformity of practice throughout the country, and points out that departures from the standard system only result in a general depreciation of the value of that system. It recommends the immediate removal of the many unauthorised signs which still exist on highways to the confusion of the road user.

After reviewing the existing authorised signs, the report deals with such questions as the use of colour on signs, the lighting of signs at night, the use of reflecting lenses on signs and in road studs, the layout of white lines on the carriageway, the use of traffic signals to achieve more orderly, and therefore safer, traffic conditions, and the display of street names and street numbers.

With one dissentient the committee recommends the continued use of through direction signs based on the use of route numbers. It considers that any difficulties which may have arisen are not inherent in the system, but are due to the fact that the system has not hitherto been adequately explained to the ordinary road user. Wider publicity about the system and its use is therefore recommended.

In a circular letter issued to all highway authorities, the Minister commends the report to their attention, and states that he supports the committee's conclusions on the general principles which should be followed. He has, however, reserved for further consideration his decision on a recommendation that the beacons at pedestrian crossing places should be internally illuminated, and on a recommendation that the marking of three traffic lanes on two-way carriageways of approximately 30ft. width should be discontinued.

The report deprecates the tendency to draw attention to danger points by the erection of signs or symbols of a non-standard or exaggerated character. Road users have become so accustomed to danger signs erected 30 or more years ago drawing attention to spots which are no longer dangerous that there has been a tendency to ignore those signs relating to real danger points.

Unauthorised Traffic Signs

UNAUTHORISED traffic signs on or near highways should be removed. Signs should not be erected on or near the highway for the purpose of indicating to road users the proximity of entrances to works or other premises butting on the highway.

The C.T.C. has the authority to erect signs marking dangerous hills. Many of these signs no longer apply; perhaps the C.T.C. will see that they are removed. In general, we deprecate signs erected by particular organisations, largely for publicity purposes, and which have no power in law. The signposting of roads and the erection of other signs should be the responsibility of the Ministry of Transport only. In this respect may we inform our readers that it is not an offence to disobey signs erected by A.A. or other organisations—such as "Keep Left" signs.

The committee, whilst endorsing the main principles contained in the 1933 report, have recommended many additions and amendments to existing signs, for example, the triangle in Slow and Halt signs should be inverted. In general, signs should be black on a white ground and this includes route identification signs for class 2 roads. A new type of No-Entry sign is recommended and if used must be erected on each side of the road. On open roads warning and informative signs should normally be placed not less than 150 yards in advance of the places to which they apply. At fords on public roads, depth gauges should be provided. Why not embark upon a plan of getting rid of the fords altogether by means of over-bridges? Movable "No waiting this side to-day" signs are to be used when applicable.

One paragraph of the report recommends that the marking of three traffic lanes should be discontinued, but the Minister of Transport states that no action should be taken on the recommendation as it is receiving further consideration. Why appoint a committee to consider these things if the Ministry is "further to consider them." Similarly, the Minister has reserved for further consideration the question of the illumination of beacons at pedestrian crossing places. As the public does not use these crossings to any considerable extent and they have quite failed in the experimental purpose for which they were erected, we suggest that these monuments to a past Minister should be abolished.

There are far too many signs which defeat their object in that they cannot be read in the time of passing. They also distract the attention, and are likely, therefore, to cause accidents instead of preventing them. Advertising signs, whether by commercial interests or associations, concerned with road users, should be made quite illegal.

The B.L.R.C. Position

NOTWITHSTANDING the attitude of the U.C.I. in refusing to allow the B.L.R.C. to put their case at its recent meeting, and notwithstanding the ill-informed criticism of Mr. G. H. Strauss, the B.L.R.C. continues to grow, even in spite of the opposition of two national bodies supported by their dutiful and uneasy chambermaid, a third national body so-called. There is nothing like adversity in driving sympathy over to the victim. Fortunately many clubs, as a result of our leaders, the only source from which they obtain the facts concerning this controversy, have recognised who is the nigger in the wood pile. The attitude of the Irish Club, a national body, in joining hands with the B.L.R.C. is indicative of the feeling in club circles against the handful of people who have assumed proprietorial rights over the sport and the pastime. It is said that many of these old men are useful as reference books, but they are reference books which have never been revised or brought up to date. Some of them, indeed, are specialists in stabbing in the back.

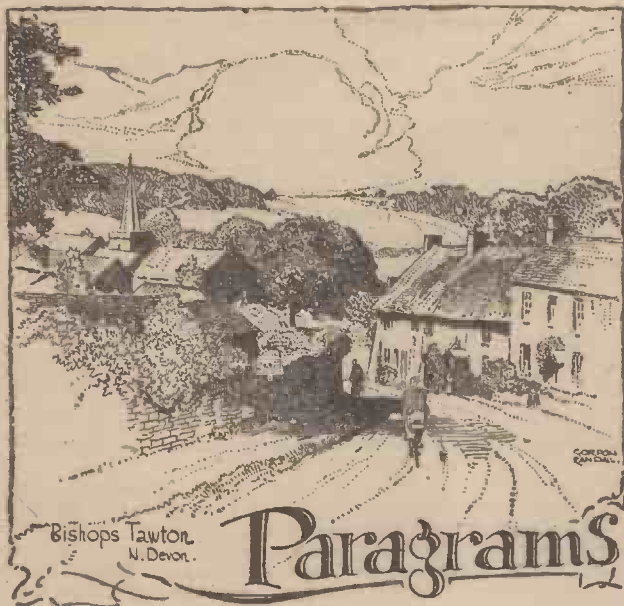
Bidlake Memorial Trust

MR. S. M. VANHEEM tells me that the committee has not made any award for 1945 in connection with the Bidlake Memorial Trust. Considering the flimsiest pretexts on which this award has been made in past years, could not the committee have found *someone* that has done something worthy of it? Surely there is a new split pin on the market?

N.C.U. National Championships, 1946

THE following are the National Championship allocations for 1946:

Championship	Promoter	Venue	Date
1,000 yards	Poly. C.C.	Herne Hill Track	22nd June, 1946.
25 miles	Derby Centre N.C.U.	Derby Municipal Track	29th June, 1946.
50 miles Tandem Paced and 1 mile Tandem Champ.	Kentish Whs. C.C.	Herne Hill Track	15th June, 1946.
½ mile Grass	Bristol Police	Bristol	6th July, 1946.
5 miles Grass	Ollerton Ath. Sports Club	Ollerton, Notts.	20th or 27th July.



Safety First!

CYCLE-RACKS fitted with locking devices have been installed at certain car-parks in Peterborough, and it is hoped that this will result in a considerable reduction in the number of cycle thefts in the city.

Manager Retires

MR. A. SKEELS, of Dogsthorpe Road, Peterborough, has retired after nearly 31 years as manager for Messrs. Currys, Ltd., Bridge Street, Peterborough. He opened the firm's first shop in Peterborough in 1915, and for a number of years was also district manager until ill-health compelled him to give it up. He is succeeded at Peterborough by Mr. G. Prince, previously manager of the Wisbech (Cambs.) branch, and recently released from the Forces.

Kettering Amateur C.C.

STEPS are being taken to revive the Kettering Amateur Cycling Club, and a general meeting of local enthusiasts is to be held as soon as the necessary arrangements can be made.

Strong Arm of the Law!

TWO magistrates, the assistant clerk, a warrant officer, police-inspector, station sergeant, and two constables got together at Sutton (Lincs) Juvenile Court just because a 14-year-old boy had committed the crime of cycling without lights.

Club Prize-giving

MR. BERT JAMES, one of the country's leading cyclists, presented the prizes at the 22nd Annual Dinner and Prize Distribution of the Grantham Road Club. The club has a membership of over 90 and is the largest in Lincolnshire.

"Old-timers"

THE Bedfordshire Road Cycling Club has formed an "old-timer's" section, which comprises older cyclists who are willing to pass on the benefit of their experience to new riders.

St. Ives Club Revived

THE St. Ives and District Wheelers' Cycling Club has been revived at St. Ives, Hunts. For the present, as membership is small, inter-club runs will be made in conjunction with the nearby St. Neots Cycling Club.

School's Safety Drive

BICYCLE wardens have been appointed at Doddington Road Grammar School, Wellingborough, Northants, to make daily inspections of scholars' bicycles to check their running condition. This idea has been adopted as part of the school's Safety Drive.

Veteran Passes On

AN Essex farm labourer, who has just died at the age of 87, had been riding the same bicycle for 60 years. It was by no means worn out when its owner died.

Landslide at Shivering Mountain

A LANDSLIDE, said to be the worst since 1929, has seriously damaged the Mam Tor road at the foot of the Shivering Mountain at Castleton. For a distance of over a mile the road surface was cracked and made uneven.

Club's Fourth Anniversary

THE Eleanor Road Club, which was formed during the war, and made considerable progress in spite of war-time difficulties, has celebrated its fourth anniversary. The club was formed in February, 1942, and last season its members won 15 open team events. The Mayor and Mayoress of Northampton were among the guests at a dinner held to mark the anniversary.

Police Training for Children

THE police of Loughborough, Leics, are training the local children in road sense by giving them rides in the patrol cars and staging narrow escapes. At every incident the children are given a running commentary, and they receive a short lecture at the end of the trip. An unfortunate dummy jay-walker has many narrow escapes and eventually meets with a sudden death.

Cycling Padre

THE Rev. C. A. Roach, who is just back in this country after six years in Baghdad and who was at one time at Boston (Lincs) Parish Church, was well known to many Service men stationed in the Baghdad district as the clergyman who always cycled when the rest of the European colony went by car. The Rev. Roach's parish covered about a thousand miles and as far as possible he made his visits on his specially built cycle, an improvement of his six-speed gear model upon which, some years ago, he cycled to a spot over 300 miles north of the Arctic Circle and then rode across Europe to Constantinople.

The "Lok-a-Bike" in the locked and inoperative positions.

British League of Racing Cyclists

THE Ordinary Meeting of the National Executive Council of the B.L.R.C. was held on Sunday, 3rd March, 1946, at Holborn Hall, London.

Chief item on the Agenda was a report by the Hon. Secretary upon his recent visit to Brussels in connection with the first post-war Congress of the Union Cycliste Internationale. J. Kain reported that through the medium of Miss Peggy Taylor, who acted as his secretary-interpreter during the week spent in Brussels, he was able to obtain first-hand knowledge of Continental reaction to B.L.R.C. activities, by contacting the many influential Belgian and French journalists attending Congress, sports promoters, riders, officials of the Ligue Velocepidique Belge, the executive and delegates of the U.C.I. and the principal Belgian newspaper editors. The result of this miniature "Gallup" poll provided conclusive evidence that the Continent is solidly behind the B.L.R.C., and the unofficial opinion of those members of the Executive and delegates of the U.C.I. who were approached is that the U.C.I. would welcome any formula whereby the League could be recognised.

Two leading members of the U.C.I. Executive tried hard to persuade the N.C.U. delegates to come to some sort of "gentleman's agreement" whereby League and Continental riders could exchange visits without fear of the N.C.U. continuing its present stubborn policy of demanding the suspension of the Continental riders involved, but the N.C.U. officials refused concessions of any sort. During the whole week in which Congress met, all leading Belgian and Flemish newspapers expressed open and candid hostility to N.C.U. methods. A further significant incident recorded by the League Secretary was the hearty and friendly welcome extended to the League delegates by leading officials of the Belgian National Cycling Organisation, the Ligue Velocepidique Belge, whereby Miss Taylor and J. Kain were given a complete and exhaustive insight into the amazingly efficient method by which this organisation is run.

Ealing Cycling Club

THE 20th A.G.M. of the Ealing Cycling Club held recently was marked by the determination of all present to make the approaching twenty-first year the most successful yet.

During the war years, the fighting spirit of the "Ealing" was notably exemplified during the early Dunkirk days, when its bold policy did so much to keep cycling sport alive during that testing period, this being particularly evidenced by the leading part the club played in fostering the "West London Combine," whereby many depleted West London clubs were able to carry out programmes that would otherwise have been impossible.

The part the club played in taking over the "Bath Road 100" in 1940, at ten days' notice, after that famous club had abandoned its famous road racing classic, will long be remembered.

It was in 1943 that the club joined up Dennis Jaggard, who has been club champion each year since, and whose club record for the 25, 50, and 100 miles aggregate is still unbeaten. His great ride in the now famous Brighton to Glasgow Five Day Road Race, finishing third to the French crack, Robert Batot, placed him as the best Londoner in the race.

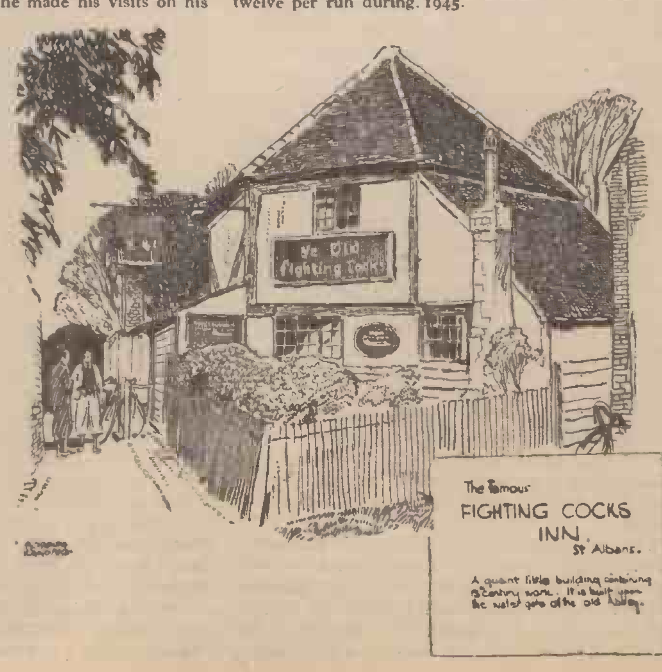
With peace conditions returning, the racing section should do well in the coming year, led by such sterling riders as Jaggard, "Pip" Burston, Busby, Stone, Chick, Ferrari, to name a few.

The Hon. Treasurer reported a small loss on the year, mainly due to the financial aid given to Junior riders towards travelling expenses when racing in distant events.

The Captain reported an average attendance of twelve per run during 1945.

"Lok-a-Bike" Lock

THE "Lok-a-Bike" device, which dispenses with the inconvenient lock and chain, locks both cycle and pump. It is simple in design, as shown in the accompanying illustration, and is made for ladies' and gent's models. The "Lok-a-Bike," which is finished in black enamel, can be fitted in a few minutes and is easily operated either by day or night, using a standard padlock. The retail price is 5s. 6d., and the manufacturers are Howard Clayton-Wright, of Tiddington Road, Stratford-on-Avon.



Around the Wheelworld

By ICARUS

Tribute to Macmillan

THERE will be a pilgrimage on Sunday, May 19th to the smithy at Courthill, near Dumfries, the home of Kirkpatrick Macmillan who produced the first rear driven bicycle in 1839. Hundreds of cyclists from England are expected to pay their tribute to this pioneer.

A tablet to the memory of the inventor will be unveiled by Sir Harold Bowden, Bart., president of the National Committee on Cycling on which most organised cyclists of Great Britain are represented. The ceremony was postponed from 1939, the centenary year, when the war broke out.

The world's first bicycle was made by Macmillan when he was 26 years old. A man brought to his smithy a hobby horse, pushed along like a scooter with the feet on the ground. Pat made a copy and built from it a new machine driven by pedals, an idea he is believed to have got from a crank and pedal device he invented to lighten his father's work at the grindstone.

The rear wheel of the first bicycle was bigger than the front wheel and the frame carried the carved head of a horse. The machine was got going by pushing it off with the feet, for which purpose the rider wore spiked boots such as a speedway rider does to-day.

In connection with this J. Miller of Dagenham writes:

"I see it is the intention of the National Committee on Cycling to unveil a tablet to the memory of Kirkpatrick Macmillan, the village blacksmith of Courthill, Dumfrieshire, the man who first propelled a two-wheeled vehicle with his feet off the ground.

How many people really realise how much the world is indebted to Macmillan? It was his invention which made the pneumatic tyre possible and between them they led to the motor-car, motor-cycle and the developments of all road and air transport.

Is this tablet on the blacksmith's shop where Pat Macmillan made the first bicycle enough to commemorate a man whose invention has played so great a part in the development of convenience and comfort for modern travellers?

Could the cyclists not request the co-operation of the motorists, the motor cyclists and our flying men to secure the smithy at Courthill and have it preserved for future generations on the pattern of Burns' Cottage."

S.R.R.A. Victory Dinner

THE Southern Roads Records Association held its first dinner since 1939 at the New Inn, Westminster Bridge Road, on February 28th. It was a Victory celebration dinner and about a hundred members and guests were present under the chairmanship of the president of the association, Mr. J. Dudley Daymond. This dinner undoubtedly spanned the war years and linked the present with those glorious days of 1939 when record breakers were active on the southern roads. The toast of the S.R.R.A. was in the hands of Mr. S. M. Vanheems who paid tribute to the early work of the association and response came from the retiring secretary, Mr. Arthur Whinnett, who in reviewing the work of the association stated that he had to give up the pleasurable task for reasons of health.

The new secretary, Mr. Percy A. Huggett, proposed the toast of the record breakers and the responses came from those two famous record breakers George Olley and E. V. Mills. The toast of the chairman was proposed by Mr. C. F. Davey. Excellent entertainment by Frank Norman, Tid, Richard Hamer and George Smart interspersed the speeches. The chairman welcomed members of his first club—The Raleigh C.C.

Ideal Bicycle Winner

THE Ideal Bicycle Contest run in conjunction with Claud Butler's Victory "Do" at the Seymour Hall, in which the entrants had to submit a specification for an ideal bicycle was won by J. S. Cross, of Richmond, who receives a C.B. bicycle built to his winning specification.

R.T.T.C. 1946 Handbook

COPIES of the R.T.T.C. Handbook for 1946 are now ready and copies may be obtained for 1/- post free. Orders from clubs and district council secretaries should be sent to S. Amey, "Wynfrith," Inwood Avenue, Old Coulsdon, Surrey.

B.L.R.C. News

A MEETING of the National Executive Committee of the B.L.R.C. recently decided to model the League on the lines of the Belgian League which was founded in 1882 and has a membership of 25,000. One rule of the Belgian League is that when entering every member must be prepared to pass a medical examination.

It was also decided that a parliamentary fighting committee should be formed to deal with local M.P.s and to arrange for deputations to be sent to the M.O.T. and the Home Office if necessary.

A new section has been formed in Scotland. In all, seven new clubs have become affiliated to the League, two in Scotland, two in London and three in Yorkshire.

Week of Cycle Racing

IN connection with the official "Victory" celebrations, the London Section of the British League of Racing Cyclists is planning to put on a week of cycle racing.

The week will commence on June 9th to June 16th. Events so far planned include June 10th, the Isle of Wight Road Race, organised by the Southern Section. An evening meeting on Thursday, the 13th, at Paddington, and on Saturday, the 15th, there will be a road circuit race at Finsbury Park. The week closes with the Ealing "50" time trial on Sunday, June 16th.

An Irish team will also be competing throughout the week.

Unity of Adversity

AN immediate result of the refusal by the recent U.C.I. Congress held in Brussels, February 9th, to deal with the claims for recognition lodged by the National Cycling Association of Ireland, the Australian Cycling Association, and the British League of Racing Cyclists (the N.C.U. claims that these are "domestic" affairs of the English body only), has been to bring these three "dissident" bodies into closer relationship, evidenced by the receipt of an air mail letter dated February 12th, from the Australian Cycling Association, by the Hon. Secretary of the B.L.R.C., confirming the participation of Australian riders in the second Brighton-Glasgow six-day cycle road race, fixed for July 29th to August 3rd next. Also, on February 17th in Dublin, Congress of the National Cycling Association of Ireland unanimously ratified the provisional agreement made by their Executive Council to join forces with the B.L.R.C.

The first result of this action will be to see Irish cyclists competing outside their own country in International competition for the first time since 1934, when the U.C.I. upheld the N.C.U. claim to control Northern Ireland, thus depriving the Free State of its ten-year-old International status.

A feature of this first Irish visit will be the staging of two International contests on the same day, Easter Saturday. One will be at Paddington track, where the Irish cracks will meet the B.L.R.C. English champions, with the other taking place at the famous Hampden Park, Glasgow, where another crack team will meet the Scottish champions in a special programme that will precede the meeting of the Scottish Football Cup Finalists in the final tie.

We now have the intriguing situation of a "split," originally confined to road racing, now developing into a direct challenge to the N.C.U. in its own, so far, exclusive prerogative, i.e., track racing.

The N.C.U. certainly invited the proverbial "elephant" into its parlour when they decided to interfere with the activities of road men after fifty-five years of neglect.

In addition to the track events, the champion Irish road men will also be entered for the classic Dover to London race on Easter Monday.

In connection with this eventful occasion, a re-union of all Irish sportsmen living in London is being arranged, and particulars will be issued later.

B.L.R.C. National Championships

THE following national championships will be run during 1946:

June 2nd—Ladies Road Race Championship. Approx. 25 to 30 miles. Organised by the North Eastern Section.

July 7th—Junior Road Race Championship. Organised by the Southern Section.

August 18th—British Road Race Championship. Organised by Scottish Section.

September 8th—Time Trial Championship. Senior, Ladies, and Juniors. Organised by London Section.

September 22nd—Team Time Trial Championship. Organised by the North Western Section.

October 6th—Hill Climbing Championship. Organised by the Yorkshire Section.

Brighton to Glasgow Road Race, July 29th-August 3rd. In six stages.

Brighton : London - Wolverhampton - Bradford - Newcastle - Edinburgh - Glasgow.

"Contact Corner" Party

THE Contact Corner Jamboree organised by Miss Audrey Allis will be held at the Porchester Hall, Bayswater, on Saturday, April 6th. Sir Edmund and Lady Crane are expected to be present. Reception is at 6.30 p.m.

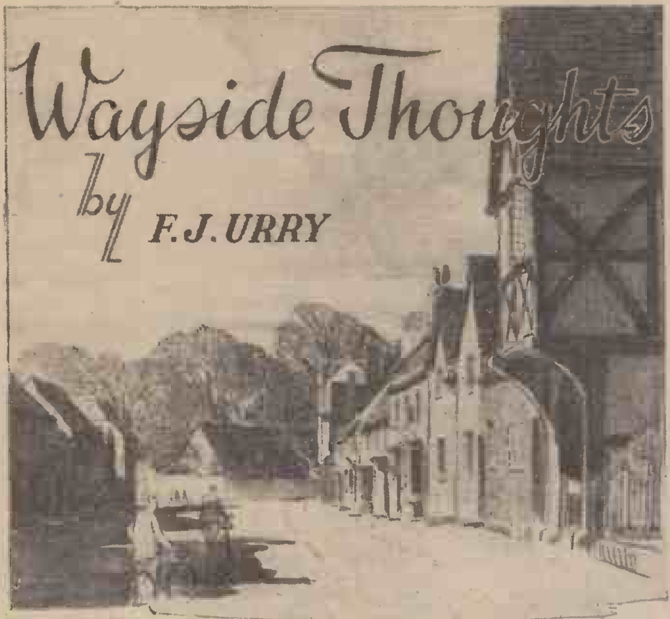
N.C.U. News

THE N.C.U. Emergency Committee held its last business meeting on February 16th and 17th, 1946. This was the 46th meeting of the committee since its first meeting on October 2nd, 1939.

The four original members of the committee, i.e., "Dick" Taylor (chairman), Messrs. A. E. Taylor, H. E. Miles and A. P. Chamberlin were present, and those who joined it later, i.e., Messrs. E. J. Southcott, A. J. Spurgin, M. P. M'Cormack, F. Biddulph, J. F. Ditchman and E. Anderson, also attended.

On the Saturday evening, the chairman entertained the committee to dinner at the Ambassador's Hotel, and a pleasant evening was enjoyed by all, which was devoted almost entirely to reminiscences of the strenuous war years.

Wayside Thoughts
by F.J. URRY



What Prospect?

I STILL hold to my view that the immediate coming years will be cycling years. We are beginning to see daylight in the matter of living costs, wages, and taxes, and the people who cannot understand we shall be poorer—but I hope neither less happy nor less pleasant—surely have their heads in the sand. Motoring is going to be expensive, even supposing the P.T. on the private vehicle were cancelled, and the average citizen will not be able to afford it out of the average salary. No doubt some people will have part of the expense met by a business subsidy, but generally speaking the great expansion in the use of the private car so long prophesied will not take place in the near future. Possibly the car will be used in this country in a similar manner to its use in Sweden, which is for long journeys, but not for the daily travel of purely personal convenience. The business man in Sweden uses a bicycle for short travel; it is a national habit, and is the reason why there are some three million cyclists in a country whose population approximates that of Greater London. Now, I do not offer this opinion because I am a confirmed cyclist, but rather for the reason that I try to be a realist, understanding that travel means depend on wages, and the latter, even at their enhanced level, are not really commensurate in purchasing power with the averages of 1939. The real reason for this is taxation, and I do not see any possibility of a return to pre-war imports for many years. I know this view of the travel position is not a popular one among many people, but I think it is a very true one and needs stating. I am sorry about it because any form of purchase restriction is bad for the long term view of trade, and besides I have full faith in my own happy method of roaming to know the game and pastime of cycling will extend and prosper in any case.

My Satisfaction

IF, as I surmise, there will be more cyclists than ever on the roads of Gt. Britain, I am sure that my compatriots in the pastime will also be a healthier community, and, I hope, a happier one. Now, I'm a utility rider as well as a pleasure and touring cyclist; indeed, my daily work journeys count up to more miles than my leisure cycling. Yet—and this I say without equivocation—I get more kindly joy and fun from my daily journeys than I think would be possible if I adopted any other form of travel; and, of course, I know well enough they keep me fit and very much alive. If I can gather such interest from my simple form of movement at the age of over sixty, why cannot other and much younger folk? I think the answer is fashion; people get the idea that cycling is a trifle *infra dig.*—you only indulge in it as a last resort; it is a trifle better than walking, but not much. In other words both young and old have been spoilt, things have been made too easy for them, and they have lost the habit of self-reliance in the matter of movement from place to place. Now, I want to encourage the truth that activity was an intended ingredient in the make-up of the average human, a way to fitness and happiness and a fuller life of variety. Walking is the natural means, and cycling is the mechanical aid to swifter and easier walking, with the body weight carried, yet all the muscles thereof comfortably at work. Therefore, in my view cycling—which can and should be the embodiment of grace—is a far finer thing to undertake than any form of power movement, for it is so natural, so convenient, and so low in cost. These truths need far greater expression than they are now getting, for if cycling can give ordinary people half the happiness it has presented to me, then millions of non-cyclists are missing a very simple and cheap means of giving to existence a variety and a healthiness no other form of travel can approach.

Giving a Wrong Impression

TO some extent I think the modern fashion of "dancing" on the pedals whenever foot pressure becomes necessary (a fashion borrowed from Continental racing), so commonly practised by many of the younger riders, is not conducive to cancelling out that mistaken notion that "cycling is hard work." I am an old—and probably old-fashioned—rider, and I am bound to confess this exercise of the dobbing horse gives me the impression that the ordinary rider who practises it is making hard work of the passage. Racing men tell me it does assist in maintaining speed on hills when the performance is correctly synchronised with the other muscular efforts, but they admit quite frankly enough that most riders under normal travel have much to learn about this gymnastic, and in any case it is quite unnecessary in maintaining touring speeds for the rider to add any abnormal body movement to the action of pedalling. That is my own view, and I deplore the growth of this action among the newer generation because it detracts much from the grace of cycling without adding anything to its ease, and it certainly makes the non-cyclist think a man is talking nonsense when he affirms riding is just a short matter of getting fit in order to enjoy the comfort and ease of movement under one's own power. Indeed, the point has been put to me on numerous occasions by my motoring friends, and it needs full faith in one's convictions to persuade them the game is as good as I contend. I remember one of the first of our racing boys to practise this dancing business was the late H. H. Gaylor of happy memory, and those of us who saw him win an Anfield "100" in under five hours nearly thirty years ago prophesied at half distance that he would never stay the course. He did, and proved us wrong; but Gaylor was the expert, and the racing lads who have followed him are experts, trained to synchronise effort and use every ounce of energy at a given moment and under arduous conditions; but you and I are not in that category, and methinks ought not to encourage a habit which does not improve the grace, style or ease of the ordinary rider.

Our New Roads

THE Trunk Roads Bill is before Parliament, and, on the face of it, seems to be an early instalment of the motor road architecture which is bound to come in the not distant future. If the new Bill is passed without serious amendments, some 8,000 miles of highway will go under the direct control of the M.O.T., and these roads will be converted into one-way traffic arteries, complete with separate footpaths and cycle paths. That seems to be the scheme in the minds of the M.O.T. officials, and the objection of official cycling to the latter part of the programme on the sound grounds that we shall lose our ancient road rights has not at the moment been debated. It would almost seem as if the new Labour Parliament is as purely motor-minded as the Tories, judging by the second reading acceptance of the provisions indicated by the Bill. We shall see what happens when the measure reaches the committee stage; but in the meantime I presume our defence officials will concentrate their energy and arguments on the objection we harbour regarding cycle paths, and particularly the certainty of the desire in official quarters to make their use compulsory. Let us, however, be realistic in these matters and not merely destructive critics, which I am afraid is too often the advocacy of the hot-heads. Accommodation must be found for the increasing traffic, which the M.O.T. actuaries judge will be twelve million cars on the road in less than twenty years. Our point on cycle paths should surely be an acceptance of the short term necessity of existing road improvements, but the long term insistence that only motorways will solve the problem for motorists and *other road users.* If that notion finds any reasonable acceptance, then surely the space occupied by cycle paths in the scheme of immediate road improvements would be more valuable to all concerned if it were thrown into the one-way traffic channels.

Other Snags

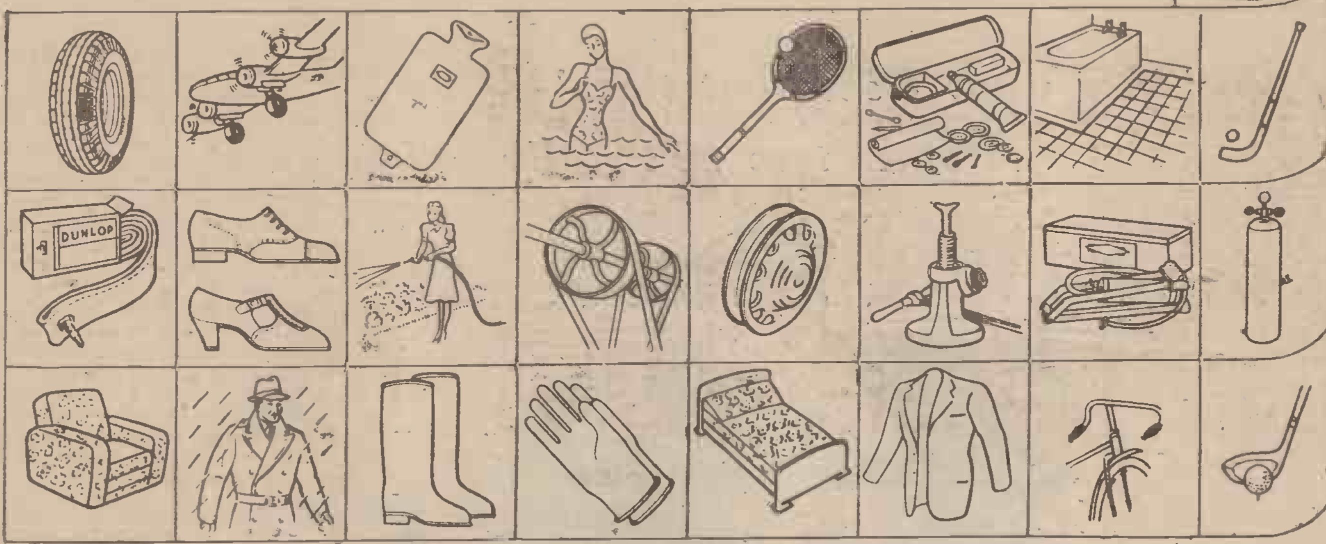
THAT, however, will not solve the difficulty of the sporting cyclist. The choice of routes for time trialling has been severely restricted during the last twenty years. With 8,000 miles of trunk roads converted to one-way channels, the restriction will be greater still. I have seen so many old courses disappear, owing to the erection of traffic lights and halts, that further impositions on 8,000 miles of highway will be difficult to overcome. Yet a Government seeking accommodation for a certain increase of traffic is little likely to accept a condition that will present to sporting riders an easy way out of their difficulties. Our grounds for protest must be sounder than that and far more constructive. The two-way traffic lines have been generally accepted and even applauded, so I do not see how we can combat this widely suggested change on our trunk roads. Our hope and endeavour surely must be to concentrate on the lines suggested: that if motorways are in the offing and in the minds of the Ministry, it seems futile to go to the expense of cycle paths and narrow the carriageway on the short term policy for existing roads. The pity is that cyclists are lacking organisation in any decent relationship to their numbers. Most of them don't care, and will only become critical when and if they lose their road rights by surrendering that ancient freedom to the community that has no use for bicycles or their riders. That, unfortunately, if a fact; ten million riders could call a merry tune is they would but organise. As it is the fight to retain their present freedom must be undertaken by the few, backed, let us hope, by the industry, to whom changes in road usage must mean so much.

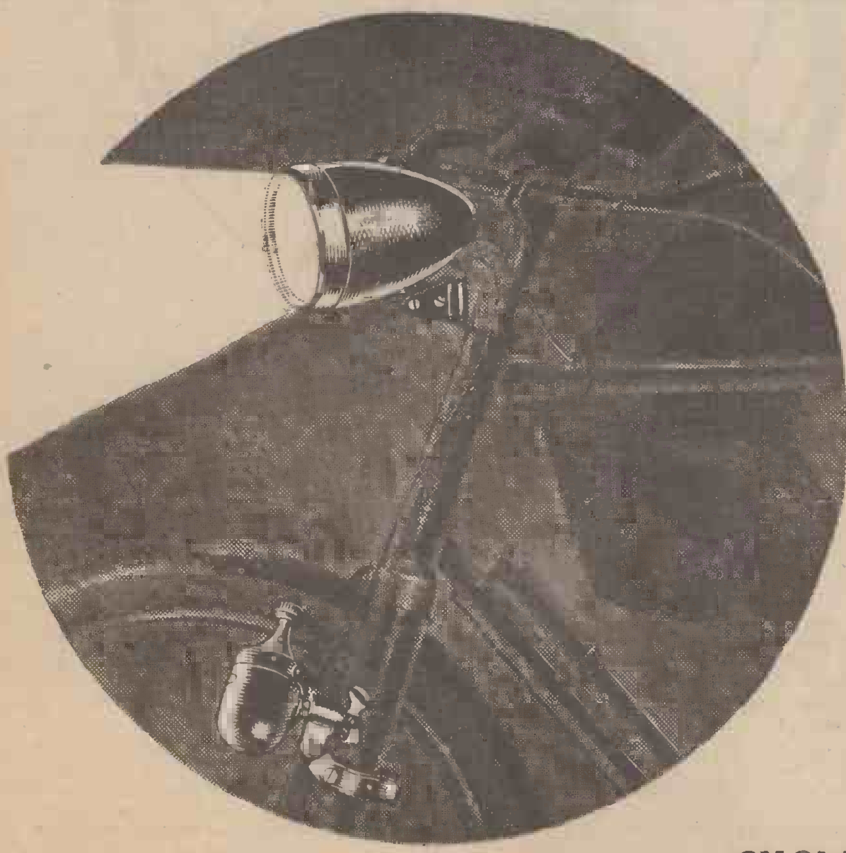
This Cycling

THERE are some lovely winter days—hours when the inside man misses the beauty, and often the majesty, of Nature. The value of cycling as a pastime, particularly to folk with an eye for loveliness, cannot be exaggerated, and the wonder to me is that so comparatively few people seem to be aware of it. I went out after heavy rain one Sunday morning with several companions. The air was cool, but, as so often happens following storm, calm, with a grey sky and little wind. The brooks were babbling and the last of the leaves on the road verges were losing their colour, but against the clear sky the naked outline of the trees was beautiful, and hard on noon a shadowy sun dropped a soft light into the little valleys along and over which we sped to a small farm on the edge of the hills, where a roaring fire made our frugal lunch into a feast. It was a beautiful ride of nearly thirty miles under the woods and by the rich lawns of winter wheat intersected with plough and the vivid green of remaining patches of kale. In the early afternoon I made tracks for home along the main road to keep a tea appointment with my people, and for the latter half of the journey I passed through a countryside burnished with the fires of sunset, when every fringe of trees was mightily scribbled on the horizon. You cannot tell the joy of these things—a beautiful sunset, it just happens to you as if its splendour was for your private enjoyment, and, indeed, that's how I like to think of it. Such exhibitions are common enough, or we should make a fearful fuss of them; but it is the cyclist of quiet discernment who cares, and, per-adventure, praises the vehicle that has helped to teach him the meaning of beauty.

Lewes Castle. Sussex

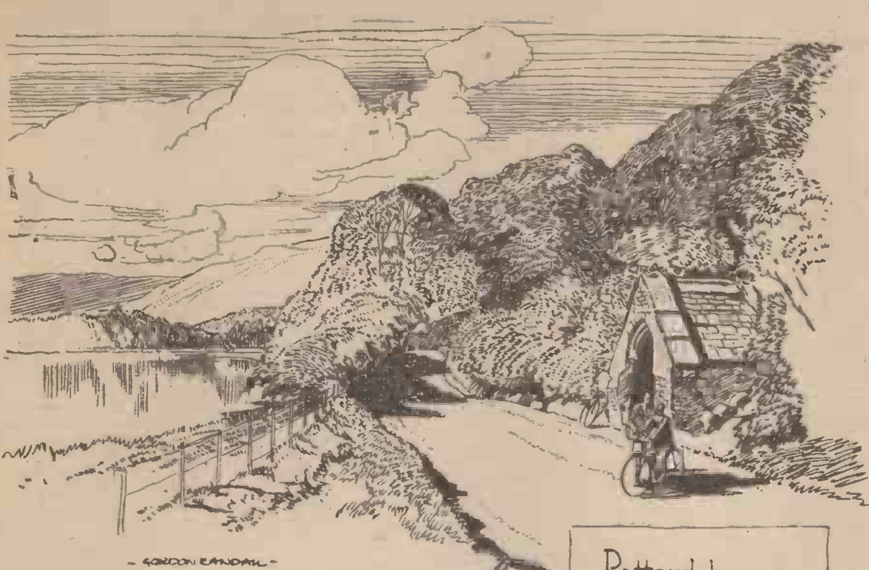
Lewes, rich in old inns and picturesque corners is dominated by the remains of its fine Norman Castle built by William de Warenne, first Earl of Surrey.


DUNLOP



CYCLORAMA

By H. W. ELEY



Patterdale, Westmorland

A stop by St Patrick's well. A scene at the head of lovely Ullswater.

County Pride

IT is one of the main charms of England that her counties vary so much. Look at your map of England, and recall your tours through her various shires . . . the picture you conjure up is a colourful "patchwork" —the broad, flat lands of Lincoln, the rugged coast of Cornwall, the narrow, scented lanes of Devon, the moors of Yorkshire and Derbyshire, and the quiet pastoral scenes of Suffolk—to mention but a few. I think that every Englishman is possessed of a real sense of pride in his native county, and I could wish that, within the limits of "security," more had been made of this pride of county in connection with the war and the epic achievements of the Line Regiments. But I am not going to dwell on the war, but on a conversation I had recently in a little inn—a wayside inn in my beloved Warwickshire. In my little "party" there was a man from Dorset, a man from Lancashire, a man from Kent, and a man from Leicestershire, a goodly little band of representative Englishmen, and the talk turned to counties, their scenery, their characteristics, and their place in the warp and woof of English life. And how county pride shone forth as we talked, and smoked, and drank our English ale! The man from Leicestershire painted a wondrous word-picture of the Vale of Belvoir, and all the glories of fox-hunting. The soft accents of the man from Dorset told us of the Hardy country, conjured up pleasant visions of Dorset villages, and gave me such a nostalgia for that fair county that I feel that my first tour of 1946 must be in that region. But there was the man from Kent—and he would yield to none! Whether he was a "Man from Kent" or a "Kentish Man" I forget, but he made us see the glory of Canterbury, the charm of the Weald, the alluring desolation of Romney Marsh, and as he talked of his native land, we could almost smell the hops, and see the rosy apples in the smiling orchards. The Lancashire man put down his tankard, and puffed hard at his pipe. Then he told us that he was born and bred among the cotton towns . . . and Bacup, and Bolton, and Bury, and Nelson were still his loves. But he knew his Lancashire well, and could tell us of the unspoiled beauty which still remains, untouched by the hand of Industry. It was an inspiring talk . . . and I commend a study of English counties to every cyclist; each has its own brave history, each its own peculiar charms. Make a good resolution for 1946 —get to know our counties better! And if you desire some good books on the counties, I cannot do better than recommend you to buy those fascinating volumes by Arthur Mee. He wrote several, and I have just finished reading his "Staffordshire" . . . typically good and informative.

What's in Your Kit?

HOW different are cyclists in the matter of the items they carry in their kits, and what wide degrees of tidiness and untidiness one meets with when saddle bags are opened, and a search is made for some tool or "gadget." The other day, riding with two friends, one sustained rather a nasty cut on the finger . . . and there was a cry for iodine, bandages, etc. . . . but among the curious assortment of repair outfits, rubber bands, knives, nails, brushes, dusters, route-maps, etc., which came to light as we stopped by the roadside, no hand first-aid outfit could be found! My own, complete with every necessity, was at home . . . but I am carrying it again now. When you do that winter overhaul, and get things right for the spring, look to your kit . . . and take the road equipped for everything!

Cyclists Will Honour His Name

THE "name" is Kirkpatrick Macmillan, the inventor of the first real bicycle, and on Sunday, May 19th, there is to be a cyclists' pilgrimage to the smithy at Courthill, near Dumfries, where a tablet will be unveiled by Sir Harold Bowden, Bart., the president of the National Committee on Cycling. This is a fine gesture, which will appeal greatly to all cyclists who have reverence for the past, and who feel that they owe—as indeed they do—a debt of gratitude to the man who invented the cycle, and so bestowed upon humanity one of the greatest boons of all. Let us hope that the day will be a good May day, with sunshine, and the song of birds, and that for many a long year cyclists will be glad to ride to Courthill and pay their homage to the old blacksmith who has given such joy to so many.

St. Valentine

I DID not let St. Valentine's Day go by without a thought of the romantic past, when it was the great day for lovers to be particularly sentimental; when they sent each other gay beribboned cards, ornamented with hearts and Cupid bows, and adorned with mottoes suggesting undying affection. It is a day, like Shrove Tuesday, which always seems to me to mark the approach of spring; it marks a step forward in the seasons, and this year it was not at all a bad day . . . periods of sunshine . . . and I rode towards Barnet, and thought of the ancient fair, and the gipsies who used to haunt it, and all the shouting and laughter associated with the old-time horse fair so beloved of our forefathers. I fancy that Barnet Fair goes back some 600 years, and it is still a mecca for those who want to buy a horse! As an American soldier said to me one day in 1942, "England is a land where things endure!"

When Did You Last See a Tricycle?

FOR myself, I seldom see one; but recently, on a road in Kent, I met a fine old man riding a tricycle . . . and happy he looked. And yet a little incongruous. I should have liked to talk with him, for I felt that he was probably an enthusiast. The sight of him brought memories to me of old A. J. Wilson, a great performer on a tricycle, and a man whose memory will ever be revered by the older generation of riders. And, thinking of "A. J.," I hear that the Motor and Cycle Trades Benevolent Fund, which he founded and which was so near to his heart, is flourishing, and that the ball held in Birmingham on February 15th, in its aid, was a huge success. The fund does a fine work, and deserves all our support.

Artists' Lure

I HAVE often referred to my old note-books wherein are recorded jottings made on tours and travels; looked at one of these old books the other day, and found references to Southwold and Walberswick—those delectable places in quiet Suffolk, so unspoiled and so full of charm. Walberswick was ever a lure for the painter, and many a time, having crossed the old ferry from Southwold, have I watched an artist working in water-colours or oils—depicting those quaint bits which seem to bring to mind Constable, and all his genius for this part of England. This summer, I hope to take my bicycle to Southwold, and ride around Aldeburgh, and slip out to Framlingham Castle ruins, and ride to ancient little Covehithe for a bathe.

Those Wartime Riders

YOU know . . . the riders who "took up" cycling when there was hardly any petrol; the men who had not been astride a bike for many a long year—and said, with loud emphasis, that they had rediscovered a joy, and found a new happiness. Have they all retained their enthusiasms? Or have most of them, now that it is easier to use a car, put the bike back in its shed, to be neglected and forgotten? I fear that many have. It is a tremendous pity, for I used to like to think of that big army of "reconverted" men, finding new health, losing over-weight, and discovering that the best way of seeing our matchless countryside was on a cycle. Of course, I may be unduly pessimistic; perhaps the "conversion" has been permanent in far more cases than we know. Let us hope so. As a doctor friend of mine said to me recently: "A bit of cycling would do many folks far more good than all the medicine I could prescribe!"

Bullington Church. Sussex.

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

My Point of View

By "WAYFARER"

Simple Cure

A WAYWARD thing is an electric battery lamp, quite beyond the comprehension of an unmechanical mind like mine! On a recent evening, as I was cycling home from business, I observed that my front lamp, fixed on the fork bracket because of the rain, was not "doing its stuff." So I reached out with my foot and gave the thing two slight taps, and, lo and behold! the volume of light at least trebled. A completely unscientific way of carrying on, but effective! Moral: When your lamp fails, kick it.

No Squealing

THE cycle-tourists who were wont to make a song and dance about the "monotony" of breakfasts when on holiday—bacon and egg being varied only by egg and bacon!—have been singularly quiet during the war years. There has been no squealing. As a matter of fact, most of us are only too glad to welcome the dish named—in either order!—day by day on our tours.

"Corn in Egypt"!

WHICH reminds me that at a farmhouse where I had tea a Saturday or two ago the caterer placed two boiled eggs on the table and asked: "Can you manage those?" Slightly dazed at this sudden and unexpected plunge into the middle ages (or thereabouts), I said: "Well, I'm a bit out of practice, but I'll do my best." And, believe me, my best was quite successful! I was not so het-up about this incident on the following day when another caterer told me of eight cyclists who had turned up unexpectedly for lunch on the previous Sunday. She, naturally, had no meat to offer them, but they "made do" with a couple of boiled eggs each.

These events provide a gleam of hope in these days when food prospects have so dismal an appearance—on paper, anyhow.

Better Batteries

IT is pleasant to be able to record that the batteries now available seem to be of much better quality than those supplied during the war period. I use an electric front lamp only for getting me home from business, as required, preferring carbide for my serious cycling; but I rely on batteries for my back lighting, and I must say that my troubles in this respect have been greatly reduced within recent months. That is all to the good, especially after the rubbish which was being dished out to us only a few months ago.

The Retort Obvious

A YOUNG cyclist whom I picked up along the road the other Sunday and travelled with for a few miles said this to me, amongst various other things: "A former touring pal whom I had not met for two or three years was surprised to find, on a recent chance encounter, that I am still riding. He asked me when I was going to pack up cycling, as though that were the proper thing to do at the end of a specified term of years, and I replied that I proposed to give up the game a few days before the undertaker called for me!" I thought that a very suitable and effective retort—and the obvious one—to a foolish question.

Method to Avoid

THIS classic example of "how not to do it" has often been cited by me, but it will bear repetition. One of my colleagues in the Liverpool office where I started my business career was an ancient ledger clerk who liked to keep his ink-pot well on the left-hand side of his desk. At frequent intervals, as required, he would transfer the pen from his right hand to his left hand. The latter would then reach out and dip the pen in the ink, afterwards being drawn back to convey the pen to the other hand, when operations on the ledger could be resumed. This curious method has nothing—nothing whatever—to do with cycling, but scores of cyclists have adopted a no less laborious and time-wasting plan of pumping their tyres, and that is why the matter is mentioned here.

When you see a man making hard work of the inflation job, thanks to the valve being at the lowest point of the wheel, you may realise that you are in the presence of the lineal descendant of the ancient ledger clerk above-mentioned. My policy in life is to find the easiest way of doing everything, leaving the hard method for people who like to give themselves unnecessary trouble. If you come in the latter category, try pumping your tyre with the valve not far from the highest point of the wheel, and see how much more effective it is—and easier on the back.

Unsuspected Danger

A YOUNG couple, cycling along a main road, witnessed an incident which suggested a new and unsuspected danger. A knife, some six or eight inches long, fell—from nowhere, apparently—in the middle of the highway, and an open motor car which had just overtaken the cyclists came to a standstill. Examination showed that the knife, thrown at random by a mischievous boy behind the hedge, had gone through the hood of the car. A "local" came along and helped in the inquiry, with the result that the boy and his companions were bundled into the car and carried off to the nearest police-station, where, it is to be hoped, they were suitably dealt with.

The Safe Time

WHEN buying carbide the other day I murmured that I was very fond of night-riding, and must have a good light. To my surprise, a stranger who was standing by said: "That's the safe time for cycling, isn't it?" This was interesting to me because he voiced a view I have always held regarding the safety aspect of riding in the dark. As a rule there is less traffic about and you know where it is, particularly at cross-roads.

Longings

THE Three Musketeers, who sometimes foregather (fortuitously) for Sunday lunch, and then spend the rest of the day together, were riding through a small country town when they overtook a young man and his wife, walking, complete with laden pram. As the cyclists went by the man said, very quietly: "You *lucky* chaps . . . I used to do a lot of that!" I called out, as the cavalcade moved on: "And will do so again, it is hoped!" Looking back, I noted that the faces of the happy couple were wreathed in smiles, and so one trusts that the day will come when cycling enthusiasm, obviously hardly slumbering, will boil over, with the result that another tandem, plus side-car, makes its appearance along the road.

Gratuitous Advice

ONE evening in January, as I was making my way home from a visit to the country, a motor-car sidled up alongside and quietly ran by me for a few yards, gradually closing in. "Somebody wants to know the way," was my thought, and then a voice spoke thus: "I say, mister, I'd get a new rear light for that bike if I were you. That's a very poor one." Without removing my eyes from the road, but wondering who my thoughtful and solicitous friend could be, I ejaculated: "All right!" The car forged ahead, showing me the inscription "POLICE" on its back. It might have made a difference to my reply had I known earlier, and there would surely have been an argument—more forcible than polite on my part. I was (and am) concerned only with obeying the law, and I felt satisfied that I was doing that. Therefore, the police "advice" was unwarranted, and I would have told the occupants of the car so. Anyhow, the "very poor" battery lasted me for another fortnight and was then scrapped, in the ordinary course of events.

The Imponderable Dog

I FIND that, as a cyclist, I am really becoming rather afraid of dogs. Probably this state of fear arises because of the conviction that it is undesirable for one of my years to be thrown off his bicycle more often than is really necessary. Moreover, there is the question of damaged clothing—and the outrageous price (and quality) of new garments, with coupons lurking in the background or, rather, with the knowledge that there are no coupons lurking in the background, or anywhere else! If there is anything in my view that our canine friends have been taking advantage of the reduction of motor-car traffic during the last few years, then there is some hope that, with the return of "the basic," they will trim their sails—and mend their manners.

On a recent daylight occasion, as I was passing through suburbia, a dog which was accompanied by (but was obviously not under the control of) two people dashed across the roadway and disappeared into a spinney. A mild attack of intuition at once told me that, when the dog had completed his investigations, he would dash back across the road, unmindful of anything but rejoining the folks to whom he belonged. I therefore made a point of watching my step. Intuition was correct. It probably saved me, at worst, a crash; at best, a fright.

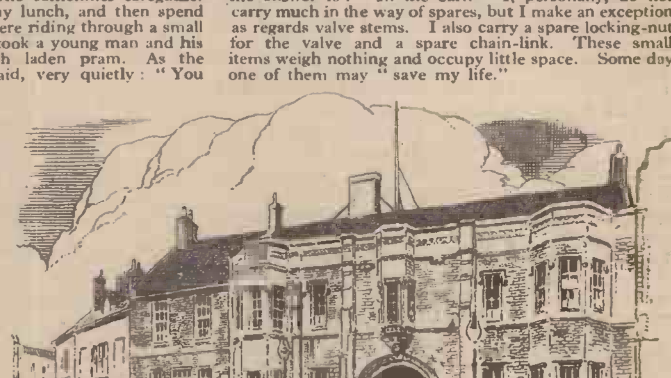
Perpetual Policy

"SAFETY FIRST" is no doubt a good slogan, but "Safety Always" is better. To act in the safe way must be a perpetual policy. Personally, I refuse to take liberties, even in the presence of a road intersection provided with automatic signals. And this is one of my reasons: On a frosty morning this winter the lights had changed down to green, and I was free to cross a busy main road. I was 100 per cent. correct in doing so. But on my right I noticed a motor-cyclist coming along. He was either foolish, or careless, or both. Anyhow, his brakes were on and he was squirming all over the place. Being unable to stop he went through "on the red," and, having completed the crossing, managed to come to a standstill. Fortunately for me, and perhaps for the motor-cyclist as well, I instinctively decided to let him have the road while he completed his gymnastics, willingly abrogating my rights, which I am not prepared lightly to exchange for rites of the funeral type!

The hymn which adjures us to "cast care aside" has no application whatever in respect of road usage. The practice of safety as a perpetual policy is eminently desirable.

The Small Things

WE do not always remember, as cyclists, how much depends on the small things. Take, for example, a valve stem, which forms an infinitesimal percentage of the bicycle as a whole. But the importance of this is out of all proportion to its size. Lose your valve stem—it sometimes happens during the repair of a puncture—and where are you? In the vernacular, the answer is: "In the cart." I, personally, do not carry much in the way of spares, but I make an exception as regards valve stems. I also carry a spare locking-nut for the valve and a spare chain-link. These small items weigh nothing and occupy little space. Some day one of them may "save my life."



The Angel, Grantham. S. Lincolnshire.

A splendid medieval inn on the Great North Road. Note the lovely oriel window over the archway.

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Practical Mechanics. April, 1946.

Published about the 30th of each month by GEORGE NEWNES, LIMITED, Tower House, Southampton Street, Strand, London, W.C. and Printed in England by the Newnes and Pearson Printing Co., Ltd., Exmoor Street, London, W.10. Sole Agents for Australia a[nd] New Zealand—Gordon & Gotch, Ltd. Sole Agents for South Africa—Central News Agency, Ltd. Subscription Rates (includi[ng] postage): Inland, 10s. 6d. per annum. Abroad, 10s. per annum. Canada, 10s. per annum. Registered at the G.P.O. for transmissi[on] by Canadian Magazine Post.