A CAMERA ENLARGER

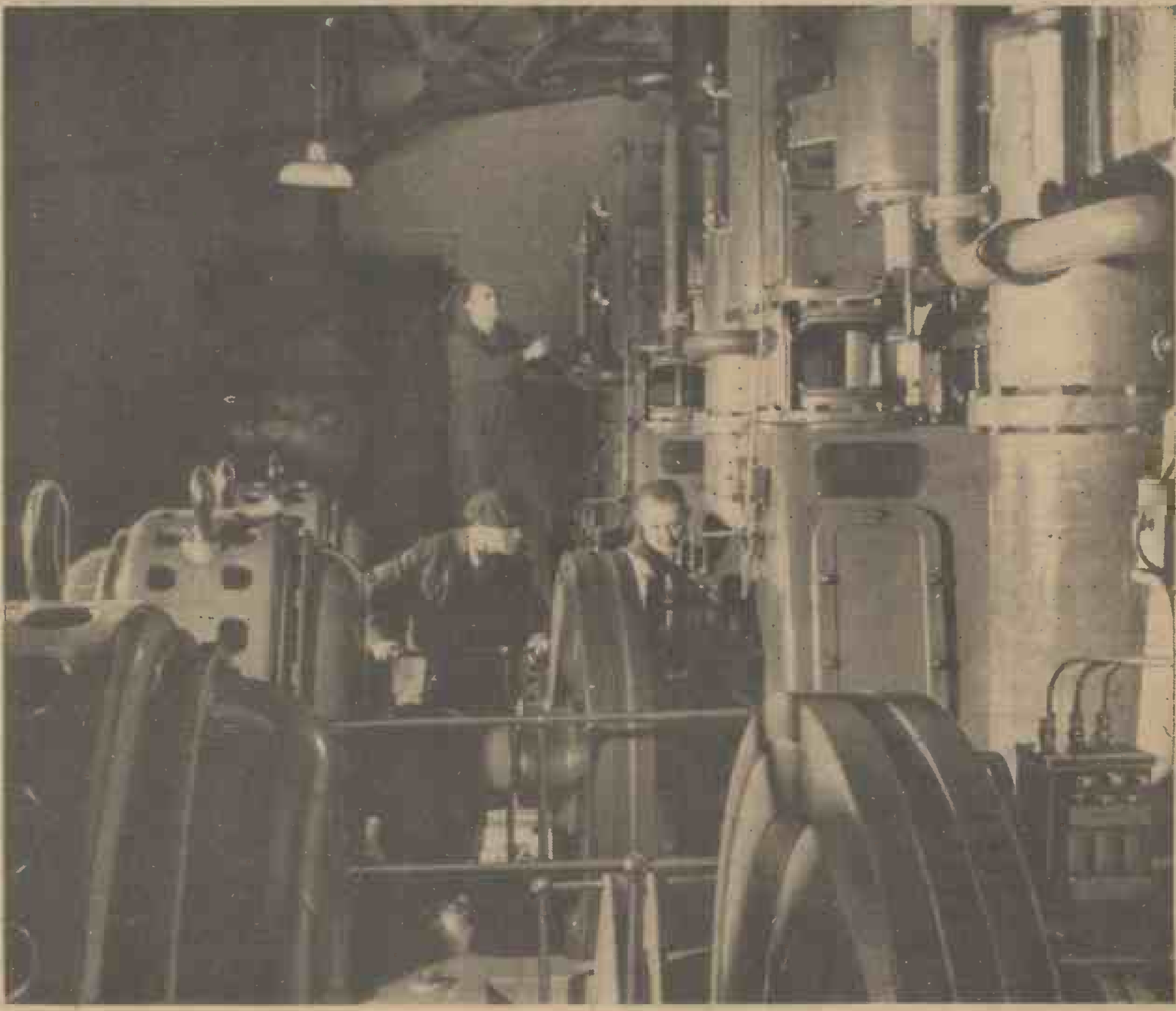
NEWNES

PRACTICAL MECHANICS

9D.

EDITOR: F. J. CAMM

FEBRUARY 1946



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Editor: F. J. CAMM

VOL. XIII FEBRUARY, 1946 No. 149

FAIR COMMENT——BY THE EDITOR

Invitation to Young Designers

EVER since the commencement of the art-in-industry movement, which is receiving encouragement at all hands, industrial design has become of increasing prominence in the consciousness of artists, art teachers and art students. Not only have distinguished industrial designers, in signed articles and public lectures, emphasised the importance of the subject to the individual artist and to the nation at large, but official spokesmen for the Government have warned us that in the stern struggle for export trade, on which most of our hopes for the future depend, good design is of paramount importance.

Prominent teachers of commercial art and industrial design take especial care to induce the students to use their imagination and to think out their own solutions and designs in answer to the various problems that may be set. This valuable exercise in developing thought forms a basic foundation on which the students can tackle future propositions.

Of timely encouragement to the young artist-designer, and to the art student, is a competition, "The Shape of Things to Come," organised by the Central Institute of Art and Design, in which British competitors of either sex under 30 years of age are asked for their practical ideas for new articles of furniture and domestic equipment which they think will add to comfort and labour-saving in the home.

Many young artists are serving in the Forces and art students are being called up, but these are eligible to enter the competition, which offers £1,500 in prizes.

The six sections of the competition take such a wide range as to include anything (except purely decorative design on articles), that could be used by way of furniture or equipment in the kitchen, dining and/or living-room, bedroom, bathroom and lavatory, or the nursery. There is a section, too, for general domestic equipment.

That the work of young designers will be competently judged (solely on the merit of the ideas portrayed) is guaranteed by the composition of the panel of distinguished judges, which comprises such well-known leaders of design as G. E. Crowe, N.R.D., T. A. Fennemore, Mrs. Grace Lovat Fraser, Sir Charles Tennyson, C.M.G., Grey Wornum, F.R.I.B.A., and F. R. Yerbury, Hon.A.R.I.B.A.

The competition remains open until March 31st, 1946, and full particulars, and entry forms may be obtained from the Central Institute of Art and Design, P.O. Box No. 213, 9, Kean Street, W.C.2. A stamp, with addressed envelope, should be enclosed.

The Society of Model Aeronautical Engineers

THE Society of Model Aeronautical Engineers is the official body governing model aeronautics in Great Britain, and is recognised as such by the Royal Aero Club. They have some large-scale plans on foot and are appealing to clubs to help to provide funds to put these plans into effect. They invite gifts of money and suggest that clubs might organise whist drives, competitions, etc., to provide this. Model aircraft clubs could jointly manufacture model aircraft for sale and provide further money.

The society aims to further the education, through grants and other means, of students choosing aviation as a career, and to give grants for the completion of flying training at recognised schools; establish a research section which will include a scientific library and adequate wind tunnel facilities to investigate fully the problem of low speed flying and other problems in connection with aircraft development; acquire a nationally flying and training school; act as liaison agent between the industry and potential employees so that the full value of experience gained in model aeronautics can be harnessed to the benefit of the industry and the nation; acquire a travelling lecture and demonstration van to give illustrated talks to schools, colleges, clubs and institutes; foster by means of national and international competitions and by every other practical means the spirit of air-mindedness in boys and young men; establish a central headquarters in London for the direction and supervision of all these activities.

Combined British Astronautical Society

IN view of the great developments which are taking place in connection with reaction propulsion, the Combined British Astronautical Society assumes the status of an important national body. It had modest beginnings some years ago but like most new movements it was laughed at until the Germans demonstrated the practicability of jet propulsion with their V-I and rocket propulsion by their V-II.

This society consists of the joint memberships of the Astronautical Development Society and the Manchester Astronautical Association and they combined forces some years ago to fortify and strengthen their efforts to promote interests in this new science. The society has now been wound up and a new society born under the title of the British Interplanetary Society, a company limited by guarantee with offices at Albemarle House, Piccadilly, London, W.1. The entrance fee is 5s. and the rates of annual subscription are 1 guinea for fellows, £1 for members and associates 10s.

The society has been formed to take over the rights and liabilities of the B.I.S. and the C.B.A.S. and will continue the work initiated by these societies. It aims to obtain further knowledge of conditions existing in the upper atmosphere and beyond, by the development of manned and instrument carrying rockets capable of being projected in and beyond the earth's atmosphere; the study of recent developments in the technique of reaction propulsion in all parts of the world; the development of recording and controlling apparatus; and the development of reaction propulsion systems capable of application to supersonic flight.

In addition to these studies, the society has undertaken a survey of the problems of control and navigation in spacial investigations of the conditions on the surfaces of the planetary bodies of the Solar System; the design of equipment and instruments for use in interplanetary travel; the physiological and mechanical problems associated with space-flight and technique for the computation of interplanetary trajectors.

"Newnes Engineer's Reference Book"

AN important new work has just been published from the offices of our companion journal, *Practical Engineering*, under the above title. It is a work of reference on every branch of mechanical engineering, containing sections on workshop mathematics, capstan and turret lathes, plastics, dies and press tools, die-casting, metallurgy, non-ferrous metals, aeronautical engineering, radio, internal combustion engines, screw threads, gear cutting, wire gauges and wire drawing, milling, planing, shaping, grinding, drawing office practice, patents, designs and trade marks, heat treatment, pyrometers and pyrometry, cutting speeds and feeds, coolants, riveting, tube drawing, gauge and screw thread measurement, panel beating, pipe unions, joints and glands, stampings and forgings, aero castings, bending, soft and hard soldering, welding, metal polishing, electro-plating, degreasing, belts and pulleys, broaching, production control, time and motion study, rate fixing, quality control, works costs accounts, etc., etc., and a vast number of tables dealing with functions of numbers, trigonometrical functions, the metric system, screw threads, etc. The book is chiefly the work of Mr. F. J. Camm, editor of PRACTICAL MECHANICS, with sections by contributors on special subjects. The work contains a fully cross-referenced index.

A Camera Enlarger

Constructional Details of an Efficient Apparatus for Home Use

By "HOBBYIST"

The completed enlarger.

ENLARGED photographs are always more enchanting than ordinary contact-printed pictures. The latter, apart from being rather small, are sometimes too "sharp" in focus, particularly in respect to portraits or full-length pictures of relatives and friends. An enlarger produces "flattery" in a photograph which, if printed in the normal manner (actual size), would be harsh and uncomplimentary. It does so because one can adjust the focus to make sharp features, wrinkles, etc., softer and less noticeable. But, of course, good enlargers are expensive. . . .

A Simple Horizontal Type

However, if you happen to own—or can manage to obtain—an old quarter-plate stand camera, it can be adapted to make a reliable horizontal enlarger for practically no cost. In fact, a new stand camera can be used, because it will not be harmed in any way. Thus, the camera serves a double purpose—taking pictures and enlarging them.

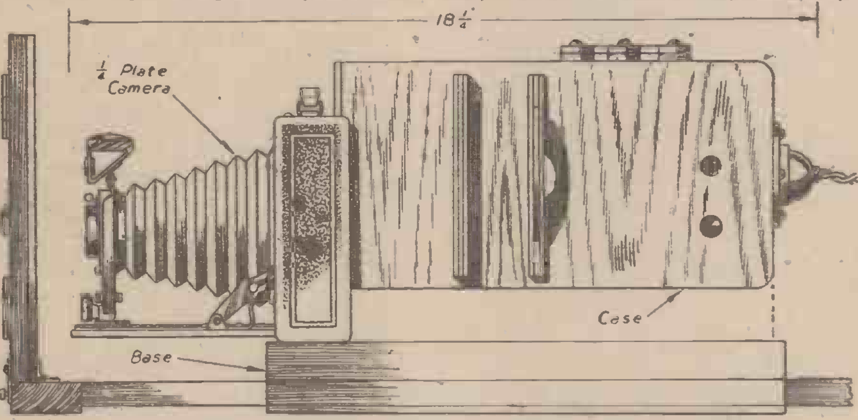


Fig. 1.—A side elevation of completed enlarger, showing how case fits down behind the camera to rest on the base.

In the writer's case he managed to buy a Bausch and Lomb quarter-plate stand camera for £1 in a second-hand store. Although somewhat old-fashioned, it took fairly decent "snap" and "time" exposures on ultra-speed orthochromatic Kodak plates, such being sensitive to colours. The pictures enlarged splendidly by means of the enlarger which was eventually designed and constructed from odds and ends, and the enlarger detailed herewith is based on this model.

No Condensing Lens Required

No large, expensive condensing lens is needed in building the enlarger. Moreover, the enlarged image projected on the printing paper is shown clearly and fully, i.e., oblong in shape as on the negative, this being due to a special opalising "screen" placed between the plate holder and the single lamp used for illumination. Without the screen, the projected image is not lighted up fully at the sides and ends, there being a bright, hazy ball of light showing in the centre—a "reflection" of the lamp itself, even though this happens to be a 60-watt gas-filled "Argenta" Philips lamp (made in Holland) having an opal bulb. The same effect applies to pearl or "frosted" lamps, hence the need for the screen. A clear lamp, used in conjunction with the opalising screen will produce the unwanted "ball of light" effect, despite the screen; the lamp must therefore be an opalescent type to diffuse and spread the light more evenly behind the screen, a reflector also helping in this connection.

Irrespective of quarter-plate *glass* negatives, the home-made enlarger takes *film* negatives ranging from $4\frac{1}{4}$in. by $3\frac{1}{4}$in. to miniature sizes, due to the special negative holder which has been designed. And instead of the usual printing easel, on which the printing papers are mounted, a print holder—which resembles a printing frame—is used, taking half-plate printing papers ($6\frac{1}{2}$in. by $4\frac{3}{4}$in.), and giving a neat $\frac{1}{8}$in. white border all round.

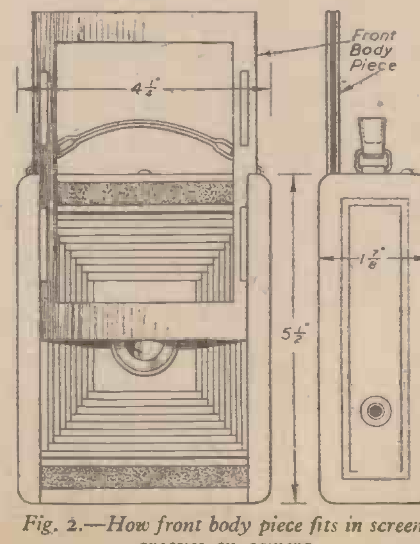


Fig. 2.—How front body piece fits in screen grooves on camera.

Making the Case

A case, with apertures for the negative holder, the opalising screen frame, plus sufficient lamp housing, is made from $\frac{1}{4}$in. plywood and $\frac{3}{8}$in. wood in the following way. First of all, having obtained the quarter-plate camera, remove its slip-in back, the latter being a framework containing the ground-glass focusing screen and a folding hood.

Now, as will be observed from the side elevation of the enlarger in Fig. 1, the case front, like the original back of the camera, fits into the grooves behind the camera. The front of the case, consequently, is made first to fit into the camera, as indicated in Fig. 2.

Not all quarter-plate cameras are similar in construction. The old type used by the writer measured $5\frac{1}{4}$in. by $4\frac{1}{4}$in. by $1\frac{7}{8}$in. overall. The grooves at the back accommodated a piece of 3/16in. plywood $5\frac{1}{2}$in. by $3\frac{3}{4}$in. This panel was then cut to make a $4\frac{3}{8}$in. by 3in. oblong aperture in the centre, with two $1\frac{1}{4}$in. by $\frac{1}{8}$in. mortises cut at the sides, as detailed in Fig. 3.

If your camera differs slightly in size, make your parts accordingly, following the same constructional plans given in these instructions. Use a piece of three-ply wood so the bottom end of the case front can be more easily rebated (see side edge view) by removing a strip from the face ply, this allowing the framing to fit flush with the bottom of the camera.

The back end piece (Fig. 3) is cut from $\frac{3}{8}$in. wood. To the inside of this is fixed the lamp reflector piece (Fig. 4), which is cut from $\frac{1}{8}$in. plywood, being mounted on blocks 3in. by 2in. by $\frac{3}{8}$in. The collar, for the lamp-holder, is cut from $\frac{1}{4}$in. plywood and affixed centrally over the $1\frac{1}{2}$in. diameter hole cut in the back piece.

The case sides are identical and are cut

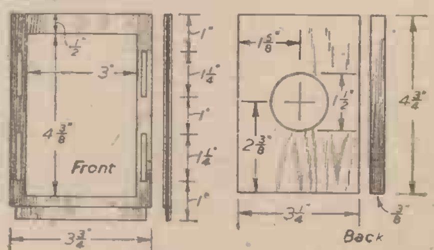


Fig. 3.—Front and back of case, with chief dimensions.

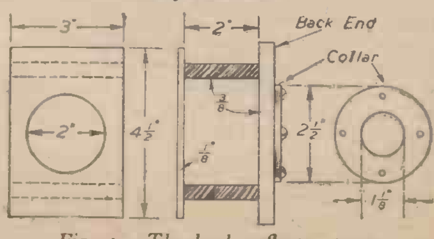


Fig. 4.—The back reflector parts.

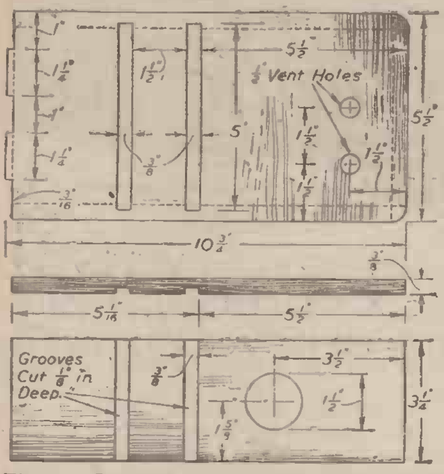


Fig. 5.—Case side and top. The bottom piece is cut similar as the top piece.

from $\frac{1}{8}$in. plywood, the top and bottom pieces (also identical) being cut from $\frac{3}{8}$in. wood, as detailed at Fig. 5. To assemble, glue the side tenons into the mortises in the front piece, fix the top and bottom between the sides with glue and nails, then add the back. It is imperative, of course, that the slots in the sides correspond with the grooves cut in the bottom and top pieces. The parts should be assembled minus glue and the case tried in its position behind the camera. The front should be an easy, slide-in fit; if satisfactory, reassemble, using glue.

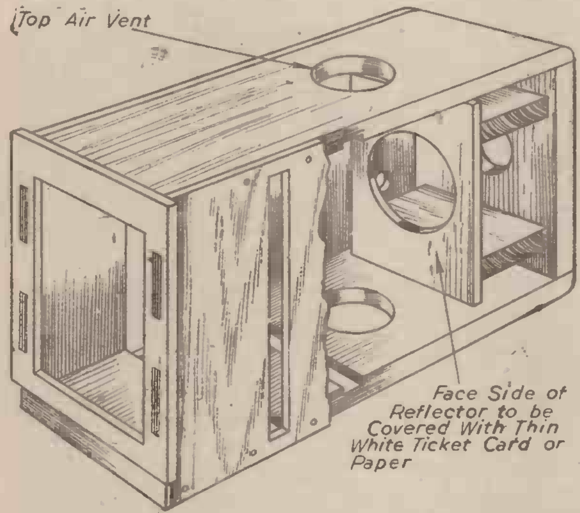


Fig. 6 (Left).—A cut-away-constructional view of the case.

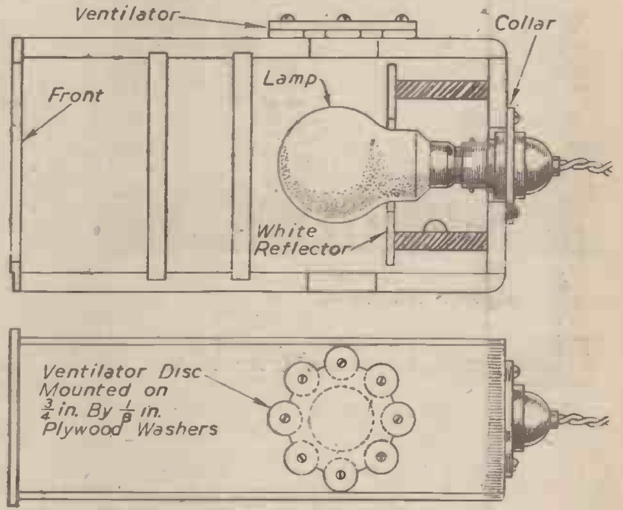


Fig. 7 (Right).—Sectional side view, showing lamp housing, with plan view below.

Top Air Vent

A considerable amount of heat is emitted by the lamp. This heat needs an outlet (Fig. 6), otherwise—during damp weather—a condensation of "steam" may form on the cold negative plate. The $\frac{1}{2}$in. diameter holes cut in the case sides admits air, with the top vent (which is covered by a light-trap) allowing the heat to escape. The light-trap consists of a shaped disc cut from $\frac{1}{8}$in. plywood (see top view, Fig. 7) mounted on suitable washers with $\frac{3}{8}$in No. 4 roundhead screws.

Lamp and Reflector

Having obtained a 60-watt opal or frosted electric lamp and a pendant ceiling fitting of standard size, unscrew the collar from the case back and fix it on the fitting by the screw ring, then replace the collar against the back (see side sectional view). A suitable length of twin flex, of course, is attached to the fitting beforehand; an adaptor, or plug, is connected to the opposite end.

The reflector piece is either coated with whitewash or else covered with a piece of thin, white ticket card cut to the same size, with a 2in. diameter hole in the centre. If the latter method is preferred, it will be found more convenient to adhere the card on the reflector piece prior to the assembly of the case parts. If already assembled, glue can be brushed on the part and the card carefully placed in position with the hand.

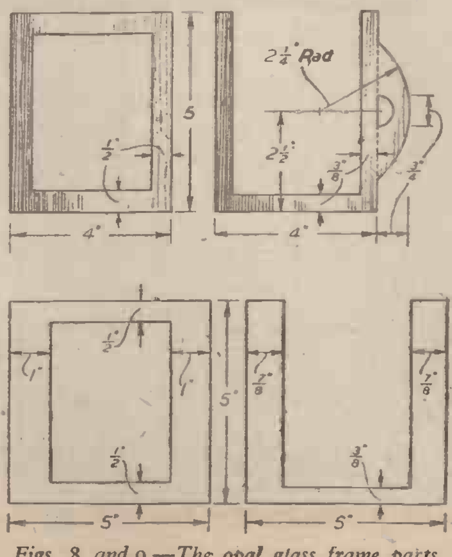
Opalising Screen Holder

The opal glass frame parts are shown at Fig. 8. The frame consists of three shapes cut from $\frac{1}{8}$in. plywood. The middle piece has a handle or "lug" at one side, with a top end cut away. Cut the two cover pieces identical and glue to each side of the centre piece; it may be necessary to drive in a few panel pins here and there to keep the parts together.

To provide the screen, obtain a piece of 15oz. (or 3/32in. thick) opal glass. This glass, owing to war conditions, may be opalised on one side only. The glass sizes are shown in Fig. 10, and it only remains to fit the glass into its frame.

Negative Holder

The holder for the negatives is built similarly as the frame dealt with, using $\frac{1}{8}$in. plywood. Cut out two cover pieces and a centre piece to the size and shape shown in Fig. 9 and glue together. The holder, it will be seen, is 5in. square; this enables it to be used so the negative plate can be inserted to show vertical or horizontal images on the focusing easel.



Figs. 8 and 9.—The opal glass frame parts.

It is essential that the negative holder is a neat, smooth fit. It should not be tight nor too loose. When tight, the difficulty of movement is apt to spoil focusing and adjustments. If rather slack, some amount of light escapes, and although this light is deflected, it is wiser to reduce it as much as possible.

The completed holder is shown in Fig. 10. In use it takes a single glass negative. If you wish to use film negatives of varying sizes, these can be placed between two cleaned quarter-plate glass negative plates. The plain pieces of glass are put into the holder as shown.

It is advisable to have the negative holder stained black, this also applying to the front interior of the case. There is no need to stain the wood beyond the negative holder frame apertures in the case. The outside of the latter could be stained black all over.

Do not apply oil or varnish stains, since these (when the wood heats slightly) create a nasty smell. Use a water or spirit stain, a single application sufficing. A simple stain can be made by mixing a little lamp black in sufficient water or cheap methylated spirit. The vent cover and its washers, by the way, should be stained all over, removing the parts for this purpose.

Testing the Enlarger

You can, at the moment, fit the case behind the camera and, having placed a glass negative in the holder, switch on the light and try focusing the enlarged image on a sheet of white paper. Images can be made clear and sharp, but a lot depends on the clearness

(*Continued on page 183*)

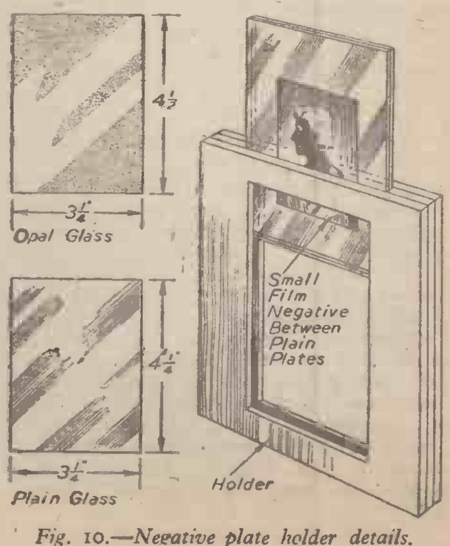


Fig. 10.—Negative plate holder details.

The Mechanics of Meteorology—3

Cloud Formations : Fog and Visibility

By G. A. T. BURDETT

(*Continued from page 139, January issue*)

Fig. 18.—Contrails. Clouds formed by aeroplane exhaust. (Royal Met. Society.)

THERE are two heap clouds, cumulus and cumulonimbus (cumulus being Latin for "a heap").

The bases of these clouds are between 1,500ft. and 8,000ft., and, though comparatively low, they extend vertically to great heights, but with little depth. In Great Britain their bases are usually in the order of 1,500ft.

Cumulus clouds are the most common fair-weather clouds (Fig. 19). Sometimes they almost cover the sky, while at other times the sky is clear except for one or two cumulus clouds. When the sun shines on them they have a white, puffy, or cotton wool appearance, but if of marked vertical extent they appear black, being full of moisture (rain).

All heap clouds are caused by upward currents of air which give off their moisture as they cool, contract, and reach their dew point. As these clouds are supported by the ascending currents of warm air, precipitation, or rain, rarely falls from them, but when they develop to a great extent, the moisture becomes too heavy for the air to support, and rain falls in the form of showers.

The presence of heap clouds is of particular importance to glider flying, since glider pilots are able to make use of the numerous ascending currents of warm air to obtain the necessary "lift," known as thermals.

The cumulonimbus cloud, which is cumulus in a more highly developed form, is the thunder cloud and one which aviators always avoid and, if necessary, fly round. Should the aircraft be flown into them, as the clouds hold high charges of electricity, they are likely to damage wireless apparatus, particularly where trailing aerials are extended and also the compass readings may be upset.

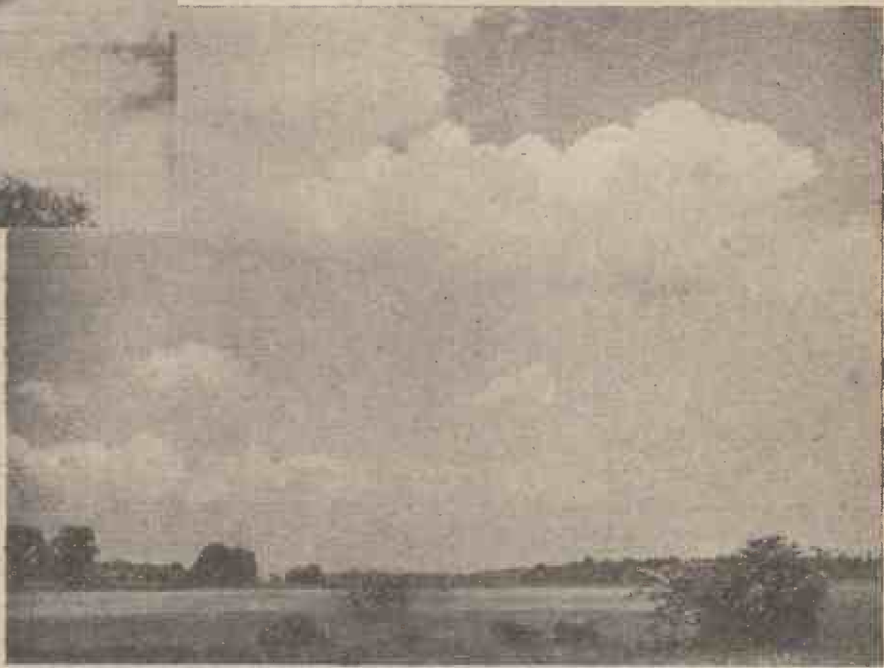


Fig. 19.—Cumulus cloud. The most common cloud of the heap formation.

Heavy icing of aircraft is a further risk. A typical cumulonimbus cloud is illustrated in Fig. 20. The "anvil"-shaped top is of particular interest and is caused by the strong horizontal winds always present at these heights in the circumstances. The wisps of cloud extending from the anvil top are known as "false cirrus" and are also created by the horizontal winds and not by the frontal condition which causes true cirrus.

Fig. 20.—Cumulonimbus cloud. A good example of a fully developed cloud with the anvil top. (Royal Met. Society.)

Thunder Clouds

Electrical storms, normally termed thunderstorms, are caused by the electrical discharge of one or more cumulonimbus clouds. It is the cloud which causes the storm and not the lightning and thunder (which are a direct result of the rapid discharge of electricity from the clouds).

The large mass of cloud (Fig. 21) becomes highly charged with static electricity very much in the same way as an airship or balloon does. The electrical resistance of the air breaks down and a flashover occurs (Fig. 22). Following the lightning flash we get the explosion, termed thunder, which can be heard up to, though rarely greater than, a distance of ten miles. It is possible to estimate the distance away of a storm from the point of observation by counting the time in seconds between seeing the flash and hearing the thunder. The speed of the thunder (the sound) is one-fifth of a mile per second.

The development of thunderstorms is more fully dealt with later.

Cloud Amounts

When observing clouds it is not only important to judge what type of cloud is present over a specific area, but also the amount.

Meteorologists always term cloud amount in so many tenths. For example, if the sky is completely overcast with nimbostratus, they report 10 tenths of nimbostratus, or if the sky is half covered with cumulus, 5 tenths of cumulus at, say, 3,000ft. Another report may be 7 to 8 tenths of altostratus at 7,000ft., with patches of stratus at 1,000ft.

Fig. 22.—A remarkable photograph showing single flash of lightning. (Royal Met. Society.)

The table at the foot of the page is adopted for simplicity.

Judging Cloud Heights and Types

Only with constant practice is it possible to estimate accurately cloud heights and their type. The best method at first is to note the comparative size of a known type of aircraft. At first a cloud may appear fairly low, but when it is observed that an aircraft is at a great height, but still below the cloud, it will be obvious that the first estimate was incorrect.

The first difficulty in judging types of cloud is because rarely do actual clouds resemble the text book illustrations. Usually a number of different types will be observed at the same time, and it is then the job of the observer to ascertain which type of cloud is more general.

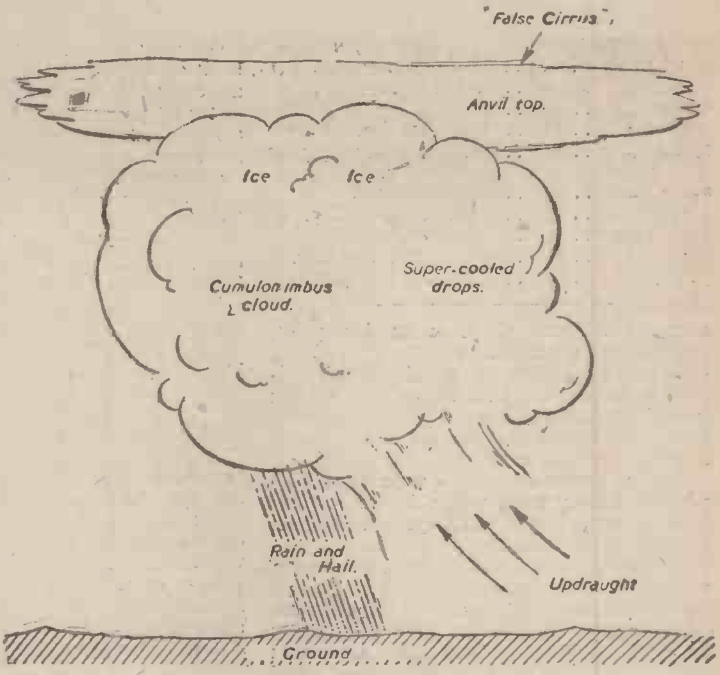


Fig. 21.—Diagram of a thundercloud.

Fog

Fog is really a kind of cloud at ground level. Like cloud, it is produced by the removal of moisture from air cooled below its dew point. There is not, however, any appreciable movement of vertical air when fog is produced.

There are four main types of fog. (1) Orographic or hill fog; (2) radiation fog; (3) movement fog; and (4) mixing fog.

Orographic fog is really low or orographic cloud, which covers hill tops under conditions which will be described more fully later (Fig. 23).

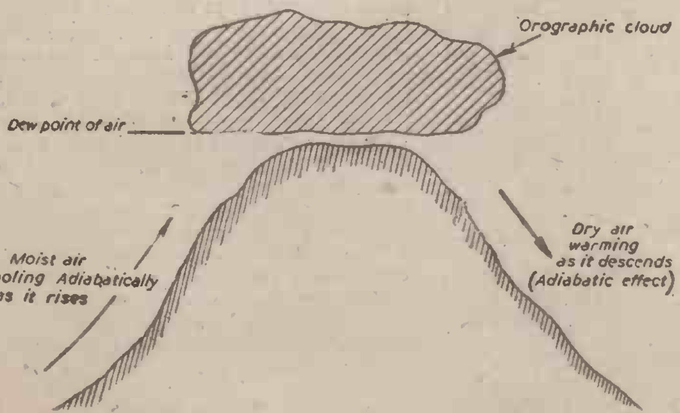


Fig. 23.—Orographic (or hilly cloud. In rising, cools. The moisture is precipitated (cloud forming). The warm dry air then descends. In the Alps these warm dry winds are known as the "Fahn."

Radiation fog is usually associated with three main factors. Air with a high moisture content, i.e., a high relative humidity, a clear night sky and a very light wind. Although radiation fog appears more frequently and is more persistent during the winter months, it does form during summer nights, but is dispersed shortly after sunrise. Valleys and flat country, particularly marshland, are very susceptible to radiation fog.

Frequently the fog will remain for days on end over low-lying country, while the surrounding higher districts will be clear. These low-lying areas are, during such times, completely isolated from the neighbouring areas.

Cause of Radiation Fog

At night, when the sky is clear, and there is no cloud blanket to prevent the heat from the earth escaping, the ground soon cools. The light, warmer wind or air then brushes across the cool ground, and as this will have a high relative humidity, dew point of the air is reached and fog is formed.

The shorter the period of sunlight, e.g., winter-time, the longer the period during which the fog is formed, which results in winter-time being most favourable to the formation of fog.

Although radiation fog is soon lifted and dispersed after the sun rises, the fog is usually thicker immediately after sunrise. A number of explanations have been offered for this, each of which contains much logic.

Movement Fog

Movement fog usually forms over the sea, when it is generally termed sea fog. It more frequently occurs in spring and summer, when the sea, which absorbs heat slowly, has still a temperature little above that of winter. The warm air from the land moves

0 = clear sky.
1 = trace of cloud.
2 = 1/10.
3 = 2/10–3/10.
4 = 4/10–6/10.
5 = 7/10–8/10.
6 = 9/10.
7 = over 9/10 but below 10/10.
8 = 10/10.
9 = Sky obscured by fog.

TABLE OF VISIBILITY

Distance	*Description*
27 yards	Dense fog.
55 „	Thick fog.
220 „	Fog.
550 „	Moderate fog.
1,100 „	Mist, haze or very poor visibility.
2,200 „	Poor visibility.
5 miles	Moderate visibility.
12½ „	Good visibility.
18 „	Very good visibility.
31 „	Excellent visibility.

over the cold sea, drops to its dew point, and the fog is formed.

The well-known fogs over the Newfoundland Banks are a typical example of sea fog caused by the warm air from North America coming into contact with the cold streams flowing from the north.

Sea, or movement fog, occurs even with a fairly strong wind which blows the fog over the coast and covers large areas of land for some miles inland.

Movement fog is not confined to the sea and will on occasion form on the land; this particularly when the ground is covered with snow or after heavy rain followed quickly by a cold period. These land movement fogs do not as a rule last very long, since they are quickly dispersed by the sun or wind.

Mixing Fog

This is caused by the mixing of two currents of air in close proximity, one cold and the other warm. The warm moist air strikes and mixes with the cold, drops below its dew point and gives off its moisture in the form of mixing fog.

Industrial Haze

The smoke from towns, particularly in industrial areas such as the Black Country, will mix with fog and form a dense yellow or black fog which causes poor visibility. This mixture of fog and smoke will pollute the atmosphere for days on end until the rains come and wash it away.

This fog, usually called a "pea souper," was a common occurrence in London until recent years, but owing to the increased utilisation of smokeless fuels, electricity and gas, "pea soupers" are rarely seen in that area now.

A further cause of low visibility is the presence of smoke haze. Smoke is carried by rising warm air well up into the atmosphere, while at the same time horizontal winds carry the smoke well out to sea.

As the prevailing winds in Great Britain are westerly, the smoke from the Black Country and Lancashire are blown to the eastern side of the country and over the sea. Therefore the eastern counties have more smoke haze than the western.

When an anticyclone is stationary over the area where smoke is present, the inversion (that is, an increasing temperature with altitude—see last month's article) prevents the warm air rising above a specific height. Therefore, while the anticyclone and the inversion remain, the industrial smoke will throw a smoke blanket over the area, through which the sun will be unable to penetrate. Aerodromes in these areas may be rendered unfit for flying for long periods.

We now know that during the war FIDO (fog, intensive, disposal of) installations were devised and used to enable our bombers to operate against the enemy in spite of fog. Petrol was burnt, the heat from which temporarily lifted the fog and allowed pilots to land their aircraft.

Mist

Not everyone is clear as to the correct meaning of mist, or what is the difference between fog and mist. The only difference is that of visibility. Both are caused by moisture or water drops given off by air of high relative humidity cooled below its dew point.

From the accompanying table it will be seen that as a general rule we can say that when visibility is less than 2,200 yards (2 kilometres), but more than 1,100 yards (1 kilometre), it is mist, but when below 1,100 yards it is fog.

Measuring Visibility

Visibility is defined as the distance from which one can see objects with the naked eye. This is dependent upon the weather conditions at the time of observation. For instance, fog, haze, rain, snow and hail all reduce visibility.

Fig. 24.—Sunshine recorder, Campbell Stokes pattern, for temperate latitudes. The sun's rays are focused upon prepared and printed cardboard strips. As the sun moves from east to west so is a tracing made on the strip.

While many of us may make a rough guess at the visibility at a specified time and place, few will be accurate, since each will make a different estimate of the exact distance. Such guesses, being inaccurate, have little, if any, practical value.

The golden rule is: "First select recognised objects at a known distance away. If these can be seen and beyond, the visibility is greater than the distance of the objects. If in a strange locality, locate a suitable spot on a map, e.g., a church spire, or a group of tall trees. For short distances up to ten miles select small objects, but for greater distances select larger ones, e.g., a chimney stack or a high hill."

Fig. 25.—Rain gauge. Simple type of gauge for measuring rainfall, showing graduated measure.

There are, however, a few points to bear in mind. For example, if a church shown on the map is 10 miles away, but is hidden from the observer by a clump of trees or a hill, it does not necessarily follow that the visibility is only eight miles. If, on the other hand, a hill 25 miles away is visible to the naked eye, but not a church spire 20 miles away, the visibility will be 25 miles at least. Should the top of the hill be covered by cloud, and therefore not visible, though the base of the hill is visible, the visibility may still be reckoned as 25 miles. If a chimney stack can be seen 8 miles away, but not the church at 12 miles, the visibility will be between 8 and 12 miles.

Visibility at Night

During the hours of darkness visibility is much harder to measure within any degree of accuracy. Lights are very deceiving from the point of view of distance. A fairly bright light may not be seen 10 miles away on a moonlight night, but on a dark, clear night it may be seen much farther away. A brighter light will, of course, be seen for a greater distance than one not so powerful.

For measuring night visibility, meteorologists use lights which have a standard predetermined candlepower and are viewed through a special or smoked glass screen.

One point must be appreciated—that visibility at night has nothing to do with degree of darkness. Obscurity is the chief factor to consider. Obviously, visibility will be better with the aid of artificial illumination, viz., a torch, on a very dark night than on a moonlight night when the area is enveloped in fog or haze.

Visibility also varies in moonlight. An observer looking "up-moon," that is towards the moon, will be able to observe objects at greater distance than if he were to look "down-moon." The converse is true in sunlight, where visibility is better down sun than up. This is due to the glare from the sun which reduces the observer's vision.

This factor is of particular importance in wartime, for when military authorities decide to engage the enemy on sea, land, or in the air, they plan their activities as far as possible to ensure that the enemy is either facing up-sun or down-moon and are therefore at a disadvantage.

Snow on the ground at night, whether the moon is up or not, also increases the range of visibility.

Thunderstorms

Thunderstorms are dramatic. Nearly all of us enjoy witnessing Nature's own vivid "firework" display. Some, of course, fear thunderstorms, but it is believed that these are in the minority and that this fear is due largely to some incident which occurred during childhood.

Thunderstorms are likely to develop at any time of the year, though, as we shall see later, the probability of their occurring is greater during late spring and early summer.

Two "weather" conditions are essential for the development of thunderstorms. (1) There must be an adequate supply of moisture in the lower regions of the atmosphere, viz., 5,000ft. to 10,000ft., for the development of the cumulonimbus or thundercloud; or (2) there must be a steep temperature lapse rate (fall with altitude) up to at least 10,000ft., viz., unstable atmosphere.

Any of the following conditions are necessary for the steep temperature lapse rate:

(i) The day must be clear with a strong sun to raise the temperature of the ground to a high value, provided that the upper air is relatively cold.

(ii) Warm, moist currents of air must be present in the lower regions, provided the upper air is relatively cold.

(iii) There must be cold currents of air undercutting existing warm, moist air.

(iv) Deep polar currents of air travelling in a southerly direction are warmed at their base by currents of warm air near the ground.

Occurrence of Thunderstorms

The first type of thunderstorm may be expected during the afternoons when the temperature of the ground and the surface layers of air have been raised sufficiently. These occur during the summer, and are most frequent in the early part when the upper air is still relatively cold.

The second type also occur in summer in the British Isles and usually arrive after an anticyclone has passed over and a depression is arriving from the Atlantic, bringing in its wake currents of warm air.

The third type occur by day and night, are not confined to any particular season, and may therefore be expected at any time of the year. They are associated with well-marked cold fronts.

The fourth type are rarely well-developed thunderstorms, but they occur frequently in Great Britain, particularly off the West Coast in winter-time and off the East Coast in summer-time.

Break up Fine Weather

It is frequently considered by the amateur that thunderstorms break up a spell of fine weather. To some extent this is true, but they also tend to stabilise the atmosphere and therefore contribute to the further extension of the spell of good weather.

The summer-time type of thunderstorm, caused by heating of the ground, are local and not national in character. They develop from the unstable atmosphere, and as a result of the considerable precipitation of rain, hail or sleet, they do what might be termed, dry out or remove the moisture from the atmosphere. It often happens that the days which follow thunderstorms are less thundery than those which precede it.

The other type of thunderstorm, that is, frontal, does mark the breaking of up fine weather, though this is rather putting the cart before the horse, for it is the frontal system which breaks up the weather and causes the thunderstorm, though the presence of unstable air does cause a local depression to form.

Passage of Storm

It is usually possible to follow the direction of a thunderstorm. This normally moves with the main current of air in the main body of the storm, that is, the direction of the wind, between 10,000ft. and 20,000ft., and can be measured by observing the speed and direction of the clouds. When the clouds are moving quickly, a storm will come almost without warning, but when they are moving slowly a fair warning is usually given.

Forecasting a Thunderstorm

Most of us have heard the old saying, "Mountains in the morning, fountains in the evening." If on a summer's morning there is much cumulus cloud which appears rapidly to develop both in size and depth, viz., cumulonimbus ("mountains"), a series of thunderstorms ("fountains") will occur sooner or later.

The rate at which the thundercloud develops will depend upon the temperature lapse rate (decrease with altitude). If the air is unstable, that is, a decrease in temperature is in excess of 3 deg. for each 1,000ft., clouds will develop so rapidly that the upper currents of air can no longer support the moisture content, and a storm will result.

A further method which the forecaster may adopt to ascertain whether thunderstorms are likely to develop during the day is to measure the relative humidity or moisture content of the atmosphere. Where the cumulus clouds do not develop before, say, 10 o'clock, the relative humidity test may be the only means of forecasting thunder. A high relative humidity at 8 o'clock G.M.T. in the morning spells thunder, but if the relative humidity is low, the possibility of thunderstorms is very remote.

Theory of Thunderstorms

Lightning is caused through the breakdown of an electrical stress where it has been set up between two distinctive parts of a thundercloud. No one knows quite how this electrical charge has come about, but scientists agree to the following.

The electrical charge is given to moist particles of the atmosphere, viz., rain and hail, etc., due to contact between ice particles, viz., hail, or the breaking up of rain-drops. A developed thundercloud carries a *negative* electrical charge in its upper portion and a *positive* charge in its lower. It has been proved that contact between ice particles gives rise to a negative charge and the breaking up of rain-drops causes a positive. Therefore we may expect hail in the upper region and rain in the lower.

As the hail in the upper part, if moved up and down by the heavy lifting currents and the rain-drops are continually being broken up, a high electrical stress of many million volts is built up. When the limit of this stress is reached we get the lightning flash, followed by the rumbling of thunder.

What is Lightning?

Lightning is not one flashover as is generally considered, but a series of sparks. All these are added up, which results in the forked lightning we all know.

What is Thunder?

The thunder follows the lightning flash and is caused by the abrupt expansion of air particles of the lightning discharge.

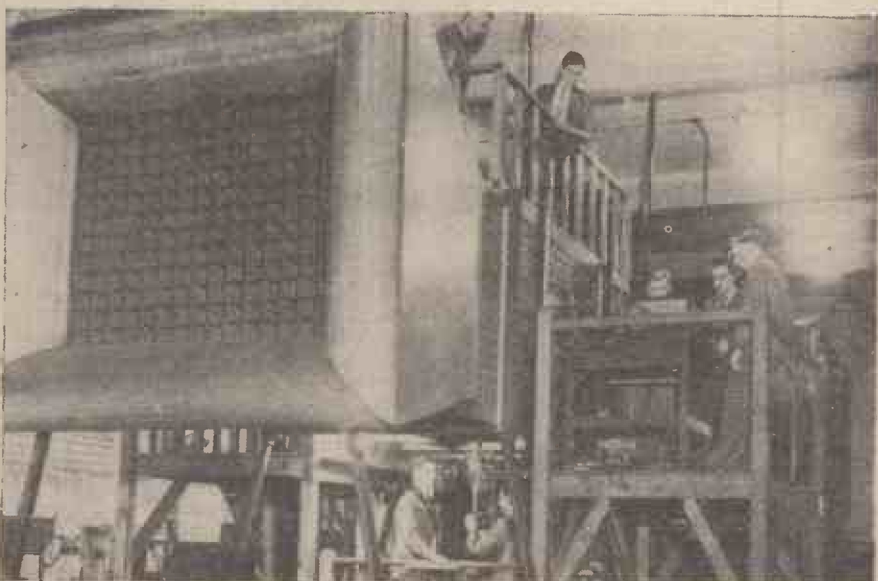
It is heard as a sharp crack followed by a rolling sound which was very closely resembled by explosions of the V2 rocket shell sent over by Germany during the war.

Three reasons are given for this rumbling, which are: as the lightning follows a zig-zag path the sound reaches the hearer by delayed action, due, of course, to the low relative speed of sound as compared with light. Although the sound waves from the thunder have all occurred simultaneously, as those of the rocket shell on its downward path, they have travelled various distances and do not reach the listener simultaneously.

The second reason is that a number of lightning discharges usually occur in quick succession.

The third reason is echo from the hills, valleys and even from the clouds themselves.

(To be continued.)



The centenary celebrations of the Imperial College of Science and Technology took place recently, when the college was open for inspection to invited guests, and the normal working of the college demonstrated. The illustration shows a pressure distribution test on a model wing under flight conditions in a 2ft. wind tunnel.

The Physics of the Photograph

The Functions of Photographic Exposure and Development

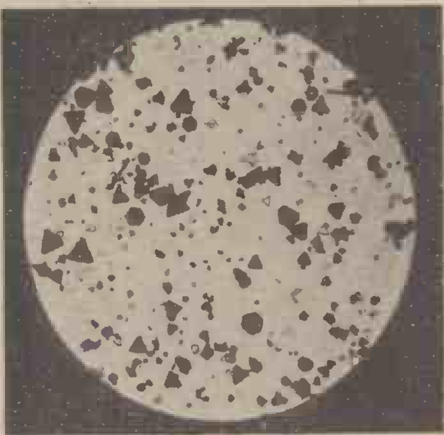
IT is an amazing fact that the manifold triumphs of photography have, so far as fundamentals are concerned, been based on purely trial and error methods.

Photographic workers and investigators have invariably prepared their various light-sensitive emulsions according to certain fixed rules which trial and experience, added to basic chemical knowledge, have shown to bring about the most desirable results, but until recent times we have all been quite ignorant as to the exact mechanism and the "why," so to speak, of the photographic process.

It does seem remarkable, therefore, that the photographic industry, which until fairly recently was more or less in the dark as to the exact nature and the precise mechanism of light-sensitivity, should, by empirical methods alone, have been able to originate and to turn out so consistently sensitive material of such undoubted excellence. Yet such is the case, and had it not been for the dogged and persistent labours of a mere handful of photographic investigators, both chemists and physicists, here and in America, we would still have been totally ignorant of what really happens when, for a fleeting second or even for the merest fraction of a second, we allow light rays to exert their decisive influence on the sensitive plate or film within the camera.

Much indeed, is wanting to complete our understanding of the whole mechanism of light-sensitivity. Nevertheless, the at one time utterly mysterious business of photo-sensitivity has at last begun to yield to the repeated investigations of our present-day experts, so much so that the plate and film-making operation is rapidly becoming less and less a business of rule-of-thumb method and more and more a technique of pre-determined scientific exactitude.

Unexposed silver bromide grains in the emulsion of a photographic film, 2,000 times magnified.



The emulsion grains after exposure and full development—2,000 times magnified.

Most of our modern photography is based on the light-sensitivity of certain salts of silver, notably the chloride and the bromide of this metal. There are other methods of photography and of photographic printing whose mechanisms are, to say the least, very incompletely understood, as witness, for instance, the well-known carbon process depending on the insolubilisation by means of light action of gelatine containing a bichromate salt, but these specialised problems cannot be included in our present discussion.

Silver chloride sometimes occurs naturally in mineral form, and for this reason its characteristic action in darkening under light influence has been known for centuries.

Showing the "mass effect" of silver grains in the exposed photographic emulsion constituting the negative.

Silver Bromide

During the early experiments in photography the darkening effect of silver chloride was made use of, but it was subsequently discovered that silver bromide is much more light-sensitive than the chloride, and, moreover, that a short initial action of light on the silver compound could be continued afterwards by chemical means alone. Thus came the idea of "development" into photography.

In other words, the possibility of producing by means of a very short exposure to light an invisible or a "latent" image on a silver bromide surface was realised, and it was the ability of this mysterious image to be developed up afterwards by chemical treatment which formed the basis of modern photography.

A photographic plate or film consists fundamentally of an emulsion of silver bromide grains or particles in a medium of gelatine.

Now, after these gelatine emulsions had been commercially manufactured for a number of years it was found that they could be increased in "speed" (i.e., in light-sensitivity) by warming the prepared emulsion up to a certain definite temperature and by carefully keeping it at that temperature for a definite length of time. During this "cooking" or "emulsion-ripening" process the silver bromide grains coalesced together and gradually grew in size.

Unfortunately, there was a rigid limit to this arbitrary method of increasing the speed or sensitivity of the emulsion because the increased grain size of the silver bromide particles conferred an unwanted coarseness or "graininess" on the definition of the photograph.

There was also a very mysterious factor which at one time gave an enormous amount of trouble and anxiety to the photographic emulsion makers. This source of trouble lay in the gelatine which they used, and which was specially made for them by the highest skill in the gelatine trade.

It was found that different batches of gelatine gave different results with the same amounts of silver bromide and when used under precisely identical conditions.

The "x" Material

It seemed, therefore, that commercial gelatine invariably contained traces of a naturally occurring substance which had the power, in some mysterious way, of conferring a very high light-sensitivity on silver bromide, and that it was a natural variation of the amount of this unknown "*x*" material in the gelatine which was responsible for the difficulties under which emulsion makers had long laboured in endeavouring to keep their products up to a standard high speed.

At last, about 1927, the "*x*" material was isolated from the gelatine. It proved to be a fairly simple sulphur-containing compound which chemists had long known. In fact, it turned out to be nothing more than mustard oil. So that afterwards, by using the highest grades of gelatine and by purposely "inoculating" it with small amounts of mustard oil, photographic manufacturers were able not merely to get over their own previous practical difficulties in emulsion-making, but, better still, to produce emulsions of still higher sensitivities and, at the same time, to dispense with some of their former "cooking" processes for increasing the sensitivity of the silver bromide grains.

The silver bromide "grains" in a photographic emulsion are really crystals, each of which is separately embedded in the matrix of carefully prepared gelatine. It is known, also, that the atoms of silver and of bromine in silver bromide are arranged in each crystal in a very definite and regular alignment with the bromine atoms forming the framework of the crystal and the silver atoms filling the interstices.

When an electric potential is placed across silver bromide, no matter whether in the solid state or in solution, the bromine atoms

The daguerreotype—the earliest type of photograph comprising a silver-mercury image on a silvered copper plate. Note its ornamental case.

become negatively charged and the silver atoms become positively charged.

Crucial Experiment

Some years ago a very crucial experiment was made, and this gave a basic clue to the explanation of photographic action and the formation of the "latent image."

An electric current was passed through a mass of *solid* silver bromide. It was found that small amounts of silver accumulated at the negative electrode, demonstrating the fact that, even in a solid material such as silver bromide in which the atoms are supposed to be tightly bound down to one another and incapable of much movement, it is possible for at least some of the silver atoms to migrate across the mass of material and to give themselves up at the negative electrode of the cell, although the number of these "free" atoms is not very great.

It seems, therefore, that the inner structure of the silver bromide crystal is such that it allows for a small proportion of these "loose" or wandering silver atoms which, under certain directive and/or attractive influences, can actually move from one part of the silver bromide crystal to another, although they cannot actually leave the crystal itself.

We have already become aware of the enormous importance of the gelatine-derived sulphur compound, to wit, of mustard oil in sensitising photographic emulsions of silver bromide. Now we shall proceed to see exactly why such is the case.

There is a slight interaction between the silver bromide crystals as they exist in the emulsion and the sulphur compound, which action gives rise to the formation of minute specks of silver sulphide here and there on each minute crystal.

Formation of Latent Image

Now, when light falls on the silver bromide crystals, as it does during the instant of photographic exposure, what happens is that the light-energy liberates free electrons in the silver bromide crystal, these electrons being derived from the bromine atoms in the crystal. After the cessation of the light impulse, some of the liberated electrons recombine with the bromine atoms, but the remaining ones attach themselves to the extremely minute specks or areas of silver sulphide which have been formed by the action of the sulphur-containing compound (mustard oil) on the silver bromide crystals, and the electrons (being negative particles of electricity) charge up these sulphide areas negatively.

Consider now the atomic mechanism which is initiated in the silver bromide grain or crystal immediately after its exposure to light.

Light energy is absorbed by the silver bromide crystal. It liberates electrons from the bromine atoms. Some of these electrons attach themselves to the areas of silver sulphide which are always present in the silver bromide crystal, these areas being charged up *negatively* by the negative electrons.

What is more to be expected under these conditions than the migration of the positively charged "free" silver atoms to the now negatively charged silver sulphide centres, and that, as a consequence, these silver sulphide areas or nuclei begin to grow in size?

This sort of thing is definitely to be expected, and it is indeed just the effect which takes place. Thus, in consequence of this light-initiated mechanism a latent or invisible image is brought into being on the exposed photographic plate or film. The local silver sulphide nuclei continue to increase in size as more and more silver atoms are attracted to them, and this growth continues until all the liberated electrons have been used up or found a home for themselves, as it were.

Because the number of liberated electrons is conditioned by the duration and the intensity of the light action, it follows that the ultimate size of the built-up silver areas will be proportional to the amount of light action on the individual silver bromide crystals, or, in other words, on the length of the exposure and the strength of the light.

Thus the latent image on a photographic film or plate is simply composed of a collection of minute silver particles which, by the above-explained mechanism, have been assembled around a tiny, invisible speck of silver sulphide in the silver bromide crystal.

Once positioned, these silver areas are quite stable. The individual silver atoms do not tend to fall apart again. Indeed, so far as we know at present, they cannot be made to do by ordinary means. That is why it would be possible (provided that you can arrange to live long enough) for you to take a photograph to-day and to develop it 50 or 60 years hence.

The Nature of Development

Concerning the precise mechanism of the development of the latent image on the exposed film or plate, photographic chemists and physicists are not yet quite sure of their findings. It may be that the small grains of metallic silver which form the latent image act as nuclei on and around which are deposited other silver grains which have been chemically liberated by the action of the developer on the silver bromide.

The trouble about accepting this simple explanation is that silver bromide is not a very soluble material and, therefore, that it is doubtful whether sufficient of it would dissolve in the developer to be able to supply the requisite amount of silver for the building up of the developed image.

It seems more probable that when we develop up the latent image on photographic film, plate or paper, what we do is in reality to *continue* by intensive chemical means the previous effect of the light exposure.

Ribbon Formation

Very recent investigations by means of the electron microscope have conclusively demonstrated the fact that the latent image develops up in the form of exceedingly minute long ribbons of metallic silver, each silver ribbon being about five atoms wide. Whether there is anything particularly significant in this strange ribbon formation of the silver image we do not know, but these most recent observations do seem to prove beyond all doubt that the formation of the latent image on the photographic film or plate and its subsequent development to visible proportions both proceed from isolated centres in each individual silver bromide crystal and that they do not initially affect the crystal as a whole.

It seems, therefore, fairly certain that light-exposure and chemical development of a photographic plate, film or paper are merely different phases of the same thing.

After the film, plate or paper has been fully developed, it is a simple chemical matter to immerse it in a bath of sodium thiosulphate ("hypo") solution, which acts as a solvent for silver salts and consequently dissolves away any unchanged silver bromide in the emulsion, leaving a photographic image composed of metallic silver permanently embedded in a matrix of purified gelatine.

A "glass positive" photograph, the image of which comprised silver grains embedded in a matrix of albumen, or egg-white. It preceded the modern gelatine plate or film.

The Story of Radar—4

Radio Navigation : Beacons The "Gee" System

(*Continued from page 122 January issue*)

A radar operator is seen here sitting in front of the apparatu; in the wireless cabin of his aircraft checking on the radio beam which assists his navigation.

THE conception of I.F.F. at the very beginning of radiolocation in 1935 gave time for the development and production of numerous valuable consequent devices while the other applications of the R.D.F. principle were being brought to maturity.

Once it was established that pulses from a transmitter could be received and used to "trigger" automatically another pulse transmitter with uniformly negligible time-delay (not necessarily repeating the original pulse, or even the original frequency) it became clear that such a "transponder" (as it was later called) could be set up at any convenient place and would act as a beacon: a beacon which would normally keep "wireless silence," only speaking when spoken to, capable of being made to respond only to certain coded sequence of pulses on a given frequency, and giving accurate information of the distance between beacon and interrogator.

The response could itself be coded, so that such a beacon could be identified among other, or distinguished from spurious enemy transmissions made to mislead the inquirer.

Thus, not only were there I.F.F. equipments in our aircraft, and later in ships and other vehicles, which would respond to questioning pulses from our ground stations, but aircraft and other moving vehicles could now carry small questioning transmitters ("interrogators") and obtain replies from "responder" beacons on land or sea, in addition, of course, to those in other friendly aircraft. Moreover, by use of selective frequencies, response could be limited to any particular beacon or groups of beacons.

In the spring of 1935, there was a plan that when "R.D.F.2." (as A.I. and A.S.V. were at first known) should be achieved, the aircraft so fitted could find their way across country by reference to a chessboard pattern of ground beacons, and this plan was known as "R.D.F.3".

But when "R.D.F.2" came, in the form of A.I. and A.S.V., "R.D.F.3" came almost immediately in its train, for aircrews set up I.F.F. Mark II sets to act as ground beacons just as proposed for R.D.F.3, save that for the chessboard was now substituted a baseball pitch; the beacons were mainly placed for guidance into the home base. This was the first of the planned radiolocation aids to navigation to become operational, and it was the beginning of a long and varied train of ingenious devices. The night fighters were the pioneers of this kind of beacon; a creditable number of aircrews owe their lives to this facility for getting back home to "Mother," as they very reasonably called the radiolocation beacon.

Network System.

Coastal Command had already a radiolocation guidance system, to be mentioned in the next section, but they supplemented it by a network system of these novel and well-brought-up beacons which spoke only when spoken to. Now there is an elaborate network of such beacons for each of the R.A.F. Commands concerned.

The network of beacons which have come to be relied upon in war can well be foreseen as an important adjunct to navigation in peace, both at sea and in the air.

The earlier beacon signals were presented to the pilot of the questioning craft as fluctuating "blips" on his range scale, with whatever indication of azimuth (or "bearing") the apparatus might be capable of displaying. Since the introduction of the P.P.I. presentation (Plan-Position Indicator), the beacons show up as "winking" spots or arcs of light in their positions relative to the P.P.I. interrogator, on the scale of the map-like P.P.I. picture.

In addition to the fixed network described above, isolated beacons have been dropped by parachute behind the enemy's lines to guide our airborne troops in gliders to the assembly point for the courageous and spectacular attacks in the rear which distinguished our succession of invasion landings.

Similarly, buoys containing responder beacons can be dropped to mark the suspected position of an enemy submarine. Our attacking forces then close on the beacon and endeavour to locate the enemy without too lengthy a search.

Aircraft launched from carriers in mid-ocean have no hope of survival unless they can find their parent ship again before their fuel is exhausted; in this case, responder beacons have proved of inestimable value in maintaining the morale of homing aircraft crews, while guiding them home by the shortest route.

Another most valuable aid to morale is the use of a "squegging oscillator," which can be coded, to act as a beacon to summon and guide help to airmen in distress at sea. When the crew of an abandoned aircraft have got their dinghy inflated and themselves into it, a small box can be set up to send for many hours an intermittent pulsed signal which will show like a beacon on the radiolocation display of searching friendly aircraft or rescue vessel.

As in the case of I.F.F. equipment, and indeed because the beaconry and identification are allied both technically and operationally, it has been found necessary to standardise the coding and responses throughout the civilised world (that is, among the allies).

"Gee."

Ever since radio direction-finding became practicable, it has been used to provide ships and aircraft with a knowledge of their position relative to fixed points. By taking cross-bearings of at least two stations (or from two land stations to a moving transmitter), an intersection of lines can be used to fix position, just as if the methods of visual surveying had been used.

Direction-finding by radio thus supplemented solar and stellar observations and has proved a very valuable aid to navigation since the 1914-18 war.

But the kind of radio navigation we are now about to consider makes use of the knowledge of the velocity of radio waves and can give a precision of location altogether of a different order from the older methods. By astronomical methods, a really good observer can determine the position of a ship to within a mile or so, and of an aeroplane to within perhaps eight miles in favourable circumstances, but with possibilities of errors much greater, if circumstances are adverse. Errors in radio direction-finding are comparably large. The methods of what may fairly be called "radar" navigation are capable of determining position to within a few tens of yards, while one method over a somewhat restricted area—a few hundred miles square—can show directly on an indicator the position to within a few yards. This fantastic accuracy is such that the geodetic surveys of the past cannot provide maps of sufficient reliability and permanency to show up the inherent errors of navigation by these new methods; in future, with a world at peace, it may be possible to re-survey the earth with a precision of which the cartographer could only have dreamed before the war.

The essence of the new methods is this: if two radiolocation transmitters send out synchronised pulses, that is to say, the pulses of energy leave the transmitters at the same moment of time as judged by an observer at rest relative to them, then a suitable receiver situated anywhere on the perpendicular bisector of the straight line joining the two transmitters, will receive the two pulses simultaneously, because any point on this bisector is equidistant from both transmitters. At any other point, there will be a time difference in the receipt of the pulses, because the receiver will then be nearer one transmitter than the other, consequently the pulse from the nearer transmitter will get there earlier. Sets of lines can be drawn, joining all the points having the same time-differences, and it has been agreed to call these lines "isochrones," just as the lines joining all points on a weather map, having the same barometer readings, are called "isobars." In general, these "isochrone" lines are "hyperbolæ," not straight, but curving outwards on either side of the zero "isochrone" and bunching close together, but *never* crossing, as they pass between the transmitter stations.

The time-differences are displayed on a cathode ray tube attached to the receiver, and if the observer notes, for example, that the pulses from station A and B arrive 20 millionths of a second apart, he can say (if he is mathematically inclined) that he must be situated on one of a pair of "conjugate hyperbolæ," of which A and B are the foci, but what he probably *does* say is that he is somewhere on "blue 20," A and B being the "blue" pair of stations.

Repeating the observation on another pair of stations C and D (of which *one*, say C, *may* for convenience be also the second station of the first pair, B) he may observe that he is also somewhere on "red 16." Now, his map or chart will have ruled on it, intersecting "families" of confocal hyperbolæ, coloured blue and red respectively, and numbered at intervals like contour lines of "isobars." The observer has but to follow "blue 20" with his pencil until he comes across "red 16" when (subject to an ambiguity which, because it will never mislead him, we need not discuss here) he can fix with great precision the position of his receiver at the intersection of the two isochrones, on both of which he is situated at the moment.

This is the basic method of navigation which, in its British form (proposed in 1937 at Bawdsey) is called by the code-word "Gee," and which, using longer wavelengths, has been developed in the U.S.A. as "LORAN" (Long Range Navigation). The Loran system has the advantage over "GEE" that its greater wavelength pulses are propagated over wide stretches of the earth's surface by multiple reflections from the ionosphere, but it suffers from the disadvantage of all reflected propagations, that the path lengths are not precisely determinate, and the errors of position-finding are, in consequence, usually somewhat greater.

It is important to observe that here are systems using all the pulse techniques of transmission and reception developed for radiolocation, but that no "echo" is used; it is a straightforward reception of pulses which started out together from their respective transmitters. With this preliminary technical explanation, the following operational notes may be readily understood.

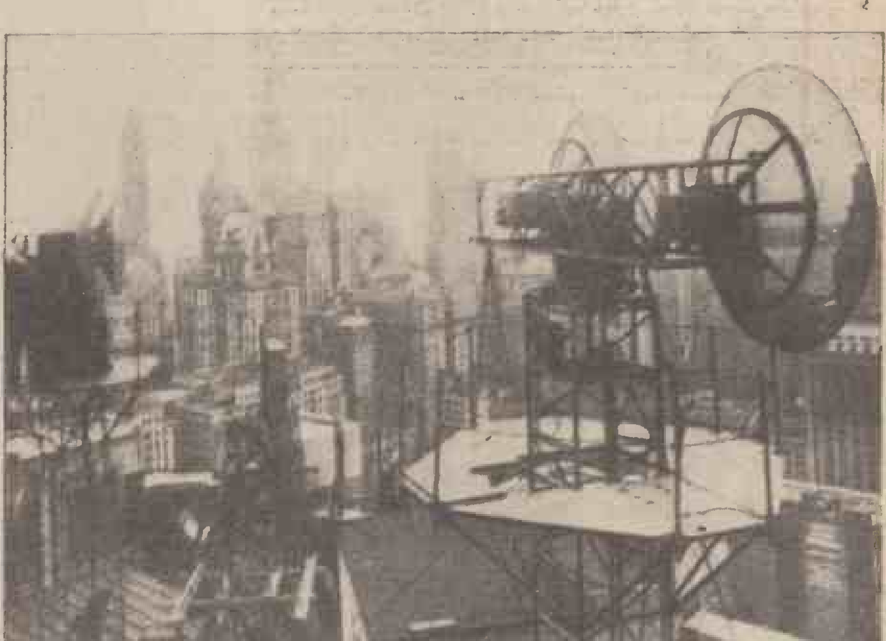
Wireless Direction Finding

From experience gained between the outbreak of war and the early summer of 1940, British R.A.F. Bomber Command realised that although their aircraft were able to navigate over large distances to target areas in Germany and German-held territory, the methods of navigation in use in that period were not sufficiently accurate to enable bombers to find and identify specific targets with any degree of certainty under bad weather conditions, when the target was obscured by cloud. The expectation of effective bombing was remote, apart from their inability to find their targets in such conditions. The bomber crews were confronted also with serious difficulty in finding their way back to base. Wireless direction finding systems were in use to help bombers to return to base, but these relied on radio communication from ground stations to aircraft in order to pass D/F information, and were necessarily cumbersome and unable to handle large numbers of aircraft in a short time.

T.R.E. set themselves to solve the navigational problem, and as a result the Gee System was developed.

This system provided a 24-hour a day "fixing" service to an unlimited number of aircraft over a range sufficiently great to include important targets in the Ruhr and other vital areas of enemy territory. All this was done by means of three relatively simple ground stations sited in the British Isles, and any aircraft within range could make use of the service, provided that it was equipped with a receiving and indicating unit. Further, the aircrew concerned could be confident that any "fix" taken would be accurate, irrespective of weather or other flying conditions. The aircraft carried no transmitter, which meant that "wireless silence" could be maintained, and thus no warning of the approach of a raiding force would be given to the enemy.

The first small-scale test flights were carried out in the autumn of 1940, and by means of two very low-power ground stations situated about 15 miles apart on the south coast, it was found that an aircraft could obtain "position lines" up to distances of about 100 miles and many flights along specific position lines were successfully made.



On top of the New York Telephone Building, 140, West Street, New York City, are the antennas used during a recent demonstration of a hitherto secret U.S. Army Radar microwave relay system. The demonstration, conducted by Bell Telephone Laboratories, included a two-way voice transmission carried out successfully over links totalling 1,400 *miles.*

During the time the small-scale tests were being carried out plans were made for setting up a full-scale three-station system with high-power transmitters and accurate monitoring equipment to give coverage over W. Germany. At the same time an efficient aircraft receiver was under development. T.R.E. test flights were carried out over this country during the spring and summer of 1941, and by July of that year all the ground station equipment had been thoroughly tested and modifications made where necessary. Aircrews had been trained in the use of Gee in flights over the British Isles, and twelve aircraft were fitted and ready for operational flights over Germany.

The operational service trials over Germany took place during August, 1941, and the results, which were of outstanding success, were enthusiastically received by Bomber Command. Not only were navigators able to find targets within range of the ground stations, but they were able to obtain accurate information on wind velocity, which enabled them to navigate more accurately than before to places outside the Gee coverage area.

As a result of the service trials a policy decision had been taken that large numbers of aircraft equipments would be manufactured on the highest priority with the final aim of fitting every bomber aircraft in service. It was further decided, in order to keep information from the enemy, that no Gee fitted aircraft should fly over enemy territory until sufficient aircraft had been fitted to make heavy and accurate raids practicable.

The first Gee raid was made on the night of March 8, 1942, when about 350 aircraft made a heavy attack on the Ruhr. Approximately one quarter of these were equipped with Gee, and they were used mainly as fire raisers. The raid was highly successful compared with previous attacks, as were others mounted on a similar scale on succeeding nights. Reports showed that the aircraft equipments were behaving satisfactorily with only a small percentage of failures, the ground stations proved to be reliable and aircrews were unanimous in their praise of the new system.

Monitoring Equipment

During 1942 considerable development work was carried out at T.R.E. Improved ground station transmitters and monitoring equipments were designed and manufactured on a scale sufficiently large to equip all existing ground stations with main and standby gear; the latter could be brought into operation at extremely short notice should a fault develop in the main units. A new airborne set was designed incorporating many improvements which had been suggested during the early flights with the Mark I set, and a very large production of the new sets was planned.

At the same time a new chain of ground stations was erected by the Air Ministry along the south coast in order to give cover over France, including the then most important naval ports of Brest and Lorient and St. Nazaire. Later, two further chains were designed, mainly for use by Coastal Command in the South-Western Approaches and off the coast of Northern Scotland.

By March, 1943, the Mark II airborne receiver had successfully passed its operational trials and had been introduced into R.A.F. Bomber Command on a massive scale. Practically all heavy bombers and also certain squadrons of light bombers had been fitted. From this time onwards the whole Bomber Command system of mass raids, involving control of large numbers of aircraft and the very complicated problems associated with routing of both outgoing and returning bomber streams, was based on the use of Gee.

In the summer of 1942 the Navy began to install Gee in their light naval craft, and by utilising the facilities offered by the Southern Gee Chain they were able to navigate accurately in all weathers in the English Channel. Since then naval craft have been fitted in ever-increasing numbers, and the use of Gee has been found of inestimable help in many directions, e.g., it enabled minesweepers to sweep definite lanes with precision. Coastal Command aircraft also use Gee very extensively for patrol and strike aircraft against both U-boats and surface craft. It has also been used for accurate minelaying from both ships and aircraft.

Early in 1943 it became evident that the enemy was endeavouring to interfere with the Gee system by radiating "jamming" signals on the Gee frequencies. This contingency had been foreseen in the early days of development, and the new Mark II receiver, which was about to come into service at that time, was equipped with anti-jamming circuits which gave a measure of relief. It was also designed to allow the reception of Gee signals over a very wide band of radio frequencies. Transmitters and other ground equipment had also been designed which would cover the same wide frequency band, so that by making irregular changes of frequency it was possible to evade the enemy's jamming barrage to a large extent.

When plans for the invasion of Europe on D-Day were made, it was decided that Gee should be the main system of navigation. It was planned that the general navigation of all aircraft (British and American) of the bomber and troop-carrier types should be by means of Gee, and also that surface craft should make use of this method of navigation. In the case of troop-carrier aircraft, the actual dropping was to be carried out, using "Rebecca/Eureka," but Gee was to be used wherever possible in the approach to the area of the landing zones. Before the Eureka beacons had been planted, aircraft would depend entirely on Gee if visibility was bad. In fact, Gee was used successfully to land some of the "pathfinder" paratroops. It was thus vitally necessary that every effort should be made to prevent the enemy from jamming the Gee system. In order to achieve this an elaborate scheme was evolved for radiating signals, not only in the frequency bands already in use, but in an entirely new band. The technical effort involved in achieving the synchronisation of these transmissions was considerable, and the equipment was almost entirely hand-made by T.R.E. The scheme proved completely successful. Coupled with the bombing of his jamming sites, the appearance from the South Coast of new Gee frequencies very widely separated completely upset the enemy's jamming organisation, and for several days Gee was completely free from any interference at all.

The Gee system was the most important of all the radar contributions to the offensive. In its application to Bomber Command it permitted those close concentrations in time and space which were essential to the defeat of the enemy ground defences and the special tactics required to defeat his fighter defences; it was essential to the "thousand-bomber raid" by night; it made practicable great elaborations in the close, relative timing of separate attacks, real and feint; and it gave invaluable aid in bringing the great bomber formations and their individual aircraft back by the most suitable routes, and under close time control, to their allotted return bases, an aid which was invaluable in bad weather. The corresponding advantages to other Air Commands and to naval formations have already been indicated.

(To be continued)

The Technology of Glass in its Application to High Vacuum Engineering

A Paper Read Before the Institute of Practical Radio Engineers

By E. G. BULLEY

SERVICINGS of electronic devices, electric lamps, radio receiving and transmitting valves are among the many uses to which glass has important application. Although the principle and intended use of each device differs, all depend upon the provision of glass bulbs and tubing as well as the requisite metals to produce effective vacuum-tight seals.

What Glass Is

Glass in its solid state can be defined as a hard, amorphous, brittle substance, although sometimes described as a supercooled liquid, made by the heating of a mixture of silicon, boron or phosphorous oxides with certain basic oxides; such as sodium, calcium or magnesium. The main reason why glass is said to be a "supercooled liquid" is because it does not crystallise upon solidification. However, before glass reaches this solidified state, it changes from a liquid condition to a plastic one.

All students of vacuum technique should appreciate the conditions through which the glass must pass and the various characteristics applicable to the type of glass in use.

Grades of Glass

Glass exists in two main grades—"soft" and "hard." The former is sometimes known as soda-lime or lead oxide glass and has a melting point between 1,350 deg. C. and 1,450 deg. C. The latter type of glass has a much higher melting point, viz., 1,450 deg. C. to 1,550 deg. C. This type of glass is sometimes known as borosilicate, because of its chemical composition. It is used extensively on high-power valves or tubes, as it has the property of being able to withstand vibration and electrolysis. The property of any grade of glass when in the liquid state is known as the "viscosity." This means that the fluid property of glass is the internal friction due to the molecular cohesion, and is dependent upon two factors, the glass composition and the temperature. The most important stage in the working of any particular glass is the plastic, as it is in this stage that it can be controlled and shaped to any design.

When the glass is passing from a plastic to a solidified state, the utmost caution must be observed. It must, for instance, be kept free from draughts or cold air, otherwise cracks or leaky seals will result. Upon reaching solidified condition, or the transition point, the glass becomes hard and brittle. It is essential, therefore, that whatever shape or form, whether seal, stem, or such like component, the glass must be annealed at a temperature suitable for the type of use.

Removal of Internal Stresses

Annealing, an essential process, relieves the internal stresses that have been set up in the glass during the working of it. Failing to remove these internal stresses will cause the glass to fracture or crack, especially when subjected to heat radiated from adjacent or nearby components that have been assembled to make a valve or lamp; the annealing temperatures for glasses is in the neighbourhood of 350 deg. C. to 450 deg. C. for the soft grade, whereas 450 deg. C. to 550 deg. C. is suitable for most types of hard glasses. These figures are far below the actual melting points of these glasses mentioned previously in this article. For comparison, the working temperature of these glasses is of importance, the annealing temperature is far below that temperature specified for the working range.

Working Ranges

The working range for soft glasses lies between 600 deg. C. and 1,100 deg. C., whereas, for the hard grade, the working temperature is much higher, i.e., 750 deg. C. to 1,250 deg. C. It is at this temperature that the glass becomes a plastic body. By a study of these temperatures it will be appreciated how, if one does not adhere to the correct annealing temperatures, the glass will resume a plastic or liquid form.

Glass to Glass Seals

This type of seal is extremely common to those engaged in the vacuum industry, and unless similar or like glasses are used a vacuum-tight seal will not be obtained. This can be appreciated by considering the coefficients of expansion of the various glasses. Those having identical or similar coefficients of expansion can be sealed successfully, but should they differ to a great extent, one type would expand at a different rate than the other, this resulting in a bad and leaky seal, caused by cracks in the glass.

Metal to Glass Seals

Metals selected for this type of work should have similar coefficients of linear expansion to that of the glass to which it eventually is sealed. Studying the characteristics of the various metals and glasses used in the industry it may be noted that the metals commonly used for this type of work are platinum and alloys, dumet, tungsten molybdenum, copper, and the alloys of iron, chrome cobalt and nickel. Two of the well-known alloys in use in the electronic industry at the present time are "Kovar" and "Fernico." No matter which metal is selected, its expansivity must be comparable with that of the glass to which it is to be sealed.

The preparation of such metals is an important factor. The metal must be free from dirt and grease as well as free from cracks.

Chemical Bond of Glass and Metal

The principle of all metal to glass seals is that when the metal is heated for a short period in a gas flame, the surface becomes oxidised. This is an essential feature in the production of a vacuum-tight seal. The surface oxide set up on any particular metal if in the correct proportion will readily dissolve into the selected glass and form more or less a chemical bond between the glass and the metal.

Oxidation

Excess oxidation will, in most cases, cause the seal to become leaky.

This can be put down to the inability of the glass to absorb the greater portion of the metallic oxide. This must be avoided, for if the seal does not leak it will be extremely weak mechanically.

It is recognised that molten glass attacks some clean metals, due to the chemical composition of the glass. However, this must be avoided at all costs or it will result in a poor or weak and leaky seal. This phenomena can be recognised by the presence of minute gas bubbles adhering to the metal surface inside the glass seal. These bubbles are the result of chemical reaction between the glass and the clean metal, causing gas to be given off by the metal.

Oxides are more or less a necessity in metal to glass seals. The presence of the oxide acts as a medium. When the molten glass is applied it is essential that the oxide present at the metal face must not be entirely absorbed by the glass, otherwise the chemical reaction will result as already described. It is, therefore, good practice to ensure that an extremely fine oxide coating is left upon the metallic surface, thus protecting the metal proper from any likelihood of chemical reaction.

Colour Denotations

The oxide presence of various metals is denoted by colours. For instance, a tungsten-glass seal usually is recognisable by a light straw colour, whereas copper usually gives a rich ruby red coloured seal.

Excess oxidation, as stated, must be avoided. It is good practice to take steps to control the rate of oxidation. In the United States of America sealing is carried out in an inert atmosphere. Another method which offers great control over possible excess oxidation is that of borating. This method is simple and well known to users of dumet or copper seals. By this method the surface of the copper is covered with borax. This chemical layer, if not damaged in any way, prevents excess oxidation and is essential in all copper to glass seals. Various fluxes have been devised or will be developed as time goes on to suit other metals; these, too, will play a similar part as that of borax to the ordinary copper seal. In the electronic industry, where it is necessary that all metal to glass seals must have the property of being vacuum tight as well as of good mechanical strength, it is common practice to "wet" the metal with an intermediate glass; this aids and overcomes many difficulties that arise when being sealed to the parent glassworks. To further clarify this study of glass and suitable metals expansitivities of them can be reviewed.

Expansitivities

"Dumet," known alternatively as copper clad, comprises a copper sheath with a nickel steel core, the sheath being firmly bonded to the core. This metal will seal directly to any make of soft glass, although there is a limitation to maximum diameter of this metal that can be sealed successfully. The reason for this is the difference in the axial and transverse expansions of the material. The radial expansivity of this metal is in the order of 9×10^{-6} per deg. C., and glasses with identical or similar expansitivities between 8.2 to 9.5×10^{-6} should be selected. Dumet has more or less superseded platinum as a seal metal, however. It has a coefficient of expansion of 8.9×10^{-6}, but because of its high cost and the fact that it is one of the rarer metals, the lamp industry developed the former metal, which is considerably cheaper and easier to obtain.

Tungsten and Molybdenum

Tungsten and molybdenum play an important part in the electronic field, more so than in the lamp-making industry. They are used for all types of seals, including those found in high-power valves, mercury vapour rectifiers and X-ray tubes. The oxides of these metals are extremely soluble in most hard glasses, producing the required vacuum-tight seal because of the adhesion of the glass to the metal. The expansitivities of tungsten and molybdenum are approximately 4.5×10^{-6} and 5.6×10^{-6} respectively, and as in the case of all metals they must be sealed with glasses whose expansitivities compare with that of the metals. The specific purpose of tungsten and molybdenum seals is such that they are able to carry fairly large currents found in the electronic field.

Copper to Glass Seals

Copper to glass seals are becoming extremely popular. This type of seal is commonly known throughout the lamp and valve industry as the "Housekeeper Seal." Copper can be sealed more or less successfully to any type of glass whose expansitivities lie between 100×10^{-6} and 40×10^{-6}. This is only possible, however, if the copper is carefully shaped and the thickness of the metal reduced to approximately .002in. thick.

Kovar and Fernico

These two alloys, specifically developed for the electronic industry, will play a most important part in future electronic tube development. These metals, whether in rod or cup form, will seal to any glass or glasses whose expansitivities are approximately 4.9×10^{-6} at a temperature of 10 deg. C. to 100 deg. C. Not only will they give a hermetic seal, but the seal produced will be of good mechanical strength. This can be accredited to the fact that the oxides of these metals readily dissolve in the selected glasses and form more or less a chemical bond between the glass and the metal.

The Bristol Brabazon I.

It is certain that prospects for civil aviation are far brighter than they were in 1939, and that, for the first time in the history of flying, there is a real chance that the average man, as well as the wealthy business man, will soon be able to fly about the world at prices approaching those charged by other forms of transport. This will come about because of the experience gained in aircraft construction and management during the war. This has brought about considerable improvement in aircraft engines (with more economical fuel consumption rates). Greater pay-loads and speeds have been attained, coupled with a far higher standard of safety than ever before. Our illustration shows a "mock-up" of the Brabazon I now being completed in Bristol Aeroplane Company's workshops. A plywood version of a new aircraft is always completed to scale from designer's specifications. Every detail is then checked, and altered where necessary before production begins. Some idea of the immense size of this aircraft is is given by the scale of the man on the wing.

The Foundations of Thermodynamics—4

Carnot's Heat Engine, and Its Cycle of Operations

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

(*Continued from page 128, January issue*)

THE theorem which states that no heat engine operating between two specified temperature levels can possess an efficiency greater than that of a thermodynamically reversible engine working between the same two temperatures, was established by Sadi Carnot, by examining the performance of an imaginary engine which he postulated and endowed with certain ideal properties. This theorem, as was mentioned in a previous section of this article, was revealed by Carnot's search for the theoretical principle underlying the conversion by an engine of a supply of heat into mechanical work.

Structure of Carnot's Heat Engine

Carnot's hypothetical engine employs the piston and cylinder principle and uses a

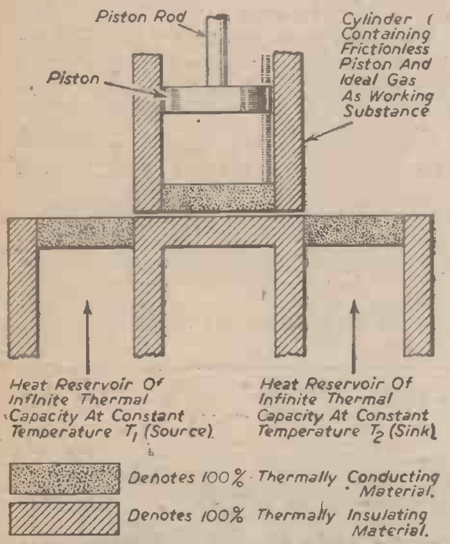


Fig. 13.—*Diagram illustrating the principle of Carnot's heat engine.*

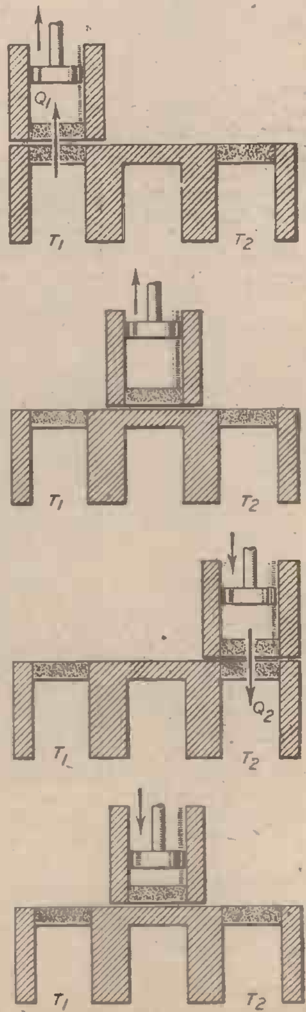
constant mass of ideal gas as its working substance. (For this particular purpose a gas is considered to be "ideal" if it completely obeys the gas laws of Robert Boyle and Jacques Charles over all ranges of temperature and pressure, and therefore has its behaviour represented by the equation $P.V=R.T$, where P denotes the pressure of the gas, V its volume, T its absolute temperature as recorded on the ideal gas scale, and R is a constant whose magnitude is determined by the chemical nature and mass of the gas). Heat is supplied to this ideal gas not by passing fuel through a valve into the cylinder and burning it there as in the case of actual internal combustion engines, or by preheating the gas in a separate compartment before admitting it into the cylinder as is done in the external combustion engine, but by conducting heat through the cylinder cover. The material of the cover is imagined to possess the ideal thermal property of infinite conductivity, i.e., will conduct a stream of heat in any direction through it without the usual application of a finite temperature difference across it, which is required by all real, non-ideal thermal conductors. The cylinder of Carnot's engine has no valve attachments and does not admit and expel quantities of gas during a cycle of work as real engines do; it contains a fixed amount of ideal gas which is sealed in by the piston, and which expands and contracts accordingly as heat is conducted into or out of it through the cylinder cover. The general arrangement of the engine is illustrated in Fig. 13.

A supply of heat is drawn from a constant temperature source which is imagined to have an infinite thermal capacity, so that the removal or addition of any finite quantity of heat produces no change in its temperature (labelled T_1 in Fig. 13). The walls of this heat reservoir are made of a material which has the ideal thermal property of zero conductivity (i.e., will not conduct heat no matter how great a temperature difference is applied across it, provided this difference remains finite), but its cover is made of ideally conducting material as is the cover of the cylinder. The operation of feeding heat to the gas is performed by placing the cylinder upon the source and allowing it to remain there long enough to enable a desired quantity of heat to pass, without fall of temperature, from source to gas. A second heat reservoir of infinite thermal capacity at a lower temperature T_2 stands near to the heat source and is enclosed by insulating walls and covered with ideally conducting substance. By placing the cylinder over it, heat is passed isothermally from gas to sink as the piston moves forward to compress the gas. The source and sink are separated by a non-conducting slab upon which the cylinder may rest in a state of total thermal insulation. The engine is further idealised by assigning to it the properties of thermodynamic reversibility, frictionless movement of piston in cylinder and frictionless slide of cylinder between source and sink.

Action of Carnot's Engine

The engine begins a forward cycle of work with its cylinder placed in position over the heat source, as shown in Fig. 14, stage 1, the gas being in a state represented by the point A on the pressure-volume diagram Fig. 15. A quantity of heat Q_1 is conducted from source into gas at the constant temperature T_1 of the source, causing the gas to expand in a power stroke from volume V_A to volume V_B along the constant temperature line AB. The cylinder is then moved laterally into position on the insulating seat (Fig. 14, stage 2), and the piston stroke continues as the gas expands adiabatically from volume V_B to volume V_C. The fall in temperature which accompanies the adiabatic expansion is arrested by bringing the piston to the end of its stroke when the gas temperature reaches the degree T_2 of the heat sink. At stage 3 the cylinder is placed over the heat sink as the piston returns on its compression stroke, and the reduction of the gas volume from V_C to V_D causes a quantity of heat Q_2 to flow from gas to sink at the steady sink temperature T_2. The cycle is completed by returning the cylinder to the insulating seat where the gas is further compressed under conditions of total thermal insulation. The rise in gas temperature caused by this adiabatic compression is halted when the original source temperature T_1 is reached, leaving the gas in a state represented by point A on the work diagram, in readiness for the succeeding cycle. The balance of heat Q_1-Q_2 which has gone out of existence during the performance of the cycle is, in accordance with the first law of thermodynamics, equal to the quantity of mechanical work W delivered by the engine.

The foregoing analysis of the Carnot cycle in which the output of work is calculated by making reference to the first law of thermodynamics, differs in certain details from the original discussion made by Carnot himself. Carnot published his essay a quarter of a century before Joule had completed the researches which led to the discovery of the first law of thermodynamics, and Carnot's proof of the reversible heat engine theorem did not take into account the disappearance of part of the supplied heat which is required by the energy doctrine to explain the appearance of mechanical work. He assumed that the same quantity of heat passed out of the engine into the sink as was drawn by the engine from the source. Carnot's reflections on the working of heat engines had been influenced, and to some extent successfully guided, by a study of the principles of gravity engines. Through this study he succeeded in establishing a heat theorem which is still



Stage 1.—*Cylinder placed over source. Gas absorbs Q_1 units of heat isothermally at temperature T_1 causing expansion from volume V_A to volume V_B.*

Stage 2.—*Cylinder slides on to insulating seat and gas continues to expand adiabatically from volume V_B to volume V_C, with subsequent cooling from temperature T_1 to temperature T_2.*

Stage 3.—*Cylinder over sink. Gas contracts in volume from V_C to V_D isothermally at temperature T_2, expelling Q_2 units of heat into the sink.*

Stage 4.—*Cylinder on insulating seat. Compression of gas continues adiabatically with subsequent rise of temperature from T_2 to T_1 and volume decrease from V_D to V_A.*

Fig. 14.—*Stages in the performance of a cycle of work by a Carnot engine working in a forward direction.*

accepted as being true, but by drawing too close a parallel between the respective processes of heat and gravity engines he used a method of proving the theorem which is considered, in the light of more modern knowledge, to be false.

Difference of Gravitational Level

In any gravity engine a quantity of matter is allowed to make a controlled descent from one gravitational level to a lower one, and through the action of a suitable mechanism its fall produces a yield of work in the form of kinetic energy, rotational or translational or a combination of both. Familiar examples of this are to be seen in the action of the water-mill wheel, the pile driver, and the springless ("grandfather's") clock. In each of these mechanisms a factor of prime importance is the difference of gravitational level. If there were no difference of level the waterwheel would not turn no matter how great a volume of water were available, since it could not be made to flow; the pile driver could not impart energy to the pile without making a fall, and the hands would not move round the clock-face if the weights, no matter how heavy they were, were not free to descend. A consideration of this fact caused Carnot to emphasise, rightly, as it afterwards transpired, the necessity of a difference of heat level (i.e. temperature) to the successful working of a heat engine. His next conclusion, that even as the quantity of matter lowered in the ideal gravity engine is the same at the beginning and end of the fall, so is the heat stream similarly conserved in the process of passing from the high to the low temperature through the heat engine, proved to be erroneous.

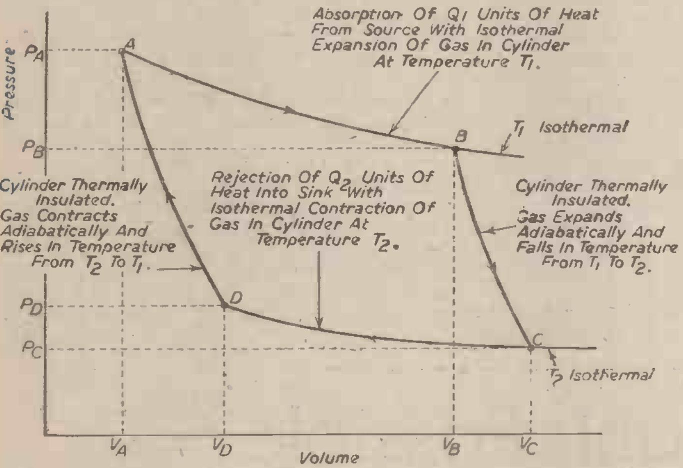


Fig. 15.—Pressure-volume diagram of cycle of work performed by Carnot's engine.

Had the phenomena of electromagnetism been known in his time, Carnot could have readily extended the notion of an engine as a device for lowering some energy-producing agent through its appropriate difference of level, so as to include the electric motor. But it was not until after Michael Faraday's epoch-making discovery in 1831 that the motion of a conductor in a magnetic field generates an electric current in the conductor which persists as long as the conductor moves or the magnetic field varies, that the means of producing mechanical work electromagnetically became available. An electric motor generates mechanical power by lowering a supply of electric charge through a difference of electric level in the presence of a magnetic field, and in the ideal motor the quantity of electric charge is the same at the beginning and end of its fall. Similarly, an optical engine could consist of an intense source of light radiating a supply of luminous energy to a less intense source—that is, conveying a quantity of light down a gradient of optical level or intensity, with a suitable mechanical device (e.g. the plane surface of a solid) inserted in the beam. The excess of mechanical pressure exerted upon the surface exposed to the brighter source would yield an output of work by moving the solid through space.

Carnot's Theorem

The original and modified methods of proving Carnot's heat engine theorem are illustrated in Figs. 16 to 19. Both methods are based upon the principle that perpetual motion is impossible. Fig. 16 represents a reversible Carnot engine working in a forward cycle by drawing a quantity of heat Q_1 isothermally from the high temperature source T_1, returning a smaller quantity of heat Q_2 isothermally to the low temperature sink T_2, and converting the heat balance Q_1-Q_2 into an output of mechanical work W per cycle (W carries a conventional positive sign to indicate that the net work is being done by the engine on its environment), for external consumption. Fig. 17 shows the same engine operating in reverse by absorbing an amount of mechanical work W per cycle (the conventional negative sign prefixed to W indicates that the net work is being done on the engine by some external driving agent), in order to absorb isothermally Q_2 units of heat from the low temperature sink and to return a larger quantity of heat Q_1 isothermally to the high temperature level T_1. The quantities in these figures are calculated in accordance with the first law of thermodynamics, which demands that the appearance of mechanical energy must be accompanied by the disappearance of an equivalent amount of heat, and that the consumption of mechanical energy must result in the production of heat by the engine.

Fig. 18 illustrates the working of an engine according to the original thesis of Carnot, since proved unsound, in which an unaltered quantity of heat Q is considered to pass through the engine, from the high to the low temperature when the engine is working forward with an output of work, and from the low to the high temperature when the engine is in reverse and absorbing work. On the left-hand side of the diagram, R represents an ideally reversible engine, consuming an amount of work W, while a quantity of heat Q is passed through it without loss from the low to the high temperature during a cycle. On the right-hand side of the diagram, I represents an irreversible engine arranged so as to carry from the high to the low temperature the same amount of heat Q which is used by R. In the process of lowering this heat, I gives out a yield of work W^1. The two engines I and R are considered to be coupled together so as to form a self-contained unit circulating a quantity of heat Q through both engines with I working forward and driving R in reverse. The thermal efficiency of a heat engine is defined as the fraction of the absorbed heat which is transformed into mechanical energy, and from this definition the efficiencies of I and R may be written therefore as $E_I = W^1/Q$, $E_R = W/Q$, respectively. Carnot reasoned that if W^1 is greater than W, a positive balance of mechanical energy W^1-W will be left over for consumption outside the unit formed by the coupled engines. For the production of this work, nothing is consumed or done inside the system apart from the circulation of an unvarying quantity of heat, which means that the system serves as an inexhaustible source of mechanical power, which would make perpetual motion possible. In order to prohibit the possibility of perpetual motion therefore W^1 cannot be made greater than W, from which it follows that E_I cannot be greater than E_R, which establishes Carnot's heat theorem.

At the time of its publication in 1824, this theorem attracted little attention. Ten years later, and two years after Carnot's death, the manuscripts were edited and republished in the "Journal de l'Ecole Polytechnique," by B. P. E. Clapeyron, and it was largely through this work that Carnot became known to scientists. Two men in particular became interested in Clapeyron's edition of the heat theorem, William Thomson in this country, and Rudolf Clausius, a Swiss Professor of Physics, and it was mainly through their efforts that the work of Carnot became united with the work of Joule and his predecessors to found the subject of thermodynamics.

At the close of the first half of the 19th century the experiments of Joule and the findings of Carnot presented an acute problem to these scientists. On the one hand, Joule had demonstrated beyond all reasonable doubt that mechanical energy can only be generated from a supply of heat if some of the heat disappears in the process, while on the other hand Carnot had proved a theorem based upon the principle that perpetual

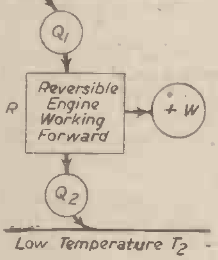


Fig. 16.

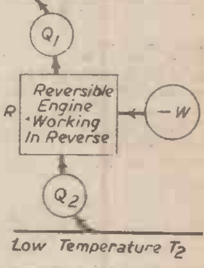


Fig. 17.

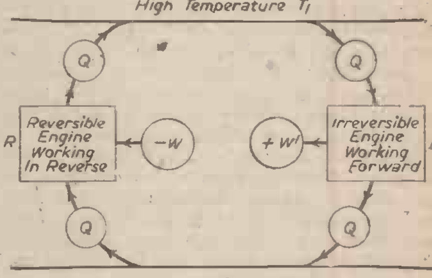


Fig. 18.

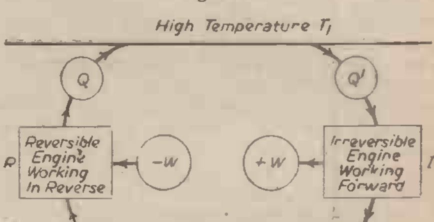


Fig. 19.

Engine diagrams demonstrating the proof of Carnot's principle.

motion is impossible, by a method in which it was taken for granted that no heat disappears in the process of generating mechanical power from a heat engine. To reject Carnot's theorem would amount to admitting that perpetual motion was possible, but to retain his method of proving it would offer a complete contradiction to the well-established energy law of Joule. It clearly became necessary to modify the proof without changing the principle of Carnot, and both men, working independently, arrived at the same solution of the problem within a year of one another. Clausius published his paper in 1850 and Thomson in 1851.

The modified proof of Carnot's theorem is illustrated in Fig. 19. An irreversible engine, I, develops an output of work W in a forward cycle by drawing Q^1 units of heat from the source, and rejecting the balance Q^1-W to the sink. A reversible engine R, working reverse, requires an intake of the same amount of work W in order to deliver Q units of heat to the source after drawing $Q-W$ units from the sink. The engines are coupled so that I drives R in reverse, and since the output and intake of mechanical work is the same for both engines, no mechanical energy is left over for consumption outside the system, and no energy is absorbed by the system from an external source of supply. The net amount of heat taken by the coupled engines from the low temperature level is $(Q-W)-(Q^1-W)=Q-Q^1$, and the net amount delivered by them to the high temperature level is also $Q-Q^1$. The respective engine efficiencies are represented by the formulæ $E_R=W/Q$, and $E_1=W/Q^1$. If in accordance with the principle of Carnot it is maintained that E_1 cannot be greater than E_R, it follows that Q^1 cannot be less than Q, so that the quantity of heat $Q-Q^1$ which is taken by the unaided system from the low temperature to the high one, cannot be positive.

This result, whose emergence is forced by the process of reconciling Carnot's principle to the first law of thermodynamics, is described as the second law of thermodynamics. In its simplest form it states that heat will not of its own accord pass from a low temperature to a higher one, a rule which is known to be obeyed in all large-scale or macroscopic phenomena which have so far been observed. Other non-mathematical forms in which the second law of thermodynamics has been stated are as follows:

(1) It is impossible by means of an inanimate material agency to derive mechanical effect from any portion of matter by cooling it below the temperature of the coldest of surrounding objects. (Thomson.)

(2) It is impossible for a self-acting machine, unaided by any external agency, to convey heat from one body to another at a higher temperature. (Clausius.)

(3) A temperature difference can never appear spontaneously in a body originally at a uniform temperature. (Clausius.)

(4) Nature tends to pass from a less probable to a more probable condition. (Boltzmann.)

The first and second laws of thermodynamics, when considered collectively for the purpose of comparison, present themselves as laws of prohibition imposed by nature on all phenomena involving transferences or exchanges of heat. The first law forbids the generation of heat without the compensating disappearance of an equivalent amount of energy in some other form. The second law forbids the spontaneous passage of heat from a cold to a hot body. This power of prohibition is exercised to a greater degree by the second law than the first, for, whereas the latter lays down an exact rule of equivalence between thermal and other forms of energy without questioning the direction of the exchange, the second law stipulates the conditions which determine the direction of the heat transference, and requires in addition that the first law shall be obeyed. The second law of thermodynamics can be profitably used in the study of practical problems in heat engineering by applying it in the form of Carnot's principle, for this principle, though evolved from an abstract consideration of a highly idealised engine which could never be constructed in practice, provides a calculable standard by which the performance of an actual heat engine may be judged or aimed at by a designer. *(To be continued.)*

Is Manual Flight Possible?

The Possibilities of Man being Able to Fly by His Own Power

By "ORNITHOPTERIST"

IN the history of invention it is usually found that one's ideas have been anticipated by others. But there has been something lacking that has given the successful inventor a great advantage over the previous ones. This usually applies to all things.

I read the other day an introduction in a book of directions of a pressure cooker. The manufacturers actually thought pressure cooking was new. Poor George Papin must have turned over in his grave if such a thing were possible. That pressure cooking was done before the advent of the steam engine is not generally known, but it is so.

That James Watt never sat and looked at the steam coming out of the kettle is probably true, but history is full of these little fairy tales. James Watt was the father of the steam engine as we know it to-day, and it certainly seems to me we are going to put the internal combustion engine on the shelf, and go right back to steam. This is the atomic principle. If this is so, what would Watt have done if he had had the atomic boiler to start with?

Nearly all the constructors of aeroplanes of the early days could have flown their machines easily. But they lacked the necessary power. Or, in Professor Langley's case, the necessary pilot, with the necessary knowledge. Have we the necessary knowledge to-day to fly by man power? I think we have. In my mind there has been a good case for the man-powered aeroplane, ever since he learnt to make a machine strong and light. But the knowledge to make so perfect a machine as the bird is equipped with has been missing.

As a small child I would sit for hours watching birds. I made models, but none of them ever flew. Like other boys with a scientific "kink," I made all kinds of models. Cranes, steam engines, boats, etc., and they all worked. But of my flying machines not one ever made the slightest attempt to leave terra firma. Of course, I made the "butterfly" contraption, but I didn't think that was *flying*.

Time marched on and a book came into my possession, "Animal Locomotion," by J. Bell Pettigrew. I devoured it, but it was mental pleasure, and nothing else.

I had reached the age of 19 (1907) when I thought of trying to make something that would get into the air somehow. Of course I knew all about the Lillienthals' short flights, and was fairly well up in the subject, so I decided on bird flight. (If I had possessed a motor it would probably have been powered flight.)

A Bird's Strength

I took it very seriously. How strong was I? Could I hope to fly? How strong was a bird? Such questions as these took a lot of answering. It is really hard to realise in these times that all our famous (now) designers would take out their machines days on end and never get a flip. A straight flight of a mile was front-page news; but I digress. Pettigrew said a bird does not fly by strength alone. Others said the same thing, so who was I to differ? Some kind of hope was indicated. About this time there were rumours about the mysterious Wrights. A Frenchman named, I think, Bellamy came to Brooklands with a strange erection of wood and canvas. I don't think he made many—if any—flights. This was before Jim Mollison's time.

However, I thought the propeller was a much simpler idea than wings. So shamelessly deserting my faithful Pettigrew, I turned to the propeller. Before attempting to make an actual machine, I thought I had better see how fast I could expect to travel by propeller propulsion. I had a cycle, so I designed and made an apparatus that transferred the power from the back wheel to the air, via a propeller.

I can't say this was very successful. My speedometer showed 25 m.p.h. with normal drive. But with the propeller 6 m.p.h. was the utmost I could do. Of course the air was very cooling, and I certainly needed it. I then put the propeller behind, but I didn't even get a cooling wind that way. And very little difference was shown. After about nine months I concluded that the loss of efficiency through the propeller precluded any hope of flying with it, so I turned back to Pettigrew.

I then made a lot of gadgets and apparatus, to see what wings would give. The result, spread over a year or so, was encouraging, to say the least. I then tackled a full-sized machine, with a 38-feet wing span. I experimented with this for many months, but it was never really successful. I could lift myself (with machine off the ground a few inches) or I could run along the ground, but never the two together. At practically every trial something broke; nearly always the spars. But the thing that lured me on was the fact that I did break the spars. There must be a lot of resistance somewhere. After some time I was compelled to give up my experiments. My circumstances and lack of opportunities denied me the pleasure of trying to break my neck—as a reporter once remarked about an attempt I made to take off from a hillside.

I often think back over the years and wonder whether, if I had possessed the constructional knowledge then that I have now, I would have succeeded? To that I can say that I am of the opinion that I would.

When, in my mind's eye, I see that crude machine, solid spars that always broke, and with a feathering gadget that had to be adjusted for every attempt, a reaction machine to take the weight of machine and self when in the air, without working all the time, it is really laughable from to-day's point of view. But I think it would have answered its purpose.

The first day I took it out was inclined to be a bit breezy, and when I started to flap the wings I was promptly blown over. So back it went to be repaired. After that, attempts took place on windless days. I just did not see that the wind would have helped if I had faced it.

Comparisons

I have written the foregoing to show that I have done a little more than just think on this subject. I will now state briefly why I think man can fly by his own power.

First, let us compare a bird and a man. A bird in the air and a man on the ground are in their natural element. To those who think of the air as a soft, intangible thing, I would point out at 150 m.p.h. it will support a 60-ton aeroplane. Nothing soft or intangible about that. Remember the damage a gale can do.

Water is soft, but fall flat from a few feet above it; it is hard enough then. So let us from the start not think of the air from the man's point of view, but from the bird's. Most birds lift two pounds per square foot, but they can do more.

Man can easily carry on his back twice his own weight. (It must be thoroughly understood when I say man, I mean a *fully developed man*. The capabilities of such a man is very different to the "man in the street.") He can lift his own weight by the strength of *one arm* alone. He can lift, with a great effort, *four times his own weight*. This is in a direct upward direction. In a rowing position his strength is much more, for his size and weight, than a bird's.

A bird uses for the purpose of flight the strength of its pectoral muscles only. These are developed to the pitch of perfection, and are approximately 50 per cent. of its total muscular power. The most a bird can do is to lift about a third of its weight. This is in a general way. I have read of birds lifting a lot more than this, but I have never seen it proved. I have read of an eagle carrying off a child or a lamb. But a golden eagle gets to a fair size. Personally I doubt these statements, because they are very different to my observations. Plenty of tests have been made, but after a third of their weight has been attached to them most birds cannot fly. One can reduce their square area without much difference, so it seems that their *power* is very little more than capable of lifting their own weight, with a comfortable surplus. I have seen a gull swallow a fish of about a pound weight, and it had quite a struggle to get into the air. To those who have pigeons, try fixing a weight of half a pound to their feet (or even four ounces) and see what happens.

"Perfect Flying Apparatus"

What does this mean? To my mind the bird has, in a pair of wings, the perfect flying apparatus. That gives the greatest effect for the least effort. Can man duplicate these? I don't see any reason why he shouldn't. Ignoring for the moment the possible valvular effect of the feathers (though I see no great difficulty in duplicating this if necessary), such a wing would have to be capable of automatically feathering.

Now comes the snag. The whole machine would have to be made for not more than a third of the person's weight. Is this possible? My machine weighed 46 pounds. With present-day knowledge it should be possible to make it, with the necessary strength that I lacked, for 30 pounds at the most. If any of the big firms were to tackle the problem intelligently and with the intention of succeeding, I think they would succeed where the individual experimenter has failed.

I could suggest a design, but I think there are others more capable than I in this direction.

I know the funamental facts, but in the past I spent quite a fair amount of time and money in trying to prove how little man knows of the possibilities of the flapping wing. I don't think he knows a lot more now. The helicopter was the very first heavier than air machine to fly. This was in 1842, and was steam driven.

As I said at the commencement of this article, things come before their time. That early helicopter certainly did.

We are constantly finding the impossible of yesterday the ordinary of to-day. What would Lillienthal have said to the modern glider? I read years ago of a Tom Moose, a Wisconsin farmer, who travelled all over his farm by glider. This was a simple affair he strapped to his shoulders. It's a pity more isn't known of this case.

How light could such a machine be made? Not more than 15-20 pounds, I suppose. Would it not be possible to become air-current minded? Just as a person balances his cycle without thought, why not glide from air current to air current with equal ease?

How does a condor fly, without a movement of the wing, after about 100 feet high? Yet it goes up and up. Are there always air currents for it to ride? Do albatrosses find upward air currents in the middle of the flat sea? I don't think so.

How Strong is Man?

The generally accepted strength of an average man is one-tenth of a horse-power. What does this mean? What is a horse-power? Oh, I know the formula, and I hope I shall not be accused of being "Joadian," but the term is about the most misleading one can possibly imagine.

Let us try to arrive at some absolute facts. What is a horse capable of? The average carthorse can pull a lorry with an all-in weight of 25 cwt. up an incline of 1 in 30, without any great effort, at about 2 m.p.h. Make the road perfectly level and increase the load to 30 cwt. and you can double the speed. This is with wheels with plain bearings, and sometimes very imperfectly greased. The horses in a railway yard can pull ten tons on rails, but here we have made some attempt to eliminate friction. The same horse can pull 60 tons in a canal boat. Now, how strong is that horse? Is it really the strength of the horse or the eliminating of the friction that matters?

On the water, as in the air, there is a practically frictionless speed. Above this speed resistance piles up and increases very rapidly. Is there a speed at which the lift of the *ideal* aerofoil and the friction more or less coincides?

Ever since the first aeroplane the chief effort has been to increase the speed, and so power has had to be increased to colossal amounts. Suppose we go backwards. How *little* power is required to lift a man? To be perfectly candid, I don't know the answer to this question. The Wrights flew at 40 m.p.h. and used a 40 h.p. engine. This machine could not take off, but had to be assisted. I think it was de Havilland who made the 3 h.p. aeroplane that flew in 1921 at 72 m.p.h. Why this huge difference? According to Professor Langley, who was, I think, the first man to make any real experiments in weight power ratio, his calculations were one pound of power would lift eight pounds weight. This might or might not have been with the ideal aerofoil, such as a bird has.

If we admit that this is so, and granting it is possible to make a machine weighing 30 pounds, the total amount to be lifted into the air is 30 pounds, plus 140 pounds (weight of average man). If a man can exert an air power of 20 pounds, that will give him a small surplus. But can he do it? First of all, I do not think he can by means of a propeller or airscrew. To do this he must use a pedalling gear. Here we start to get losses, and we use the strength of the legs only. In fact, less than the strength of the legs.

The cycling position is by no means the ideal position to exert the full strength of the body, but the rowing position is. On the other hand, in the cycling position the weight of the body is used, and in the rowing position it is not. These are small details, but they must be considered. Can the weight of the body and the rowing position be used? On my machine I made an attempt to do this, but, as I said before, my constructional knowledge fell short of my desires. I maintain that the bird does do this. What power is used by a child, who, by movements of the body, sets a swing in motion? This, of course, is done by altering the centre of gravity. Does a bird alter the centre of gravity in the same way? Watch gulls for any length of time, and you will see movements that seem to have nothing to do with wing movements, but you will see the effect in the flight. A slight movement, a bank or a turn, and it will seem to surge upward. Is it breasting an air wave? Or is it lifting itself higher, as does the child on the swing?

No one really knows the effect of the flapping wing. Many have given opinions, but until man has made a flapping wing machine, and used it in moving air, no one will know why a bird flies.

Is it power? Is it knowledge? Is it alteration of the centre of gravity? I believe it is a combination of all three, *plus* the perfect machine. Have you ever watched an expert skater? See him (or her) moving along at a fair rate of speed without lifting the feet from the ice at all. I suppose it is generally known that a person can skate faster than he can run. Here again it is the elimination of friction that counts.

With all this to consider, how can we say "how strong is man?" What does the tenth of a horse-power mean? A professional strong man can increase another man's lifting power in a few minutes. He simply shows him the best way to do it. I believe that in the air knowledge is power. Otherwise why is it that one person can glide for a longer time than another? The ordinary gliding pupil, after an hour's tuition, might make a flight of a minute or so. The expert with the same machine could fly for a couple of hours.

If a man can lift 4 cwt. and a strong man can do this, can he exert an air power of 20 pounds?

To my mind the attitude taken to manual flight is wrong. Let the presumption be that it *is* possible, given the perfect machine, plus the necessary knowledge, and I don't think it would be long before it would be an actuality. If a man can fly at 72 m.p.h. with a 3 h.p. engine, could he fly at 35 m.p.h. with a 1 h.p. engine? If so, then could he fly at 25 m.p.h. with a ½ h.p. engine?

We have a motor-assisted cycle. Is an assisted aeroplane impossible? I make no claims of originality in my arguments, I am simply giving my experiences and opinions. But if you feel very doubtful about manual flight, go to a provision warehouse, and every time you see a man carrying a sack of flour up some steps, say to yourself, "Weight for weight that is more than any bird could hope to do, yet it can fly and he can't. Why?"

Rocket Propulsion

British Sounding Rocket Developments

By K. W. GATLAND

(*Continued from page 135, January issue*)

THE rocket projectile as a means of long range, high speed, transit is no recent idea. It was, in fact, the pioneer rocket engineer, Professor Oberth, who first set down the specifications for such a vessel, which he did as long ago as 1931.

It is of interest to note that the flight control and trajectory of Oberth's hypothetical rocket bear much resemblance to the methods originally adopted in the V2 rocket shell.

The ascent was arranged vertically in order to overcome the main drag effects of the atmosphere in the least time. Having maintained a direct path to an altitude of 30 miles, the vessel's course would be reset at a predetermined angle, and at the desired speed (the requisite angle and maximum velocity would vary with the distance to be covered) the motor "cut," allowing the balance of the journey to be made under momentum. The maximum height of the parabolic flight curve was calculated to be in the region of 100 miles.

The trend of development points the way conclusively to the ultimate evolution of the rocket projectile. The orthodox aeroplane has already reached a reasonable limit of speed efficiency beyond which it is impracticable to proceed.

The operation of aircraft above the compressibility limit, as we have already seen, is a reasonable possibility, but only if the efficiency of the rocket engine, when working in atmosphere, can be substantially improved. It may be that this obstacle will be completely overcome by the development of the atomic reaction engine, and if so, then the many lesser problems associated in this development should be quickly solved.

It is only when the Sänger flight system is considered that the practicability of operating *chemically* powered rocket aircraft in the super-sonic range strikes feasible, and this obviously is merely an interim step leading ultimately to the true projectile craft.

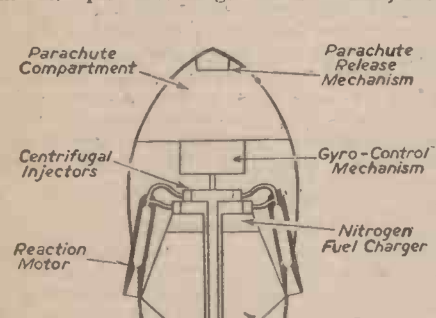


Fig. 51.—Diagrammatic layout of the original M.A.A. design for a sounding rocket (1939).

The Sounding Rocket

Apart from sea-rescue, *meteorological sounding* is another specialised peacetime use that the rocket is now serving. The war has been the means of accelerating this development, and already much important data has been accumulated in this way.

Prior to the rocket, all meteorological and specific soundings of the atmosphere had

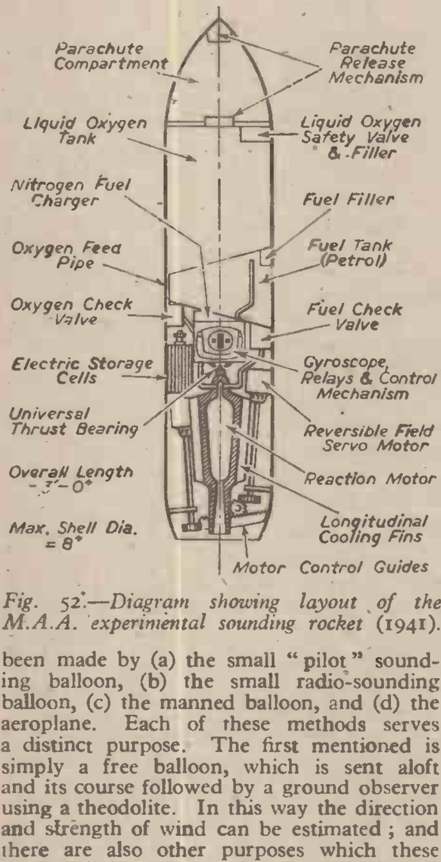


Fig. 52.—Diagram showing layout of the M.A.A. experimental sounding rocket (1941).

been made by (a) the small "pilot" sounding balloon, (b) the small radio-sounding balloon, (c) the manned balloon, and (d) the aeroplane. Each of these methods serves a distinct purpose. The first mentioned is simply a free balloon, which is sent aloft and its course followed by a ground observer using a theodolite. In this way the direction and strength of wind can be estimated; and there are also other purposes which these small balloons serve. An instrument called an "anathermoscope," for instance, can be carried, which is used for anticipating fog conditions. It consists of a delicate thermostat attached beneath the balloon, and when an abnormally warm layer of air is encountered at a certain height—the condition which normally precedes fog formation—the contacts close, and either effect the release of a paper parachute or light a signal lamp. The ground observers, with the aid of the theodolite, are then able to determine the height of the warm air layer, and also to calculate the time at which fog will begin to form.

The radio-sounding balloon is, of course, more elaborate, and it is generally employed for high-altitude sounding. The instruments carried measure air pressure, temperature and humidity, and each are linked to a midget radio-transmitter, which emits continuous signals. These are picked up and recorded at a ground receiving station. The hydrogen-filled balloon, which is normally

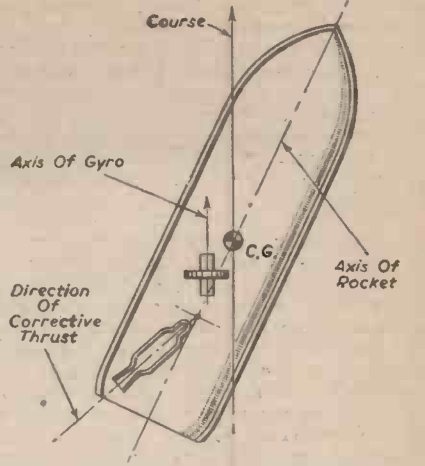


Fig. 53.—Principle of the gyroscopic corrective control adopted in the M.A.A. sounding rocket (*Fig.* 52).

between 3ft. and 4ft. in diameter, bursts at an altitude of about 35,000ft., the instruments and radio descending by parachute.

More specific soundings, of course, require different instruments, and some balloons are used which carry aloft light glass containers which return with samples of air taken from the stratosphere. Since certain of these balloons are capable of reaching heights of 20 miles and more, their importance is very great indeed.

Manned Balloons

The manned balloons, as employed by Professor Piccard and Capt. Orville Anderson, although not capable of altitudes as great as the free-sounding balloon, are, too, very valuable, particularly since the varying conditions through which they travel can actually be *experienced*. The apparatus they are able to carry is, of course, heavier and more varied, and the fresh knowledge that is gleaned from these flights invariably has an immediate bearing on many fields of science. The study of the radio-reflective, Heaviside and Appleton Layers, and the effects of natural electronic emissions is, for instance, of immense value in radio technique; but this is only one example of how the results of high altitude sounding can be applied in the practical sense.

Finally, there is the aeroplane, and it is this method that is employed for most routine soundings of the lower atmosphere for the purpose of computing the day-by-day weather forecasts. For several years past Gloster "Gauntlet" meteorological aircraft have been used for this purpose. A recording instrument, termed the "psychrometer," is attached to one of the inter-plane struts, and this, too, automatically registers the pressure, temperature and humidity.

Although the rocket should ultimately prove of great use as a meteorological instrument, its principal work will undoubtedly be in the sounding of extreme altitudes where the atmospheric pressure is too low for the balloon to penetrate.

The greatest height reached previous to the rocket was by a small sounding balloon released by Russian experimenters, which carried its instruments to a height of 25 miles. This may not be strictly true, however, as calculations show that the shells from "Big Bertha" may have reached as high as 34 miles.

The rocket will enable soundings to the limits of the atmosphere and into space itself. In this connection, the adaptation of the V2 projectile as a sounding rocket has already been suggested, and it will be remembered that the calculations for the modified version gave a maximum altitude attainable of 500 miles. Since the practical extent of the atmosphere is in the region of 200 miles, it is clear that in this development we have a means of sounding adequate for all scientific purposes.

From the experience gained in the development, handling and performance of the V2, the design and construction of sounding rockets of high reliability are certain, and, of course, these could be fitted with radio-transmitting gear in much the same way as the radio-sounding balloon. The example given of converting the V-shell for this purpose is primarily intended as evidence of what can be accomplished with a mechanism that has been proved and is available to-day. There is obviously much scope for the specific development of sounding rockets, and no doubt these will range from light meteorological types to the larger models which will ultimately be used to probe the fringe of atmosphere in search for proofs of the many controversial theories that exist, principally about the cosmic ray and other electronic phenomena. Whether or not the remaining V-rockets that are available will be converted for these latter purposes is yet to be seen. There seems no reason why they shouldn't be so employed. The cost of conversion and fuelling would indeed be cheap exchange for the invaluable data they would provide.

A brief account of sounding rocket developments in the U.S.A. has already been given (*Practical Mechanics*, June, 1945, pp. 315-6), and apart from the investigations of the American Rocket Society and Professor Goddard there is little evidence of any other pre-war research.

In Britain, too, work in this direction has been slow, and, again, it is the rocket societies that have provided the most detailed account. The initial investigations of sounding rockets are due to the Manchester Astronautical Association, whose work in this connection was started in January, 1941.

The investigation began with a mathematical survey in which the characteristics and performance of a hypothetical sounding rocket were calculated. This occupied the association for several months, and from the experience gained the design of an actual rocket was next attempted.

M.A.A. Sounding Rocket Developments

The first scheme produced was for an oxy-petrol rocket stabilised by axial rotation (Fig. 51), and from the diagram it will be seen that the design provides for nose-drive, the propellent feed being arranged in similar manner to that adopted in the M.A.A. centrifugal injector.

A parachute is provided at the nose, and a gyroscope supported immediately beneath for the purpose of maintaining stability. The motor assembly, below, comprises four concentric feed combustion units equally disposed around the circumference and axially inclined to impart the required spin. The petrol and oxygen are fed from their tanks through tubular shafts which extend from the feed unit. It will be observed that the oxygen line is fitted within the petrol shaft, the petrol being fed around it.

The performance calculations show that it would be necessary for the rocket to be 8ft. in length, and the maximum shell diameter 3ft. 9in. As this appeared unreasonable for the height that the rocket could be expected to reach—the performance estimation gave a figure approaching 40,000ft.—the entire design was scrapped and work commenced on another rocket.

The second scheme (Fig. 52) differs in several respects from the original. Its chief difference is that stability is not effected by spinning, but through the offsetting of a single rocket motor, which is regulated by gyroscopically controlled electric motors.

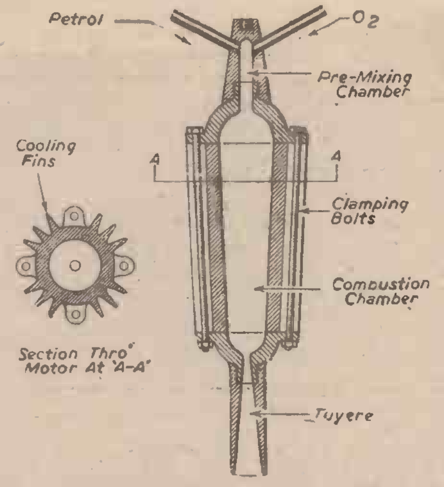


Fig. 54.—Rocket motor No. 4—developed to power the M.A.A. sounding rocket, as shown in Fig. 52.

The gyro-control is so designed to function immediately the rocket deviates from its true path, and at once alters the direction of thrust to oppose the deviation, thereby returning it to the original path of flight.

To achieve this movement, the motor is pivoted at the "head" on a universal thrust bearing, and at the nozzle end, held in place by a system of slides and ratchets. This ensures easy movement of the motor in any direction around the central pivot to apply thrust at angles ranging to 15 degrees from the normal thrust line. The method of control is apparent from the diagram (Fig. 53), reversible field electric motors being used to actuate the rocket chamber.

No motive power is provided in the rocket for functioning the gyroscope, since the period of powered flight is only a matter of 43 seconds. It is considered, therefore, that a ground motor would suffice to build up the desired rotational velocity, allowing the inertia of the gyro to maintain control during the time of thrust.

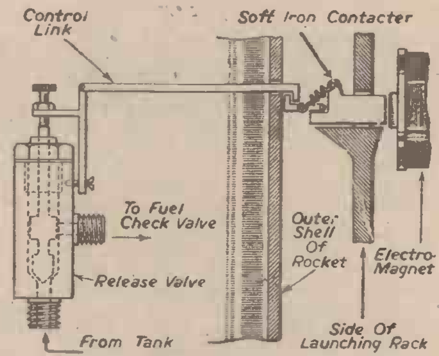


Fig. 55.—Part-sectional diagram of a remotely controlled propellent feed mechanism.

The Rocket Motor

The driving motor (Fig. 54) was designed for construction in a light aluminium alloy, being internally sprayed in order to obtain a thin coating of steel as protection against the high combustion temperatures. The chamber is built in five sections: mixing chamber, "head" portion, central portion, "throat" portion, and nozzle. This facilitates replacement should any one of the components "burn-out," or become otherwise damaged during testing. It also enables varying sizes and shapes of chamber section to be tried as well as different nozzles.

The outer sides of the chamber portion are ribbed by longitudinal fins.

Cooling of the motor is arranged by the induction of air from inlets flush to the skin, and the air is introduced by means of the negative pressure caused by the rush of the exhaust gases, thus effecting a swift cooling flow past the reaction motor.

The liquid oxygen and petrol are contained in duraluminium pressure tanks, and these are designed to allow, as far as possible, unrestricted flow to the motor.

The feeding of the liquid oxygen is a simple matter, because of its low temperature of liquefaction and the ease with which it vaporises. The method is the same as that employed in the early German experiments. The "Mirak" rockets, it will be recalled, relied upon the self-feed characteristic of liquid oxygen, as did also many other types developed by the Verin fur Raumschiffart. The only difficulties then were: (a) the liability of the tanks to explode under the considerable pressures developed, and (b) the inconsistency of the feeding pressure. In the M.A.A. design these problems are overcome to a large extent by the provision of high pressure tanks, and the use of check valves in the feed lines to stabilise the rate of flow to the rocket motor. An emergency relief valve is fitted to the oxygen tank, but it is not anticipated that pressure would be developed to the critical point within the period from fuelling to flight.

The fuel is introduced in a similar manner through the pressure of an inert gas (nitrogen) acting directly on to its surface.

A parachute is housed in the nose of the rocket, and this is released by the action of a mechanism adjusted to function when the air pressure inside the lower shell is built up to a predetermined figure as the rocket falls back to the ground. Its descent would naturally be tail-first, because when the tanks are empty the weight is largely disposed at the rear. Should, however, the rocket descend nose first, due to accident, a small clockwork "timer" is also fitted to ensure that the return is made without damage.

General particulars of the design and the calculated performance figures are as follows: The total weight of the rocket is 50.0lb., of which 22.5lb. comprises fuel and 27.5 "payload." Its overall length is 35.0in., and the maximum shell diameter 8.0in.

The jet flow is estimated at 0.464lb./sec., and the jet reaction 53.280lb. Other items of interest are the reaction chamber pressure, 700lb./sq. in.; fuel tank pressure, 1,050lb./sq. in; jet velocity, 5,000ft./sec.; time of power, 43 sec., and the total height attainable 47,000ft. within 78 seconds.

Launching Procedure

As has already been mentioned, the controlling gyro must be run up to its designed rotational speed just prior to launching, and this is arranged through a flexible drive, the auxiliary motor being held at the side of the rocket. This is, however, but one of the operations which must be attended to in readiness for firing. Previously the fuel and oxygen tanks must be filled. The feed control valves must, of course, be closed during this time, but opened again just prior to ignition. The method adopted by the M.A.A. is shown in Fig. 55.

Finally, a last-minute check must be made to ensure that each of the three tanks—propellent and feed—are fully charged, and that the pressure in the oxygen tank has been developed to the degree required for self-feeding. The parachute release gear must not be overlooked, and only when all these checks have been made is the rocket ready for firing.

A motor to the design illustrated, but built entirely of steel, has been prepared for test, and it is proposed to make this the feature of a series of experiments soon to be carried out. It will not, of course, be possible to use liquid oxygen, as this would cause an infringement of the Explosives Act, and it is likely that compressed air will be employed instead.

Although it is not anticipated that the complete sounding rocket will be constructed, it is hoped that a further design, incorporating several of the characteristics of this model, will soon be ready as the result of a new investigation now proceeding under the auspices of the Combined British Astronautical Societies. The existing design was intended merely as a practical example on which could be based the development of larger and more useful sounding rockets. The dimensions of the preliminary model have been maintained at the lowest practicable limit, and in considerations of size it will be appreciated that its performance is highly credible.

It is with regret that we record the death of Professor Robert Hutchins Goddard, who passed away recently in a U.S. hospital as the result of a throat operation.

As readers of this journal will already be aware, Goddard was the pioneer of modern rocket development. It was he who first conceived the "constant-volume" rocket system, which he successfully demonstrated in the world's first firing of a liquid-fuelled rocket at Auburn, Mass., on March 16th, 1926.

Many equally significant researches are due to him, both in previous and subsequent experiments. Readers will recall, for instance, the unique successively loading powder motor, which was one of Goddard's earliest achievements.

When war came to America, Goddard turned his capable hands to the military rocket, his work resulting in several of the highly-effective rocket weapons which contributed so large a part toward the eventual overthrow of the Axis.

Inventions of Interest

By "Dynamo"

Potato Peeler

An inventor has been devoting his attention to an improved way of peeling potatoes. He points out that there has been a method of skinning this useful vegetable by subjecting it to a sudden blast of heat of an intensity sufficient to cause collection of free moisture or vapour beneath the skin. Disintegration and removal of the skin is then effected by a cooling treatment by means of jets of cold water or air or by mechanical friction, or both of these operations.

In prior proposals heat treatment has been carried out by using a current of hot air or gas derived from an oil or similar burner at a high temperature. This action produces the separation of the skin from the pulp, but it also dehydrates and coagulates the layer beneath the skin.

The aim of the new method is to retain the whole of the pulp in a completely raw state. This system is distinguished from its predecessors by heat treatment in a closed vessel with steam at only a moderate temperature. This lasts only a short period, sufficient to swell the tissues of the skin, but insufficient to cook any part of the pulp.

The potatoes are then suddenly cooled by means of a fluid at a low temperature. This causes contraction and disintegration of the skin and thus simplifies its removal by mechanical friction.

Adjustable Golf Club

An application for a patent relating to golf clubs has been accepted by the British Patent Office. The inventor asserts that there have been several proposals concerning a universal golf club in which the angle of the striking face of the head may be adjusted infinitely or into one of a predetermined number of possible positions. Thus the player is enabled to strike his ball to various distances without having to carry a quantity of different clubs.

He affirms that previous ideas have not been entirely satisfactory. This was due to the difficulty of adjusting the head of the club, its unorthodox appearance and its inability to endure continuous use.

The inventor has aimed to devise a golf club head in which the angle of the striking face may be varied between predetermined limits and yet is of normal appearance.

The head is rotatable in order to vary the angle of the striking face by means of an element slidable on a keyway under the control of the rotatable element. The last-mentioned may be turned round by the hand of the player.

To describe the invention more particularly, an extension or stem is made fast to or integral with the club shaft at a suitable angle. It is provided with a key-way or spline. Along this is slidable an element having an external spiral thread or splines engaging corresponding keys or splines in a bore in the head. In this is a rotatable gear operable externally of the head and engaging cross teeth in the slidable member, so that rotation of the gear moves the slidable member along the spines, and the spiral splines, by engagement with those of the head of the club, cause the head to rotate.

In such an arrangement it is impossible to rotate the head except by manual rotation of the gear.

So robust is the construction that it will last for a very considerable period.

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

Pliable Toast Rack

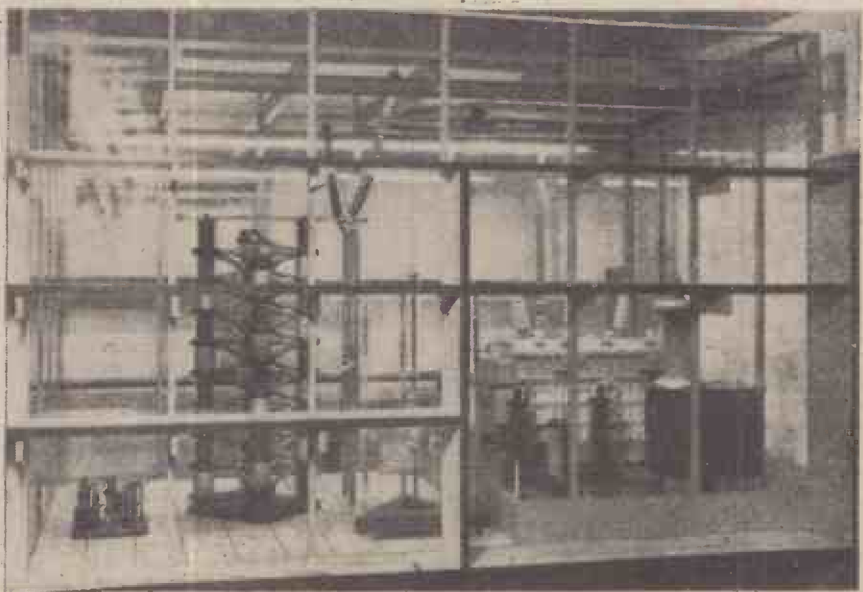
An accommodating variation of that familiar object of the breakfast table, the toast rack, has made its advent.

As a rule the toast rack is constructed with fixed rigid partitions regularly spaced apart. Consequently, unless the bread is cut uniformly, some slices may be too thick to be fitted between the partitions, whilst others are so thin that they are in danger of falling out while the rack is moved; for example, when the toast is handed to a person at a table.

These disadvantages have been borne in mind by the inventor of this improved toast rack, and he has thought out a rack qualified to accommodate slices of toast of varying thickness which are held firmly when the rack is moved.

A further characteristic is the possibility of the removal of the partitions for the purpose of cleaning the rack. Yet another feature is an arrangement whereby it can be packed flat.

The device includes a base and a number of partitions, each of resilient construction or mounted resiliently on the base, so as to be capable of gripping the pieces of toast placed between the partitions.



A model of the high-voltage laboratory at The English Electric Company's Stafford works, showing a 132kV. grid transformer, and a 132kV. air-blast switch under test. An exhibit at the recent "War Activities" Exhibition.

The Annals of Electricity—9

Hans Christian Oersted, and His Chance Discovery of Electro-magnetism

BY one fortunate discovery—a discovery which was as unexpected as it was technically spectacular—Hans Christian Oersted, a Danish Professor of Physics in the University of Copenhagen, raised himself to a pinnacle of celebrity in the electrical world of the early 19th century.

It was the discovery of the magnetic effects of the electric current which suddenly made Oersted famous, and which resulted in nearly all the scientific societies and associations in Europe flinging their honours at him in what must have been a somewhat embarrassing profusion.

Yet, for this single discovery, Oersted is undoubtedly entitled to the renown of being the "Father of Electro-magnetism," although, let it be added, he himself did comparatively little afterwards to apply the great fundamental principle which he had unwittingly stumbled upon.

As far back as the days of ancient Greece, philosophers postulated that there might be some connection between the attractive power of rubbed amber and other "electrics" and that of the natural lodestone, the one, as we now know, being an electrical phenomenon, the other being a magnetic attraction.

Right through the ages, experimenters and other people who speculated over these matters had a sort of intuitive feeling that these two attractive forces must be related to each other in some way, but, try as they might, they were never able to hit upon this supposed hidden connection between the two forces.

When Alessandro Volta came out with his first electric batteries, so strong was the general conviction among experimenters that these devices would give the clue to the mysterious relationship between electricity and magnetism that many of them actually hung up one or more of these batteries by means of insulated strings and tapes in the expectation that, under favourable circumstances, the voltaic cell would behave like a magnet and align itself along a line running north-south. This was an experiment which failed.

Electric Current Pioneer

Oersted was one of the first investigators to use the voltaic cell and Volta's Pile for the production of electricity in a state of flow. That is to say, he was a pioneer in the utilisation of the electric current as distinct from electricity in an accumulated or static condition. As far back as 1812 he published a pamphlet which endeavoured to prove or, rather, to deduce a relationship between electricity and magnetism. But the comparatively feeble currents which were then available to him precluded an exact experimental verification of the attractions and repulsions of electrical polarities, so that his explanations of electro-magnetical relationships had necessarily to remain mere surmises, which, at that time, is just exactly what they were.

Then comes the chance demonstration of the existence of electro-magnetism which was made by Oersted in 1819 and of the exact details of which several accounts, not all in agreement among themselves, have come down to us.

The life and career of Hans Christian Oersted proceeded with great regularity and precision. Indeed, it might almost be said to have been dull and monotonous in its successes. If Oersted ever stopped to count up his many academic and social honours he must have spent a considerable time over the job, for, at his zenith, he gained a lion's share of appreciation and acclamation in European scientific circles.

Humble Birth

Yet Oersted himself was of very humble origin. His father was a poor village apothecary in the little Danish town of Rudkjöbing, situated on the Island of Langeland. Here he was born on August 14th, 1777. His father, although he seems

Hans Christian Oersted.

to have appreciated the value of true education and vocational training, had not the means to send his children to any school, but he contrived to keep his two elder boys out of mischief by sending them for an hour or two every day to an old German wig-maker and his Danish wife who lived in retirement nearby.

The two Oersted boys were Hans Christian and Anders Sandoe, the latter being the younger of the two by one year. Anders Sandoe, incidentally, became a leading lawyer in Denmark, and after the death of his brother he rose to the dignity of being the Danish Prime Minister.

Christian Oldenburg, the retired wig-maker, taught the Oersted lads German, and his wife taught them to read in their own native language. The Oersted parents, also, contributed to the brothers' education, and, between these painstaking tutors, they picked up a smattering of languages, mathematics, Latin, History and English, in addition to acquiring a foundational training in the "three r's."

An early type of galvanometer based on Oersted's discovery. It was used for many years in the British Post Office.

Educational Partnership

At this stage, the brothers divided in their individual tastes. Hans Christian followed his taste for poetry, romance and history, whilst Anders developed a peculiar attraction to law and philosophy. Nevertheless, so close was the connection between the two brothers that each endeavoured to impart to the other the substance of any new learning which he had received.

For some years the two boys went on in this peculiar educational partnership until, in the autumn of 1793, they became students in the University of Copenhagen, Anders plunging into law and philosophy, in which domain he was afterwards to become eminently successful, whilst Hans Christian betook himself to the study of medicine, astronomy and physics.

During their half-dozen years of student life at Copenhagen the two Oersted brothers carried out methodically the principles of their strange partnership, Anders indoctrinating Hans Christian with the various principles of law and philosophy, and Hans Christian, in his turn, passing on the elements of anatomy, physics and astronomy, to say nothing of "minor" sciences such as chemistry and electricity, to his legal-minded brother.

At the age of 21, Hans Christian, the future physicist, gained a doctorate in Medicine and Philosophy. The year previously, he had gained a gold medal for poetry, and, additionally, he seems to have acquired some smaller prize in chemistry about the same period.

The first job which Hans Christian pursued after leaving the University of Copenhagen was that of manager of an apothecary's shop in that city. But the job seems to have been a poorly paid one, for he had at once to supplement his income by lecturing to medical students on the elements of chemistry.

European Travel

In the following year he left Copenhagen and set off on a tour of Germany, Holland, Belgium and France. During this journey, which extended over a couple of years, he met with various adventures, introduced himself to most of the leading lights in European science, translated a book or two for some of them, did a little popular lecturing and eventually returned to Copenhagen.

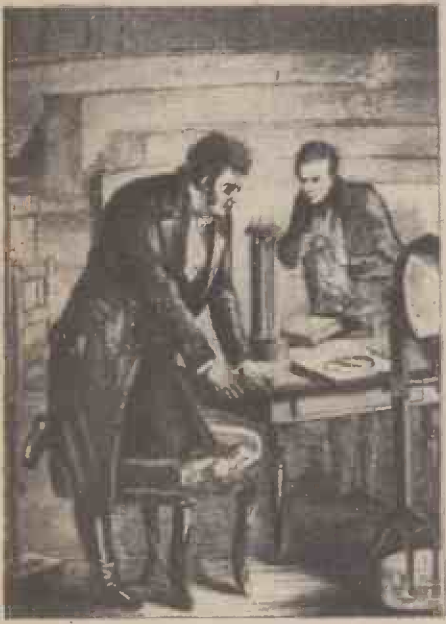
Oersted's next step was to apply for the vacant professorship of Physics in Copenhagen's University. But in this application he was unsuccessful, being adjudged too young. Nevertheless, he received a sort of Government retaining fee for the express purpose of devoting himself to scientific experiment and giving lectures in science in the university.

It was during this formative period that Oersted gained first-hand familiarity with the electrical investigational work (such as it was) of that period. In 1809 he wrote a book entitled "Manual of Mechanical Physics," which was a sort of handbook of the laboratory arts. The volume was successful, and it brought him considerable fame in Denmark.

Then during the years 1812 and 1813 he travelled again in Germany, wrote another successful book on "View of the Chemical

Laws of Nature," and generally publicised himself throughout the German scientific world.

In 1814 Oersted found time to get married. He had a family of several sons and daughters, but they never attained anything more than a comfortable mediocrity, and, with the exception of one daughter, Mathilde, who subsequently published an account of her father's work, none of them evinced any interest in their parent's career.



Oersted's discovery of electro-magnetism—a reconstructed picture of the event.

During the summer of 1818, by command of the King of Denmark, Oersted undertook a geological exploration of the Danish island of Bornholm. Therein he discovered vast seams of coal and iron ore which were afterwards commercially exploited.

Such were the circumstances and interests of Hans Christian Oersted about the time of his noted discovery of electro-magnetism. Oersted had now, like his brother Anders, become one of the leading men of Denmark. He was nothing if not an academic handyman. Doctor, philosopher, physicist, electrician, chemist, poet, traveller, mineralogist, literary man—all these, and many other roles, the ubiquitous Oersted was apparently able to fulfil at will.

The Famous Discovery

The discovery which made him famous came about the autumn of 1819. As we have previously mentioned, reports differ on the subject of the actual circumstances of the discovery, but the narrative which has received the most credence has it that Oersted was lecturing to a class of students and demonstrating electrical experiments to them when he chanced to observe that every time he made a connection to a Volta's Pile for the purpose of showing the heating effects of the electric current, a compass needle in the vicinity of the Pile was seized with a violent oscillation.

The effect was repeated three or four times during the course of the lecture, but Oersted said nothing to his students about it. However, immediately after they had departed from the lecture-room, Oersted, explaining the circumstances to his assistant, hastened to repeat the phenomenon of the oscillating compass needle and to ascertain its causation. Within less than half an hour he found that the compass needle was deflected in consequence of a wire which lay, by chance, very near to the compass needle. When current passed through this wire, the needle became automatically deflected.

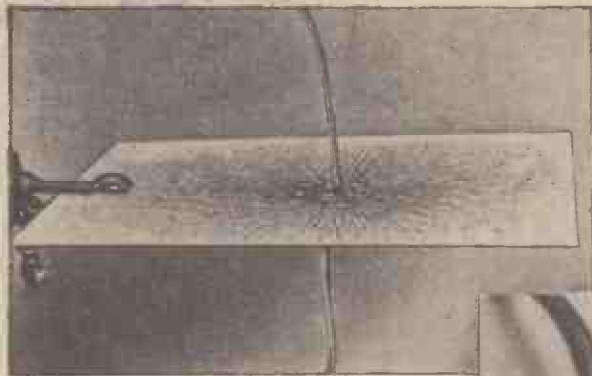
Whether Oersted realised the full significance of his discovery at that moment we do not know. But he did so afterwards as a result of other experiments which he subsequently made, and he announced his discovery of electro-magnetism to the world in a Latin pamphlet which, on July 21st, 1820, he posted to all the learned societies in Europe. In this pamphlet he stated that a current flowing through a wire produces a magnetic field around the wire and that if a magnetic needle is brought into the influence of this field it will set itself at a tangent to the circular field of influence, that is at right-angles to the path of the current. One of the poles of the needle will tend to revolve round the conductor in one direction, and if the direction of the current is changed, the needle will tend to revolve in the reverse direction.

Electricity Produces Magnetism

In short, a current flowing through a wire creates around the wire a field of magnetic influence. Electricity has produced magnetism. The long-hidden and extensively sought connection between the two has at long last been disclosed.

Scientific circles took up Oersted's discovery in a spirit which was akin to a furore of excitement. Honours and congratulations avalanched upon him. Our own Royal Society, at once bestowed on Oersted its highest honour—the Copley Medal, whilst other European societies responded in a more practical manner still with monetary gifts.

The Oersted discovery was, without a doubt, one of the highest practical importance in the science of electricity because it so conclusively established the intimate relationship between electricity and magnetism.



Iron filings used to show the magnetic field around a conductor carrying a current. This magnetic field is able to effect a magnetised needle within it, and thus give rise to Oersted's discovery of electro-magnetism.

Yet Oersted himself did little to develop his discovery in any practical manner. He missed the invention of the electric magnet and he even let others discover the principle of the galvanometer, which latter device was first introduced in the following year (1820) when Professor S. C. Schweigger, of Halle, devised his famous "multiplier," consisting merely of a few turns of insulated wire set around the compass needle, the several turns of wire thus "multiplying" the amplitude of the needle's deflection.

It must be admitted, therefore, that Hans Christian Oersted was guilty—perhaps pardonably—of resting on his oars after his famous discovery had become generally known. The big developments in electro-magnetism came at the hands of Ampere and, more so, of the illustrious Michael Faraday.

Success Brings Success

Right up to his death at Copenhagen on March 9th, 1851, Oersted remained enshrined in his celebrity. He reached the status of a national hero of Denmark. The Danish King bestowed new titles upon him. The Danish Government presented him with a country house and a country estate near Copenhagen.

In a book entitled "The Soul in Nature," which Oersted published towards the end of his life, he showed that his interests had shifted more and more to politics, sociology, poetry and even metaphysics, and that plain science had become relegated more to the background of his mind and activities.

Yet, even in our own times, Oersted's phenomenal fame has persisted. To-day we apply to the unit of "reluctance" (which is the magnetic equivalent of electrical resistance) the name *oersted*, thus perpetuating the memory of a much famed individual who, if he did nothing else of fundamental importance, at least brought the phenomenon of electro-magnetism into practical being.

Epilogue

Was Hans Christian Oersted, of Copenhagen, absolutely the earliest originator of electro-magnetism?

Standard histories, which our article above has followed, unite in answering such a query in the affirmative, but then, of course, official histories frequently have a knack of being completely incorrect on many material points.

It is true that Oersted was an independent discoverer of electro-magnetism. But independence is not synonymous with priority in the matter of discovery and invention. And, in this particular connection, it seems to be a fact that as long ago as 1802, an Italian savant, one G. D. Romagnosi, of Trent, learning of Volta's discovery of the electric "Pile" or battery, announced in a public pamphlet or other similar communication that he had observed the power of an electric current travelling through a wire to deflect a compass needle when the said wire passes near the needle.

Such is a claim which has been made, and which, if verified, would completely dispossess Oersted of the priority of the first discovery of electro-magnetism. Owing, however, to the upheaval in Europe, the investigation into Italian scientific archives and other sources cannot be made. The speculation on this important matter of priority must, therefore, still remain an open one.

The elements of Oersted's discovery—a compass needle deflected by the passage of a current through an adjacent conductor.

THE WORLD OF MODELS

By "MOTILUS"

Our Model Man tells you this month about readers' work—Let us hope with the new era of peace he will be able once again to range "far and wide" with his camera, as he did in the early months of 1939!

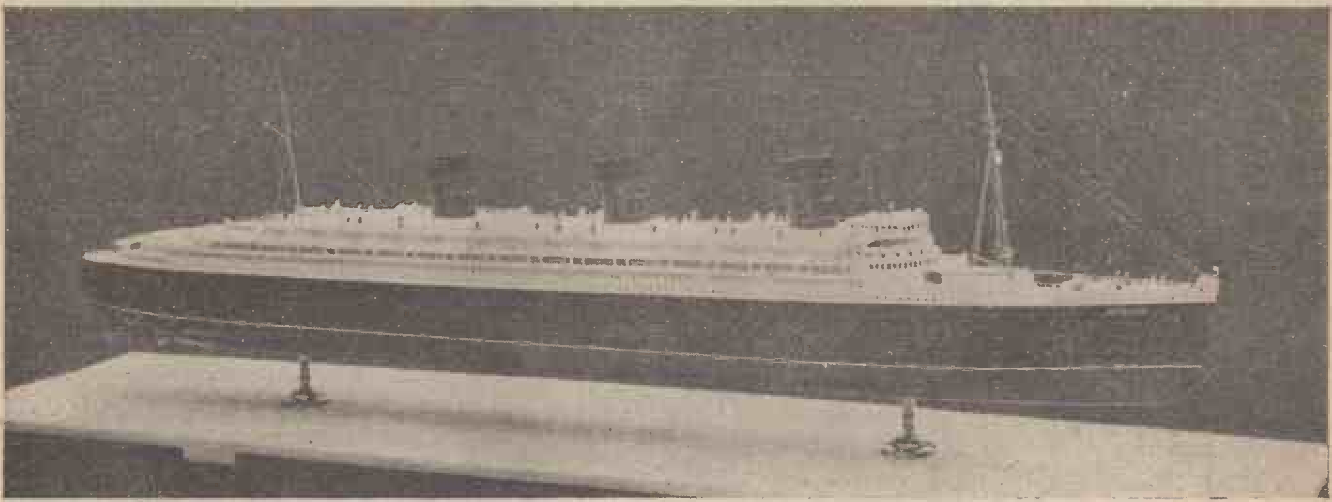


Fig. 1.—Model "Queen Mary" scale 26ft. to 1in.—the work of Mr. K. Young of Gidea Park, Essex.

"I FEEL that half the pleasure of modelling lies in the ferreting out of ways and means of making even the most complicated parts yourself, besides the satisfaction of knowing that there is no other model exactly like yours anywhere!"

This remark from a recent reader's letter set me thinking—for it is the maxim of the true craftsman. I read on and found the study of the model work of Canadian-born K. Young, of Gidea Park, Essex, was quite intriguing. Writing to him, I divulged the identity of "Motilus," and his reply brought forth a description of his individual effort in modelling the *Queen Mary* (Fig. 1).

He said: "I was both surprised and interested to note your identity, and under these circumstances I am afraid my efforts at model making may pale a little.

"My miniature *Queen Mary* was inspired by models in travel agency windows, although—with due respects—I have always felt that these usually suffered badly from the scaling down process and always *looked like models.*

"It was my intention to build a miniature *Queen Mary* that did not suffer from this scale effect and would appear as the real thing seen from a distance. A waterline model was contemplated, but this is obviously the easy way out, so a complete model down to the keel was built. The part normally below water was purposely foreshortened, not affecting the accuracy of the model seriously and helping to do away with the fault I have just mentioned.

"Another reason, in my opinion, for the unnatural appearance of most model ships is the machined and polished brass fittings. These may be exact replicas of the actual parts, but look wrong in a model. A real ship, seen at a distance to appear the size of a model, would not show all this glittering brass. Therefore all deck fittings were made in the simplest of materials and painted so that they did not appear too contrasty and, in my opinion, look better than all the expensive commercial gadgets.

Fig. 2.—Table-top picture of Imperial Airways liner "Heracles"—1/72nd actual size—the maker was Mr. K. Young.

"I know a lot of fastidious scale model-makers will disagree, but as I am also an amateur photographer, I must state that I find by following these principles I get the kind of table-top photos I want."

That is Mr. Young's view, and I am agreeing with him regarding the finish and the details of the average shipping company's glass case models, but Mr. Young should bear in mind that the customer is always right, and that if the shipping company prefers the rather old-fashioned silver- and gold-plated winches and gear, silver-plated stanchions and hand rails because they think it makes the model appear more elegant, then it has to be done; but I would like to state here that, just before the war, with the introduction of large waterline scale models, realism in miniature was beginning to play a very important part, and model ships were being finished more in their actual livery. It will be interesting to watch the trend of the post-war model.

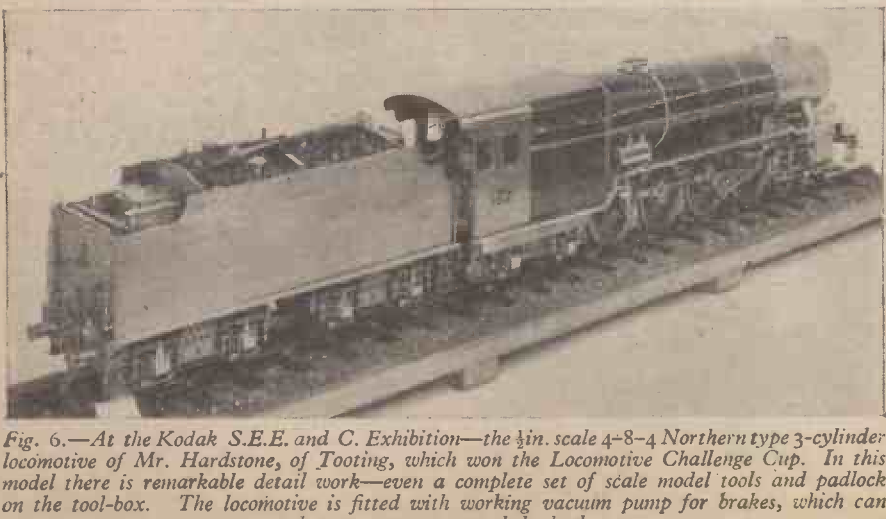


Fig. 6.—At the Kodak S.E.E. and C. Exhibition—the ½in. scale 4-8-4 Northern type 3-cylinder locomotive of Mr. Hardstone, of Tooting, which won the Locomotive Challenge Cup. In this model there is remarkable detail work—even a complete set of scale model tools and padlock on the tool-box. The locomotive is fitted with working vacuum pump for brakes, which can be seen over rear coupled wheel.

Construction of the "Queen Mary" Model

Mr. Young's model of the *Queen Mary,*

which is to the scale of 1in. to 26ft., represents about six months' spare-time work. He worked on this scale to give the model an approximate length of 3ft. 6in., and full-size plans and elevations were prepared. It was no easy matter to do this, as the model was constructed before the ship was launched, but one particular number of a shipping journal showed many pictures of the liner in course of construction and also artist's impressions of the finished ship, and all the drawings were worked out from these.

The hull, from keel to first main deck level, was a solid block of cedar, planed and spokeshaved down to shape; main keel, bilge keels and shaft tunnels were made separately and propellers cast in type metal. Side plating was indicated by cartridge paper strips accurately spaced and cut to fit. The superstructure was built up in layers of ply and strawboard, the outer surfaces containing promenade deck windows and the curved bridges was made from bristol board cut with a stencil knife. Very beautiful results can be obtained with this thin, stiff card if squarely and accurately cut, and it is very strong when glued up and brushed with a mixture of shellac in methylated spirit. Funnels were also made from bristol board glued and wrapped round a former and allowed to dry. They were then slipped off the former, cut to size, and the join sanded down smooth, wire rings being made and fixed to the outside. Ventilators and

Fig. 5.—Sgt. Rockhill's "Valerie II" on the stocks.

some deck fittings were cast in type metal, others made from wood and card. Lifeboats were hand-carved, and the davits made from square section radio connecting wire. Masts are wood, with cotton rigging and rope ladders. There are over 2,000 soldered joints in the hand rails, which are made from pins and copper wire.

The model was finished glossy red and black to deck level, the superstructure being painted flat white and the funnels glossy red and black. Deck machinery and capstans, etc., were finished white, grey or black, according to their appearance in the finished ship—at a distance. Mr. Young also decided that port-holes in the superstructure painted grey, with groups here and there painted black, whilst keeping them all accurately aligned, looked much better than rows of "regimented" brass-framed ports — all exactly alike.

Model Covered Wagon

Mr. Young has never bought a set of parts or any ready-made gadgets. His other models include aircraft and Elizabethan galleons—also a covered wagon (Fig. 3)—reminder of his Canadian birth and happy childhood days. He made this from old prints and museum specimens of the old prairie schooners. The wheels were jigsawed out from ¼in. ply, and the spokes filed to shape, metal tyres being fitted to the rims. This model was complete with canvas cover and given an antique finish.

As an example of table-top photography, readers may be interested to know that the photograph of the Imperial Airways liner *Heracles* (Fig. 2) was taken with a box Brownie on a polished table, using only light from the windows. Exposure was about half a minute.

This *Heracles* model is a solid scale model of 1/72nd actual size. The corrugated sides of the fuselage were inserts of cardboard, hardened with shellac and scored with a style. Opaque celluloid windows were placed in a position behind the cut-out inserts before these were fixed to the fuselage. Wings and tail assembly were made from strawboard, sanded to correct camber and hardened. Engines were shaped from large dowels, and had short lengths of screwed rod fixed radially to represent cylinders. The completed model was

Fig. 3.—Model of a Covered Wagon, concocted from old prints and museum specimens of old Prairie Schooners—made by Mr. K. Young.

finished in aluminium and blue, with lettering on the fuselage and wings in black.

The other aircraft model shown—a D.H. *Dragon* (Fig. 4) is somewhat unusual, as it has a built-up cabin, complete with seats, tables, and all internal decorations. It is 1/72nd actual size. Pilot's cabin has seat, dash-board and control column. The model was originally made with built-up folding wings of ribs and spars, and silk covered, but it was not possible to get a really neat result in such a small scale, so these parts were finally made in hard wood. Engines were wood with lead foil cowlings. Transparent celastoid windows were fitted, and the model finished in aluminium and blue.

Mr. Young certainly expresses some original points of view. I wonder if our readers agree?

Fig. 4.—Mr. Young's model of a D.H. "Dragon"—also 1/72nd actual size.

"Valerie II"

Sgt. Rockhill, of the B.A.O.R., sends me some pictures of his *Valerie II* (Fig. 5), a trim craft, completed in ten evenings "against a battery of 'wisecracks,' pessimistic prophecies, and the usual Army banter, which has now turned to envy!"

Materials, Sgt. Rockhill writes, presented some difficulty, but he had a supply of "liberated" ½in. plywood, which supplied the frames. The stringers seemed "hopeless" until he noticed that the weatherboards of the workshop walls were covered at each joint with 1½in. x ¼in. strips (and the walls are not now so weatherproof as they used to be!). The covering came from an old lorry cover, but as copper and brass tacks and nails were out of the question, gallons of German paint were used, and so far *Valerie II* does not leak a drop.

Sgt. Rockhill and his pals have spent many pleasant hours this summer cruising on the river which flows on to Luneburg to join the Elbe, and his only regret is that he cannot pack his canoe into his kitbag to bring her home!

Scale Model Locomotives

The other two illustrations (Figs. 6 and 7) are of model locomotives on view at the seventh annual exhibition of the Kodak Society of Experimental Engineers and Craftsmen held last summer in the Kodak Social Centre at Harrow. The general standard of workmanship, I understand, was the "best yet"—an encouraging thought for the organisers.

Fig. 7.—A 3½in. gauge Princess Royal, made by Mr. Linden of the S.M.E.E., London, which was very highly commended. This model did some good work on the passenger track.

Masters of Mechanics—109

Walter Hunt

The Story of the Early Sewing Machine

THE narration of Walter Hunt and his creation of one of the world's pioneer sewing-machines has not yet obtained entry into the standard volumes of Invention's history. No doubt, such a fact is consequent upon Walter Hunt being, at least in respect of his sewing-machine, an inventor who failed. However, Hunt's eventual failure with his machine does not invalidate his merits as an inventor of originality for, as the reader will readily agree, there is often little other than an element of mere luck and good fortune to differentiate between a successful and an unsuccessful invention.

Walter Hunt was not the first man to conceive the notion of sewing mechanically. That honour, so far as existing records reveal, belongs to an Englishman by the name of Thomas Saint who, in the year 1790, took out a British Patent for a leather-stitching machine.

More than a quarter of a century after Thomas Saint came Barthelemy Thimonnier, a poor working French tailor of St. Etienne, who, in 1830, was given a patent in respect of a mechanical contrivance for stitching short lengths of cloth together. Thimonnier was an utterly untutored, untrained, mechanically-gifted individual. Given suitable backing, he might have done brilliant things, but he was up against difficulties and trials all his life, his working career being little more than a bitter struggle against enormous odds and vested interests.

After Thimonnier comes Walter Hunt, an American Quaker. Unlike the former individual, Hunt, at the time he took up the notion of mechanical sewing, was, if not a formerly trained mechanic, at least an inventor of some considerable experience. He had to his credit several inventions of a somewhat miscellaneous nature. For example, he had already contrived the invention of a nail-making machine and a similar device for making rivets. He had invented an ice plough, a street-sweeping machine, a crude sort of bicycle (" velocipede "), a process for moulding paraffin candles, a special type of oil lamp, and a device for cutting-out paper collars.

The Safety-pin

It is said, too, that Hunt was the inventor of a revolver and a repeating rifle, together with a special form of bullet to use with the same. He certainly attained a minor degree of celebrity by inventing a safety-pin for use in the American nurseries. He had a friend, J. R. Chapin by name, a draughtsman, who was wont to prepare many of his drawings, which were necessary to accompany his applications for patents. Chapin, in later years, averred that the notion of the safety-pin flashed across Hunt's mind in an instant, that he at once sat down and made the first model of the new pin out of an odd piece of steel wire and that, within three hours, he had successfully disposed of the idea to a New York firm for the sum of £100. From Chapin's narrative, it would appear that Hunt owed him (Chapin) the sum of fifteen dollars and that the lightning-like sale of the safety-pin idea resulted from Hunt's eagerness to settle the debt.

Walter Hunt must have been a rather curious sort of a fellow, the embodiment, indeed, of the old-time notion of the perpetually impecunious, ever-fertile inventive genius. He was born in New York about the year 1793. The circumstances of his parentage and upbringing do not seem to have been preserved. It would appear, however, that Hunt was a man of some pretence to education and learning.

A General Mechanic

In the '20's of the last century he took over a small shop in Amos Street, New York City, which he converted into a general mechanic's work-room. Here he conducted the business of mechanic, repairer, hardware merchant and engineering consultant. Perhaps, by way of a sideline, he went in for inventing when business was bad, or as a form of activity to occupy his spare time. He had associated with him his younger brother, Adoniram F. Hunt, an individual who seems to have been endowed with greater actual constructive ability than Walter Hunt, albeit of little, if any, inventive genius.

Walter Hunt.

It was about the year 1832 that Walter Hunt first turned his attention to the development of the sewing-machine. Perhaps he had heard news of Thimonnier's achievements, for that individual had so developed his invention that at least 80 of his machines were put to the task of sewing uniforms for the French Army, and no doubt, intelligence of the then novel art of mechanical sewing would have gradually found its way across the Atlantic.

An early illustration of a household sewing machine. This model was shown at the great Exhibition, Hyde Park, London, in 1851.

Whether or no the above supposition happens to be mere conjecture, the fact remains that Walter Hunt, in his Amos Street shop, New York City, took up the idea of the sewing-machine, knowing nothing whatever about the mechanics of the problem and that he had within a couple of years devised and constructed a machine which, to a limited extent, really did sew.

Hunt advertised his machine as being one " for sewing, stitching and seaming cloth." The fact that it was only able to sew a continuous seam for three or four inches, after which the cloth had to be readjusted and re-positioned in the machine, seemed to him quite a subsidiary one.

Excited at his prospects, Walter Hunt, with the assistance of his brother, Adoniram, built several other similar machines which they exhibited in various places in and around New York. There was a mild public response to the advertising endeavours of Hunt. People regarded the machine as an amusing curiosity, like they did, years afterwards, the first phonograph and the first telephones. They admired it, gazed at it with perplexity, made various inquiries concerning it. In fact, the public, or, at least a section of it, showed the greatest curiosity over Hunt's contrivance for mechanical sewing. Nevertheless, they refused to take the invention seriously.

Even to this day, when Hunt and his sewing-machine have receded almost to the very background of historical inventions, this, the first American sewing-machine is hardly given the historical credit which is its due.

The 1832-34 Machine

Actually, however, Hunt's machine of 1832-34 contained within its make-up nearly all the essential parts which are present in the best of modern sewing-machines. Hunt used an eye-pointed needle which was actuated by a vertically-oscillating arm. The needle operated in conjunction with a shuttle which carried a second thread. By this combination, Hunt was able to obtain a perfectly interlocked stitch. The same principle is present in modern sewing-machines, for which reason it is perfectly safe to say that the Hunt machine played the role of progenitor of most of the succeeding machines which endeavoured to perfect the operation of mechanical stitching.

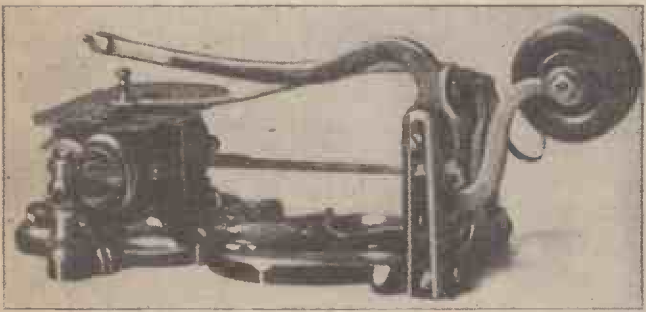
The greatest imperfections in Hunt's sewing-machine were the cloth feed and the thread-tensioning arrangements. The cloth ruckled up on the slightest provocation. It fed badly under the needle. The thread broke frequently and the shuttle often jammed under the needle. Not only was the Hunt machine unable to stitch more than about three or four inches of cloth at a time, but its stitches had all to be in a dead straight line. There was no question of stitching in curves, angles or circles by means of the machine. Hence, it was anything but a " general purpose " machine.

In spite of its imperfections, however, Hunt's sewing-machine had its uses and, in 1834, the inventor sold a half-interest in his contrivance to George A. Arrowsmith, a blacksmith, and the manager and proprietor of the " Globe Stove Works " in New York City. This Arrowsmith, at that time, was the employer of Hunt's mechanically-gifted brother, Adoniram F. Hunt.

At Arrowsmith's request, Adoniram Hunt built a copy of his brother's sewing-machine, making most of the working parts in wood instead of in metal. The performance of the wooden machine so impressed Arrowsmith that he forthwith purchased the remaining half-interest in the machine from Walter Hunt, the latter agreeing to assist him as much as possible in the preparation of the necessary specification and drawings for the obtaining of an American patent to protect the invention.

Hunt's Negligence

It may rather astonish the reader to observe Hunt's negligence and seeming indifference in the matter of covering his sewing-machine invention with a patent, but the truth was that Hunt, being a man of many inventions, regarded the sewing-machine notion as merely one of many which he had brought into actual being. Hunt showed an almost complete indifference to the success of his sewing-machine. At the time, he had other inventive notions awaiting development.



One of the earliest of domestic sewing machines, dating from about 1860.

George A. Arrowsmith, the one-time blacksmith, was a much more exuberant individual than Walter Hunt. Having procured the sole rights of the sewing-machine devised by Hunt, he at once eagerly proceeded to "develop" the invention. In this task, however, he received many set-backs. In the first place, he was not able to obtain the requisite amount of financial backing to exploit the invention fully. Secondly, all his friends and acquaintances opposed his ideas on moral and religious grounds. They pointed out that any widespread system of mechanical sewing would only react by putting out of employment countless scores of poor, hard-working tailors and tailoresses, and, therefore, that the ultimate success of his machine would mean to many American families hopeless ruin and, perhaps, ultimate starvation.

Morally intimidated by such reasonings, and financially unsuccessful in his attempts to procure backing for the exploitation of the sewing machine, Arrowsmith finally relegated the model of the machine to his lumber store and forthwith endeavoured to forget about it.

It was only at a very much later date, and at a time when the commercial machines of Isaac Singer and others were flourishing in America, that the old Hunt machine, which had been cast away in disappointment by George A. Arrowsmith, was found in a garret in a back-street building in New York, where it had been flung along with a lot of old rubbish and machine parts which had been recovered from a fire.

Although Arrowsmith was bitterly disappointed over the machine, others enthused greatly at it. Adoniram Hunt, in 1835, went on a business trip to Baltimore at the instigation of his chief, George A. Arrowsmith. He took one of the Hunt sewing-machine models with him and demonstrated it to a friend, Joel Johnson. The machine worked perfectly, and Johnson was made a convert to the idea of mechanical sewing. Fired by Johnson's enthusiasm, Adoniram A. Hunt returned home with the notion of building a strong machine all of iron.

Opinion Against the Sewing-machine

In 1838, Walter Hunt, noting Arrowsmith's failure to do anything with the machine, suggested to his daughter Caroline, who was then a girl bordering on her 17th year, that she might find it profitable to set up as a manufacturer of corsets, employing for the purpose the sewing-machine which he had invented. However, Miss Caroline was apparently on the side of the "anti" mechanical sewers. She consulted her older women friends who were experienced in the garment-making business. They told her that her father's machine would never successfully perform the heavy stitching necessary for the manufacture of stays and corsets, and, furthermore, that the introduction of mechanical sewing would be so prejudicial to the interests of the hand sewers that opposition would at once rise up against her on all sides.

Thus it came about that the Hunt sewing-machine completely dropped out of sight for some 15 years. Public opinion was opposed to it, and Hunt himself was still more or less disinterested.

Yet, despite his activity in other directions, Hunt seems to have harboured a persistent sneaking regard for his sewing-machine invention. When George A. Arrowsmith finally lost his interest in the invention, he bought back from him the original rights in the invention with the object of commercialising it later on.

The Eye-pointed Needle

The approach of the middle of the last century saw several claimants for the honour of the invention of a successful sewing-machine for trade and domestic use. Even as early as 1841, two individuals, Newton and Archbold, took out in England a patent for an eye-pointed needle which they intended to use in glove-stitching.

This eye-pointed needle was, of course, Hunt's own idea. It was, in a way, the foundation of his sewing-machine invention.

When, after the turn of the '50's of the last century, sewing-machine ideas were beginning to come fast and furious, Walter Hunt made a very much belated—and unsuccessful—attempt to patent his original machine of 1832-34. In 1853 he applied to the American authorities for a patent, but the claim was turned down on account of Hunt's alleged former abandonment of his invention.

Previous to this decision, Hunt had set the law in motion in the guise of a legal suit for infringement of his original rights in the 1832-34 invention. He built a special model of his original sewing-machine for Court demonstration purposes, but the non-recognition of his claims by the U.S. patent authorities cut the ground from under his feet, and he retired from the contest a disillusioned individual.

Hunt's Lack of Success

There is no doubt that Hunt's lack of success in the exploitation of his sewing-machine lay almost entirely within himself. The majority of his other "bread-and-butter" inventions were more or less trivial ones. They needed little commercial exploitation. In the case of the sewing-machine, however, the principle of the invention was an entirely novel one. The public were unused to the idea and their veiled hostility to it only served, at the time, to heighten Hunt's indifference to its success.

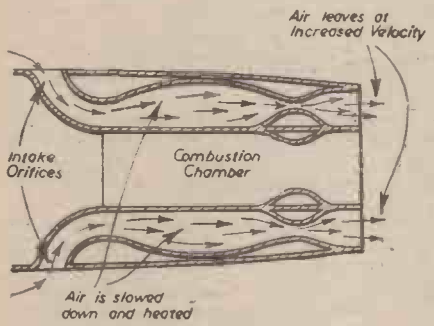
The present-day sewing-machine, however, undoubtedly owes its first origin to the 1832-34 invention of Walter Hunt, since it contains all the elements of Hunt's original machine. The credit, therefore, of having been the inventor of the first practicable device for mechanical sewing belongs indisputably to Walter Hunt. The machines of other inventors which were subsequently produced were, fundamentally, merely improvements on and elaborations of the basic principles which Hunt originally established.

This model of the "Clipper" ship Caliph, which was recently purchased by Her Majesty the Queen, was made by Captain S. Wharton from plans published by Modelcraft, Ltd.

Letters from Readers

Rocket Propulsion

SIR,—While reading the article "Rocket Propulsion" in your December issue, I was in some doubt as to the exact function of the thrust-augmenter. Thinking about this I had the idea of further increasing the thrust generated, and at the same time providing a cooling system for the combustion chamber. This is done by the following means. Air is taken in as in the thrust-augmenter. The velocity is then made to decrease and at the same time the air is made to circulate round the combustion chamber externally, as shewn in the accompanying diagram. The air is heated, taking its heat from the combustion chamber and thus cooling it. The heated air is led out at the rear of the rocket by a ring of jet section, concentric with the main orifice. It will leave the duct at a greatly increased velocity and thus add to the economy of the unit, bringing it one stage nearer a commercial proposition. I might also add that this principle has been applied to the radiators of modern aircraft and with just the heat obtained from the coolant, which is cold compared with the temperatures encountered in a rocket, it has supplied sufficient propulsive effort as to entirely overcome the drag offered by the radiator.—B. CLEMENTS (Bristol).



Section of combustion chamber of a thrust-augmenter.

Making Pipe Bowls

SIR,—I was greatly interested in an article, "Making Pipe Bowls," in your November issue of PRACTICAL MECHANICS by A. E. Bowley. I have been making my own pipes for over a year now and, with very few exceptions, they have all turned out very well.

I have tried several kinds of woods, principally apple, pear, plum and other forest woods, and find that apple gives the best results.

I select a branch of a tree that has been cut down and has been lying for a year or so, cut off the desired size, plane to the square, and mark out bowl hole in direct line with the stem hole. This requires great care, for the least bit out in measurements and you find the pipe is a failure.

I use a ⅜in. bit for the bowl and bore it to about ¼in. from the required depth, then commence the stem hole, which is done with a gimlet first. This is the tricky job now, and each hole is deepened until the stem hole meets exactly dead centre and flush with bottom of bowl. Then comes the fitting of the mouthpiece, which again is to be done with care and patience. I use a hand-drill with the size of bit to admit the mouthpiece tightly and use a counter-sink bit for close fitting.

Now that the stem is fitting properly, shaping of the pipe is begun. Hacksaw and chisel are used for this purpose until the pipe is shaped in the rough, then the sandpaper is used in the various grades until a very smooth surface is obtained. To put a very fine polish on the wood before staining, I use a piece of the discarded wood.

The pipe is now ready for staining and polishing. Firstly, two or three coats of mahogany stain, allowed to dry thoroughly, then again sandpapered—to smooth the roughness caused by the application of the wet stain. French polish is now used, two or three coats being given and allowed to dry. With a good deal of hard polishing with a soft rag the pipe becomes the finished article.—A. J. TAIT (Errol).

Photo-engraving at Home

SIR,—Your correspondent, F. J. Wells, whose letter in the January issue of P.M. commenting on my article "Photo-engraving at Home," in the November issue, seems to be of the opinion that this craft is beyond the capabilities of people with no knowledge of the trade. I do not agree, since I have proved it otherwise.

He is quite wrong in suspecting that I have had previous knowledge of "operating," as he calls it, prior to my own attempts at simplifying the process in order to bring it within the reach of the average amateur craftsman.

It may interest Mr. Wells to know that my first knowledge of the subject was gained from books which can be borrowed from any free library, and I applied this knowledge to suit my own particular purpose, making and adapting such pieces of apparatus that could be picked up cheaply.

I agree that "fine etching" is a process that will improve a halftone block, especially those of very fine screen for illustrations on art paper, but I never found it necessary for any of my blocks, which were chiefly made for illustrating a local weekly newspaper for the purpose of finding a further outlet for my free-lance press photographs. I am quite sure that in the rush and scramble of a modern newspaper photo-engraving department there is no time for "fine etching," even if they had the ability for this extra refinement, and the pictures look quite presentable.

I can quite understand Mr. Wells being somewhat surprised at this amateur invasion upon what he obviously considers to be a highly specialised trade. Perhaps I should congratulate myself at having succeeded in making a satisfactory block from such crude apparatus, but I have the satisfaction of knowing that it *can* be done, and there is no reason whatever why other "unskilled amateurs" should not do likewise, provided that they are sufficiently interested in the subject.

It is some six years since I actually used the apparatus described, but I still have it, together with several of the halftone blocks made with it; so if there is any doubt about the quality of the work turned out, they are available for inspection at any time.

E. H. JACKSON (Newcastle-on-Tyne).

Cat-hedral

SIR,—The article on S. F. Cody brought back many memories of a fine man and really a great pioneer of aviation.

There was one portion that was not, I think, quite correct. The reason was not so much the size that gave the machine the name of the Cathedral. This was purely a technical term. Not cath-edral, but cat-hedral. In other words reversed dihedral. This was seized upon by the non-technical press until a totally erroneous impression was given.

Incidentally, the machine was hopelessly instable in the air for this very reason and only a Cody could fly it.—CLARENCE THOMPSON (Kensington).

A CAMERA ENLARGER

(*Continued from page 159*)

and sharpness of the negative picture itself. Very dense negatives produce dense enlargements and vice versa.

You can, if you wish, try to make enlarged pictures right away by pinning a sheet of white paper against a wall and by setting the focus. Having adjusted the camera position and its lens carefully, a suitable sheet of bromide printing paper is pinned over the temporary focusing easel and an exposure made, this lasting approximately 12 seconds or less, according to the size of the enlargement and the density of the negative. A fairly long exposure is needed when making 10in. by 8in. enlargements, the camera, as a result, being a greater distance from the printing paper.

Bromide Paper

Bromide printing paper is always used for making enlargements, of course, it being more sensitive and quicker than gaslight printing paper, the latter being used chiefly for making contact prints. However, it can also be used for making enlargements, the approximate exposure time being 30 minutes.

This time can be reduced to 15 minutes by using a 100-watt lamp. The heat from this lamp is rather too great for the wooden case, however, and it is liable to crack the opal glass. The happy medium is a 60-watt lamp and the use of bromide printing paper. Next month the special base for the enlarger and its adjustable focusing easel will be described.

(*To be continued*)

Our Cover Subject

THE illustration on the front cover this month shows a corner in the Aerodynamics Department of the National Physical Laboratory at Teddington.

Fundamental studies in aerodynamical science, combined with routine and special test work for the British aircraft industry, are the man functions of this department.

Three heavy-duty air compressors are needed to develop the required pressure (25 atmospheres) in the wind tunnel. Full pressure may be developed in one hour.

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.

Bronzing Powders

I AM very interested in burnish bronzing as used on modern picture frame mouldings—I mean the effect obtained with bronze powders (not gold leaf). Can you tell me what method is used for adhering the bronze powder to the frame, also the method of fixing or protective finish?—L. Crowson (Woodford Green).

IN making up the so-called gold-paint from pale gold and other bronze powders, a thin solution of celluloid is commonly used, the bronze powder being worked into a little of the solution immediately before using. This gives the bronze perfect adhesion to the frame moulding, and provided that the celluloid solution is not too thick the bronze dries with a perfect matt surface.

Celluloid or cellulose solution is obtainable from most big paint stores, being retailed under the name of "clear cellulose lacquer." You can make it yourself by dissolving clean, clear scrap celluloid in a mixture of approximately equal volumes of acetone and amyl acetate, or in cellusolve alone. These solvents are obtainable from Messrs. A. Boake, Roberts & Co., Ltd., Carpenters Road, Stratford, London, E. If you require an additional finish, merely paint a little of the thin varnish (or of any other clear varnish) over the bronze after it has become thoroughly dry and set.

Bronze powders of various shades are obtainable from Messrs. Johnson and Bloy, Ltd., Metana House, Hind Court, Fleet Street, London, E.C.4. They are rather expensive, as you are probably aware.

Transparent Plastics : "Radio Crystals" : Chromium Plating

COULD you oblige me with information about the following?

(1) Is it possible to liquefy the transparent plastics Perspex or the American counterpart Plexiglass so that it can be moulded into blocks? If so what chemicals are required?

(2) What chemicals and quantities are required to make radio crystals?

(3) In your September issue you gave the formula for chromium plating. Can you please instruct me on the time it takes to plate the various articles? Must the water be distilled or can ordinary tap water be used?—J. A. Paul (Kensington).

(1) The transparent plastic materials cannot be liquefied. Under conditions of heat, they become discoloured and lose their transparency. They can only be moulded initially by the manufacturers at the time of their first production. If you wish to prepare a block of the material, you would have to cement several pieces together with a cellulose cement, but, in such an instance, the transparency of the material would suffer.

(2) By "radio crystals," we presume that you refer to the rectifying elements of crystal receiving sets. These crystals are not manufactured, except in the instance of carborundum, which is very seldom used at the present day in crystal receiving sets. The rest of the "crystals" are, nearly always, fragments of naturally-occurring minerals, which are specially selected and tested in small batches for their radio-rectifying properties. By far the commonest of these crystals is galena, which is a naturally-occurring lead sulphide. This forms the bright, silvery, many faceted crystal so well known by wireless experimenters.

All these crystals or minerals are obtainable from laboratory furnishers and chemical suppliers, as, for example, Messrs. Philip Harris & Co., Ltd., of Birmingham, or Messrs. Barrington Brothers, Ltd., 4, Oliver's Yard, 53a, City Road, Finsbury, London, E.C.

(3) With a well-balanced chromium-plating bath, the time taken to plate any given article depends upon the thickness of plating which is required and, also, upon the amount of *amperage* (not voltage) of the current passing through the bath. Let us say that an average chromium plating on brass has a thickness of 0.0002in. With an amperage of 80 per square foot of plated surface this thickness of chromium would require about 50 minutes for its deposition. If the amperage were doubled the time required for the deposition of the metal would be halved.

Ordinary tap water is perfectly suitable for making up a chromium plating bath. It is chiefly in the case of silver-plating solutions that distilled water should be used, particularly in the London area where the water is excessively hard.

Telescope Objective and Eyepiece

I HAVE a 10in. f/4.5 lens from which I wish to construct a X 12 telescope. Could you tell me the type of eyepiece required, and whether the whole thing is a practical proposition?—A. R. Turpin (Banstead).

YOUR scheme is practicable, although your proposed telescope will be rather unduly heavy with its 10in. f/4.5 anastigmat lens used as the objective of the instrument.

The magnifying power of a telescope depends on two factors. First, the focal length of the objective and secondly on the magnifying power of the eyepiece. The longer the focus (focal length) of the objective, the greater the light-gathering power of the instrument and the greater its "distance penetration."

With your 10in. objective you would be best advised to use a 1in. eyepiece, and this will give you a magnifying power of X 10. For a higher magnification you will have to increase the power of the eyepiece, but, in the instance you quote, this is not advisable. You must remember that an ordinary eyepiece will give you an inverted or upside-down image, which, although suitable for astronomical purposes, is useless for terrestrial observation. Hence, you will require an "erecting" eyepiece to re-invert the image. Such eyepieces are usually systems of four lenses.

You will require a total tube length of about 15in. and the inside of the tube must be dead-blacked with a dead-black compound paint obtainable from Messrs. Johnson & Co., Ltd., Photographic Manufacturers, Hendon, London, N.W.4, or through any photographic dealer.

Astronomical (or "direct") and erecting eyepieces of various powers are obtainable from Messrs. Broadhurst, Clarkson & Co., Ltd., Farringdon Road, London, E.C.4.

Solutions for Silver Plating and Nickel Plating

I HAVE prepared a silver-plating solution, using nitrate of silver, to which I have added a solution of cyanide; this causes a "curdling," which does not appear to be correct, although I have done a certain amount of plating with the solution. Can you please advise the correct method of preparing a bath capable of turning out first-class work, and how does one know when the solution contains no silver nitrate, as I have found it is possible to plate using a cyanide solution only? I wish to make up a bath of about two gallons, and would like to know what quantities of nitrate and cyanide to use.

I should also be glad if you can advise the method of preparing a bath for nickel plating, giving quantities for a solution of about two gallons, and also the best method of cleaning articles to be plated. I am at present boiling the articles in cyanide, finally scratch-brushing them under running water and then placing them in the plating bath, using a D.C. current of 2 volts obtained from a car accumulator. My nickel plating has not been very successful, the articles coming out of the bath black. I am told they should emerge white, and require very little buffing providing the surface prior to being placed in the bath was good.—E. Jones (Manchester).

SILVER cyanide should be soluble in an excess of potassium or sodium cyanide, so that the whitish "curd" or precipitate which you obtain should dissolve completely on the addition of further cyanide. If it does not do so, it points to the cyanide being impure, which is often the case.

The following silver-plating bath has been well recommended: Silver nitrate, 3 ozs.; potassium cyanide, 4.3 ozs.; sodium carbonate, 6.4 ozs.; water, 1 gallon.

The sodium carbonate is not essential, but its effect is to increase the conductance of the solution and also its throwing power. The presence of the carbonate also tends to give a finer "grained" silver deposit.

Use an anode of *fine* silver, *not* sterling silver, since sterling silver contains about 7.5 per cent. of copper.

A fairly slow rate of current is advisable. Use about 3 amperes per sq. ft. of surface to be plated, but, in any case, do not exceed 6 amperes per sq. ft.

Provided that a silver anode is used, the bath will always contain dissolved silver, and the rate at which the silver is being used will be indicated by the rate of solution of the anode.

The following is a good nickel-plating bath: Nickel ammonium sulphate, 4 ozs.; nickel sulphate, 8 ozs.; water, 1 gallon.

This should be worked with a pure nickel anode at the rate of 5 or 6 amperes per sq. ft. of surface to be plated.

The fact that your nickel-platings are coming out black indicates one or more of the following factors: (a) Use of impure chemicals or a faulty balance of chemicals. (b) Use of an impure nickel anode. (c) Solution used too warm. (d) Too heavy a rate of plating. Possibly, you will find causes (b) and/or (d) operative in your case.

If you are doing plating jobs seriously, it is every bit well worth while to take the trouble to employ pure anode material only. Such material can be obtained from a good firm of specialists in platers' supplies, such as Messrs. W. Canning & Co., Ltd., Great Hampton Street, Birmingham.

Regarding the cleaning of articles to be plated, scratch-brushing is hardly to be recommended at any stage, since it often produces scores on the articles which are never afterwards eliminated. The exact mode of pre-cleaning depends upon the nature of the metal articles, the type of metal and the extent of the dirt. Sometimes an acid dip is sufficient. At other times a degreasing in caustic soda or even sodium carbonate solution is sufficient, the soda solution being used hot. It is certainly good practice to immerse the articles in a cyanide bath immediately previous to plating, the articles being given a good rinse before being placed in the plating bath. It is, however, a little dangerous to use a *boiling* cyanide solution, for in this instance there may be traces of hydrocyanic acid gas above the cyanide solution, which gas, as you are no doubt very well aware, is *excessively* poisonous. A slightly warm cyanide solution should do all the work which you require of it.

The deposited plating on articles takes the form of the under-metal surface. If the under-metal surface is bright and lustrous, so, also, will be the plated surface. On the other hand, if the under-surface is "flat" and dull, the plated surface will also be dull and will require buffing to bring it up to a polish.

Rewinding Field Coils of Motor

WOULD you please supply the following information? The size and weight of wire required to rewind a Rotax 12 volt car starter as a ¼ h.p. 210 v. 50 cycles single-phase motor. Also, could the armature be used without a rewind? Would the position of the brushes have to be shifted?—L. C. Offiler (Bristol).

THE simplest way of using the motor would be to wind each of the field poles with as many turns as possible of 23 s.w.g. S.S.C. enamelled wire, all the coils being connected in series, so that adjacent poles have opposite magnetic polarity, the whole set of field coils being fed from the mains. The existing armature could be used, the two brush holders must be connected together, and experiment will have to be made to determine the best brush position. The spacing between the brush holders should be unchanged, but you may find the best results are obtained with the whole set of brushes moved 40 to 50 degrees in one direction or the other. The motor can be reversed by moving the brushes.

You may also find it an advantage to use thinner brushes, and to fit brushes of comparatively high resistance, such as the IM3 brushes made by Morgan Crucible Co., Ltd., of Norton Works, Woodbury Lane, Norton, Nr. Worcester. It should be realised that this type of machine is far from ideal for conversion to an A.C. motor, and you may find it necessary to connect a small bowl fire in circuit with the field windings in order to avoid overheating.

Silvering Glass

I WISH to render some glass surfaces half-reflective. Could you supply me with a process for chemically silvering and half silvering glass surfaces?—F. Bannister (Bristol).

SILVERING glass is not an easy process. It requires skill and patience, for which reason it is always advisable to make trials on scrap pieces of glass before commencing the silvering proper.

The following solutions are required:

(A) Dissolve 175 grains silver nitrate in 10 ozs. distilled water.

(B) Dissolve 262 grains ammonium nitrate in 10 ozs. distilled water.

(C) Dissolve 1 oz. caustic soda in 10 ozs. distilled water.

(D.) Dissolve ½ oz. pure sugar in 5 oz. distilled water. Then add 26 grains of tartaric acid. Boil in a flask for 10 minutes. Cool. Add 1 oz. of rectified spirit (*not* methylated spirit). Then dilute with distilled water so as to make up the total volume of the solution to 10 ozs.

The silvering mixture is made by mixing together 4 ozs. of Solution A, 4 ozs. Solution B, 4 ozs. Solution D. Finally, add Solution C *very slowly*, stirring well, until the precipitate which is first formed dissolves and the whole of the solution assumes a slightly brownish tint. In this condition, the mixed solutions are on the verge of depositing silver and must be used immediately.

The glass to be silvered must be laid in a dish and the mixed solutions poured over it. In the case of half silvering such as you require, it will be best to add to the mixed solution about a third of its bulk of distilled water in order to slow down its silvering action. Within about half a minute, the "half mirror" which you desire should have been formed on the glass. The glass is now withdrawn from the dish and rinsed carefully in water, after which it is air dried.

It is, of course, absolutely essential that the glass surface to be silvered must have been most scrupulously cleaned with soda, and afterwards with acid, so as to remove every trace of grease and dirt. It is advisable, also, immediately prior to silvering, to pour on the glass surface a dilute solution of stannous chloride and afterwards to rinse it off with distilled water. Note that distilled water must be used in all these silvering operations. Ordinary water tends towards a cloudiness of deposit.

For normal silvering, the mixed solutions described above are used undiluted.

Once used, the solutions cannot be employed again. The separate solutions will keep in good order for a long time if stored in clean bottles, but the life of the mixed solutions is not more than 3 or 4 minutes. Hence, they must be used immediately after mixing.

Invisible Inks

COULD you please give me a formula for a sympathetic ink, which could be developed with a gas not so pungent as sulphuretted hydrogen? I require this for conjuring purposes, and have been writing with a dilute solution of lead acetate, putting the paper to develop in a clear glass cylinder containing the sulphuretted hydrogen which as you know has a very unpleasant odour.—A. G. Hollins, (Newcastle).

THE only other gases which you can use for the development of invisible inks are iodine vapour and ammonia. Iodine vapour, for conjuring purposes, may not be satisfactory, because it is violet in colour. It is used to develop writing which has been done with a solution of ordinary starch. A few crystals of iodine placed at the bottom of a glass cylinder standing on a warm plate or in hot water should develop only a slight vapour which, regarded from a distance, would be practically colourless.

Ammonia vapour can be used to develop up to a blue colour writing which has been made with a very dilute solution of copper sulphate.

You are possibly aware, also, of the modern dry-development "Ozalid" photographic papers, which, after exposure to light under a negative (or positive) are almost instantaneously developed to a strong brown or black colour through exposure to ammonia fumes. If you can "pre-print" your written matter on papers of this type, even weak ammonia vapour will develop them, and the slight odour of this vapour can be masked satisfactorily by having on the conjuring-table a burning joss-stick or incense pastille. The Ozalid Company, Birmingham, are makers of these printing papers. Possibly they will not supply retail, in which case you will be able to get them through a good photographic firm such as Messrs. Jonathan Fallowfield, Ltd., Newman Street, London, W.1.

Hand-cleansers

COULD you give me some advice about any liquid or special kind of soap for the hands. I am taking a course in draughtsmanship, and I cannot keep my hands clean enough to do my drawing work without getting smudges on the paper. I do oily and stained work, and it is impossible to get my hands clean with soap and hot water.—D. Elliott (Apsley).

IT is possible to make a number of excellent hand-cleansers of the type you indicate, but the great trouble at the moment lies in obtaining the necessary raw materials for this purpose. A good and fairly easily made hand-cleanser is made according to the following formula:

Trichlorethylene	5.7 parts (by volume)
Paraffin oil;	26.0 "
Acetone	2.6 "
Solvent naphtha	17.2 "
Triethanolamine	11.0 "
Oleic acid	23.0 "

The above ingredients are mixed and, if desired, a little suitable perfume essence may be added in order to mask the odour of the paraffin and naphtha.

The mixed ingredients are then very rapidly stirred and water (approximately 14.5 parts) is slowly added until the mixture acquires a jelly-like consistency. It is then stored in wide-mouthed bottles for use as required.

To use the above hand-cleanser, place a small "blob" of the jelly on the palm of the hand and rub it well into the skin of both hands, well rubbing it into the finger-nails. Then wash it off with hot soap and water. Every trace of dirt and grease will be removed from the hands in one operation.

Since it is very probable that you will not be able to obtain the above ingredients yet, we would advise you that Messrs. Alexander Duckenham & Co., Ltd., Duckenham House, 16, Cannon Street, London, E.C.4, manufacture a hand-cleanser of a similar type to the above. This is still being produced, and we believe that you will be able to obtain small-sized packages of about a pint of the material from this source. The Duckenham hand-cleanser is very excellent stuff, albeit rather expensive, but it is just the thing which you are seeking.

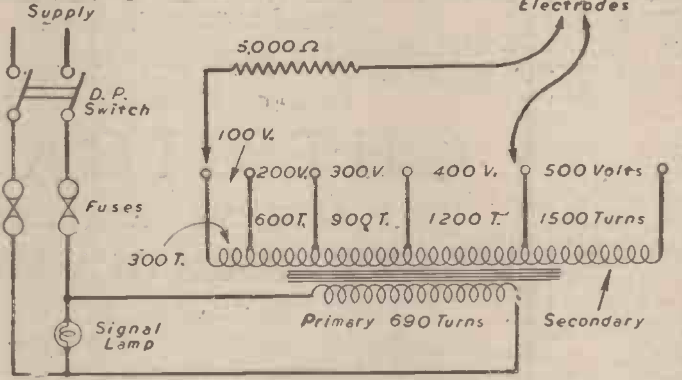
A 1,000-volt Flash Tester

I AM about to make a 1,000-volt flash tester for the testing of electrical appliances, operating on 230-volt A.C. 50 cycles.

Could you please supply me with a circuit diagram, and any details of components required? I wish to put a lamp in circuit to warn of earths. —C. W. Laight (Birmingham).

FOR your test unit you could use a double-pole switch and fusebox, red signal lamp to indicate the transformer was "alive," high-voltage transformer, resistance to limit the fault current, and test electrodes; these being connected as indicated in the diagram. With regard to a lamp for indicating faults, we consider a better plan would be to rely on the melting of a 1 amp. fuse in the primary circuit in the event of an earth fault.

A useful transformer for testing at 100 to 1,500 volts by 100-volt steps could be constructed on a core of 2½ sq. in. sectional area, this being wound with a primary coil having 690 turns of 21 s.w.g. enamelled wire with a thin layer of paper between each of the layers, and a secondary coil having 4,500 turns of 30 s.w.g. D.S.C. wire, with tappings as indicated. A resistance of 5,000 ohms is advisable in the secondary circuit.



Circuit diagram of a flash testing unit.

Running a D.C. Generator as a Motor

COULD you tell me if it is possible (without major alteration) to run a generator as an electric motor? The generator is made by the Lancashire Dynamo and Crypto, Ltd.; it is a D.C. machine, 14-32 volts, 9 amps., speed 2,500 r.p.m.; rating continuous. Electricity supply to run motor is 240 volts, 50 cycles, A.C.—G. Harrop (Worcester).

IN general, it may be said that a generator can be run as a motor on approximately the same D.C. voltage with little or no alteration. It is, however, quite a different proposition to run a 14-32 volt D.C. generator as a motor from 240-volt A.C. mains. The armature and field coils would have to be rewound, unless you can rewind the field coils and feed the motor at low voltage through a transformer. In any case, if the field iron system is not fully laminated, as it probably will not be, the converted machine would be likely to overheat on prolonged running on A.C.

If you are considering a rewind, we should like a fully dimensioned and descriptive sketch of the field iron system, including the air gap clearance between armature and field poles (which may be measured by means of feeler-gauges). We should also require to know the number of armature slots and commutator segments.

Dark Finish for Aluminium

I SHOULD be glad if you will tell me of any way to oxydize or give a dark finish to an aluminium fitting for an oak door.—G. H. Mills (Basingstoke).

A BLACK colour may be obtained on aluminium by dipping the articles in a hot, medium-strength solution of caustic soda for about 15 seconds and, after rinsing them, by immersing them for 20-30 minutes in the following solution:

Potassium (or sodium) permanganate ..	½ oz.
Nitric acid	¼ oz.
Copper nitrate	2 oz.
Water	½ gallon

The temperature of this solution should be about 175 deg. F.

After immersion, the articles should be well washed, dried and lightly lacquered over with a clear lacquer.

The purpose of the prior caustic soda immersion is to obtain a perfectly clean surface of metal.

The articles may also be blackened electrolytically by depositing a film of black nickel on them. This is effected by the following electroplating solution:

Nickel ammonium sulphate	4 oz.
Zinc sulphate	1 oz.
Sodium (or potassium) sulphocyanide ..	1 oz.
Water	½ gallon

E.M.F., 1 volt; current density, 1-2 amperes. Use a nickel anode, the article under treatment being the cathode. With use, the solution will become acid. This should be neutralised by the addition of a little zinc oxide from time to time.

Mixing Coloured Powder with Tar

WILL you please tell me how to mix a powder like yellow ochre with coal tar? I have heated the tar and tried to mix the powder with it, but the powder remains in little pockets in the tar. Is there any solvent for the powder so that the resulting liquid can mix thoroughly with the hot tar?—E. Verrall (Chichester).

THE probable cause of your trouble in incorporating a yellow ochre powder with ordinary coal tar is moisture in the ochre powder. This moisture repels the tarry oil and results in particles of the powder "balling" together into lumps which become coated with a skin of tar and thus hold tenaciously together in the manner which you mention.

The remedy is to dry the powder completely in a hot oven before incorporating it with the tar. Twenty-four hours' drying may be necessary, for many of these powders contain up to 10 per cent. of moisture.

Take the total quantity of dried powder which you wish to incorporate with the coal tar, and add to it a small quantity of the coal tar, little by little, so as to make up a stiff, homogeneous paste. Then add this paste slowly to the main bulk of the coal tar. In this manner you will get perfect mixing without any "balling" of the powder particles.

"Composition" Floors

I SHALL be grateful for any information on the following subjects:

(1) What is the composition of a floor covering which is hard, takes a high polish and which, I believe, consists mainly of wood, sawdust and cement?

(2) What is the composition of the well-known asbestos cement sheets?—C. Thorpe (Huyton).

(1) "COMPOSITION" floors of the type you mention are usually compounded on a "magnesium oxychloride" basis. They are of extremely variable composition and may incorporate a varying number of inert materials. The following is an average method of compounding such composition material:

Calcined magnesite	1 part (by weight)
Fine limestone, slate, emery, glass, brickdust or other inert powder	1 " "
Sawdust, powdered rubber, leather, asbestos, hair or other fibrous material ..	1 " "

The above material is thoroughly mixed and then slaked to the consistency of mortar by a solution made by dissolving 40 parts of commercial magnesium chloride in 60 parts of water. The resulting material is laid with a trowel. It sets dead hard in two days.

The necessary calcined magnesite and magnesium chloride can be obtained from Messrs. Harrington Brothers, Ltd., 4, Oliver's Court, 53a, City Road, Finsbury, London, E.C.1.

(2) Asbestos cement sheets can be made up on the above magnesium oxychloride basis, but they are more generally made by mixing 1 part of Portland cement, 1 part fine inert "filler," such as limestone powder, and 1 part of asbestos powder, this mixture being slaked to the consistency of mortar with ordinary water.

Flashlight Powder

WILL you please tell me what chemicals are used in the manufacture of flashlight powder, and where I can obtain them?—R. Ashford (Pelsall).

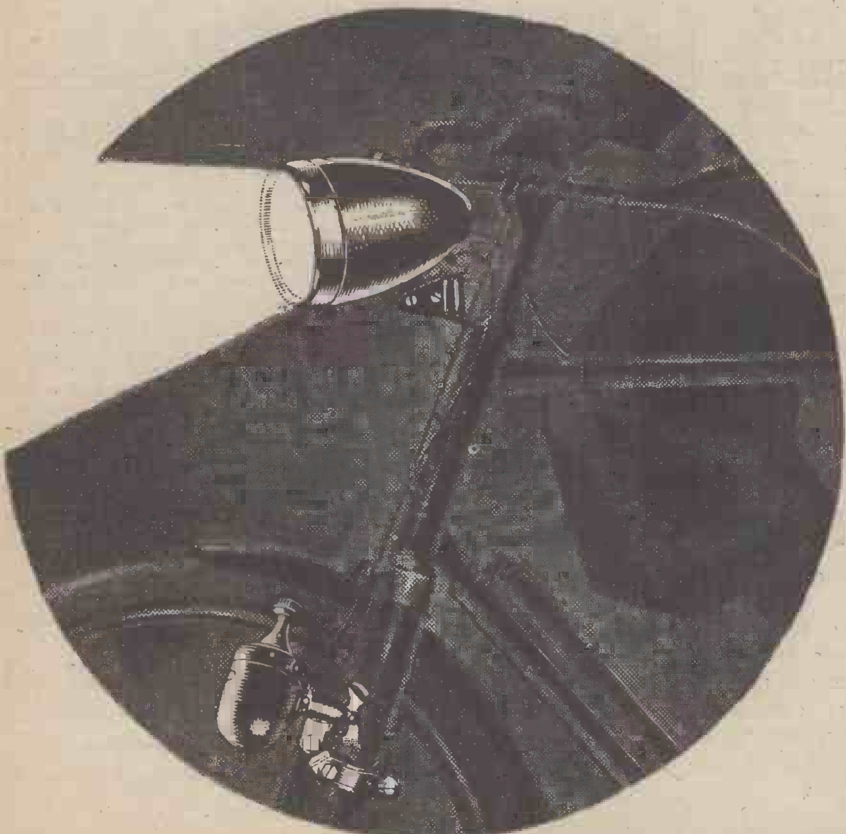
A FLASHLIGHT powder can be made according to the following formula:—

Magnesium powder ..	16 parts (by weight)
Saltpetre	12 "
Potassium perchlorate ..	12 "

Alternatively, you can make a flash powder by mixing equal parts of fine magnesium powder and saltpetre, but this is rather more difficult to ignite than the foregoing powder.

Flashlight powder making is a rather dangerous operation. All the ingredients *must* be absolutely dry and they *must not* be ground together. If any grinding is necessary to get a fine powder, the grinding must be done separately. The ingredients are best stirred together in a dry basin by means of a feather. When perfectly admixed, the powder must be stored in cans having tightly fitting lids.

The above materials are obtainable from any firm of chemical suppliers. Perhaps you may find one in your nearest big town. If not, try Messrs. Harrington Brothers, Ltd., 4, Oliver's Yard, 53a, City Road, Finsbury, London, E.C.1, or Messrs. A. Gallenkamp & Co., Ltd., 17-29, Sun Street, Finsbury Square, London, E.C.2.



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Comments of the Month By F. J. C.

Proposals for a Road Policy

THERE are curious people in the cycling as well as the motoring and pedestrian "movements" who think that the traffic problem can be solved by abolishing or penalising all other forms of transport or road users except themselves. Each of these interests provides solutions to traffic problems which do not take themselves into account. We are all aware of the fact that the growth in road mileage has not been in proportion to the increase in vehicular traffic, and we all know that cyclists now number about 10,000,000 and motorists between three and four millions.

In August, 1938, the County Surveyors' Society put forward proposals to the Minister of Transport for a scheme of motorways, and they thought that that represented the minimum programme upon which preparatory work should be undertaken without delay. The society stated their proposals in the following terms:

"That the society, having considered the views of the members . . . are of opinion that an adequate study of traffic movement information would indicate that a certain number of entirely new roads is a necessity and further that the number of such new roads would not be large.

"That completely new through roads with adequate connections to existing centres of population may, in the opinion of the society, prove more economical in construction and use than the widening of existing main arteries to the same standard, and that the segregation of motor vehicle traffic from all other forms of traffic would tend towards a substantial reduction in the number of road accidents; further that the construction of motorways for motor traffic only would be substantially cheaper than the construction of roads for all forms of traffic.

"That the new motorways should be constructed as complete units and not in short lengths.

"That the new motorways, together with other arteries of trunk road value, should form a co-ordinated system for through traffic and that the whole of the construction and improvement work therein should be controlled by a time programme.

"That existing methods of administration should be improved in the direction of speedier execution of works and the elimination of irritating delays.

"That, in the society's opinion, new roads and motorways, carefully designed in relation to the landscape and its preservation, whilst not causing injury to amenities are likely in time even to improve them. On the other hand, the widening of existing roads, with the attendant demolition of property, will in many cases offend against amenities.

"That a committee of the society be set up to prepare, for the consideration of the society, a plan for a national system of motorways for the whole country.

"In accordance with the above resolutions, the society have given the matter their most careful consideration, and now submit their recommendations."

National Motorways

THE society's recommendations comprised the construction of the following motorways which they consider may form the foundation of any national system: North Orbital Road, Dartford to north of Hatfield; London-Scotch Corner-Glasgow, with spur to Newcastle; London-Birmingham-Carlisle; Doncaster-Birmingham-Carlisle; London-Reading-Bristol-Swansea; London-Southampton-Portsmouth; Manchester-Hull.

These routes have a length of approximately 1,000 miles and from an engineering point of view are considered to be practicable and can be constructed on the motorway principle for about £60,000,000, or could have been in 1939! These proposals have been framed to meet the ordinary commercial needs of the country, and no regard has been given to the need evinced since they were made for motorways for the purpose of national defence.

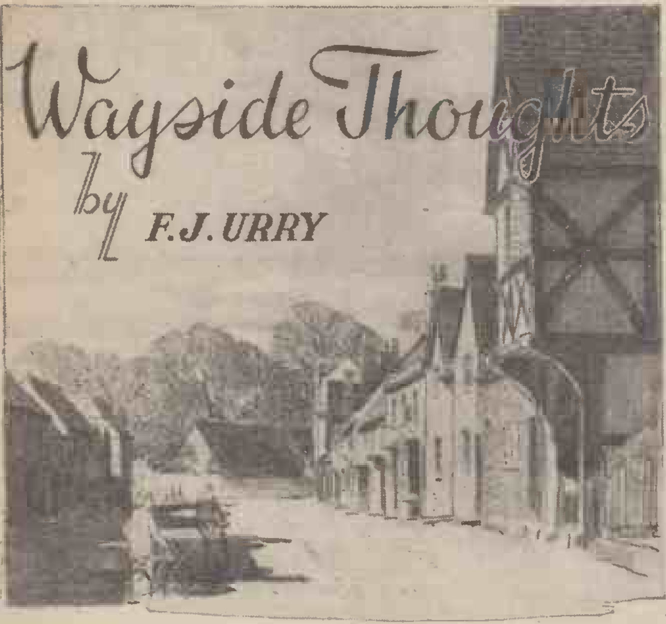
Lord Justice Scott's committee expressed the opinion that hitherto the planning of main roads and railways has remained separate from planning control and has not even been fully co-ordinated with town and country planning. The building of new railways is not likely to be a big factor in the future, but roads form an integral part of town and country planning and cannot be divorced from it. "We consider that the complete elimination of railway level crossings on important roads is long overdue and that the construction of bridges is very important. Many old railway bridges form serious obstacles on roads as well as danger spots and should be rebuilt."

The Institution of Municipal and County Engineers stated: "In considering communications the fundamental principle should be to encourage and assist every form of transport without regard to sectional interests. Transport and travel by road which has increased enormously during the past twenty years will continue to grow, and in post-war development roads must play a very important part both in the physical planning and in the recovery and readjustment of industry. During the war other advantages have become evident, other advantages beyond those of direct transport from point to point; speed and reliability in delivery have become evident, such as the use of alternative routes in overcoming disorganisation due to air attacks. While the condition of roads has been generally improved and many have been widened, progress has not kept pace with growing traffic needs. The provision of motorways is one of the most important matters for consideration." It can, however, be said that legislation has more than kept pace with development. In fact, it has been the policy of the Government for years past to presume that roads need not be improved much, but that our obsolete road system can be made to work by restrictive legislation.

The Institution of Highway Engineers said: "The main requirements of the re-planned highway system are that it should provide a means of safe, speedy, cheap and comfortable transportation of people and goods between the main centres of population and industry, wherever they now exist or where they will ultimately exist under the basic national planning scheme. In our opinion, a road system which will fulfil these requirements is one which provides: A skeleton network of high-speed roads to accommodate long-distance mechanical transport; a secondary system of mixed traffic roads connecting neighbouring industrial areas and serving as feeder roads to the main high-speed routes and as link roads connecting such routes and existing trunk roads on the outer ring of centres of industry and population; local parkways accommodating all classes of road users from industrial areas to recreational centres; minor roads to serve mainly local requirements.

Ring-roads and Arteries

NOW let us see what the Ministry of War Transport has been saying. "The Ministry of War Transport is far advanced with the plans for the post-war construction of ring-roads and radial arteries on which only fast moving motor traffic would be allowed. The change from horse-drawn to motor transport has been so gradual (sic) that we have allowed every kind of traffic to remain mixed up on the same old system of roads managed on the same old principles as before. . . . It cannot be doubted that the motor vehicle must also be segregated from other kinds of traffic on the road. . . . Such a programme might take many years. It would cost a lot of money, but in time saved, in leisure, in health and in the productivity of labour it would mean a return of at least £25,000,000 a year. On economic grounds the great capital expenditure necessary would be justified, and I am convinced that within the next thirty years these roads would be built." These are the words of Mr. P. J. Noel-Baker when he was at the Ministry of War Transport. Now, whilst all these pious hopes and resolutions have been made and perhaps served their purpose in placating public opinion, nothing is being done, and it seems unlikely in view of the economic situation that anything will be done for some years. We have the plans, but not the money or the men to put them into effect. In other words, the traffic problem, the traffic muddle, the accident and the slaughter must be a concomitant part of road traffic for many years to come. Instead, therefore, of national bodies wasting their time pointing accusing fingers and finding solutions which have already been found, they might confine their attention for a little while at any rate to impressing on the Government the need for putting existing plans into effect.



A Privilege

I NEVER remember a more glorious October than that of 1945. It really made for us some return of the short sunshine of the summer, and painted glory over field and wood, and made our slender daylight beautiful. It also made me a trifle jealous, too, when towards the end of the month I saw a S.E.A.C. man ride off on my tandem for three weeks, wandering round Devon and Cornwall. He and his companion in arms were just home from Rangoon after three years of jungle fighting and their first thought, after home celebrations had been duly completed, was to find a machine to take them—plus a little muscular activity—over the moors of Exe and Dart, and down to the restless sea at places like Lynmouth, Clovelly and Boscastle. How lovely they must have looked in that brave October sunshine, and as I thought of it when the tail of the tandem wagged up the street, how fortunate I was to have the goods to offer to men who had done so much for me and my kind through the long aching years of war. At intervals a postcard appraised me of their progress, telling its little story of legs that wearied quickly during the passage of the early miles, and how they "trained-on"; and seats that gradually became accustomed to the shiny leather, and finally comfortable. So that tandem has gone another tour without its owner, and its record of such journeys must now be nearing a score. And once, just before September, 1939, I nearly sold it, which would have been a sorry error of judgment considering the joy it has been to other people and the fun I have obtained from their wanderings. They say if you share a thing, it, and the memories it brings, doubles the joy of possession; and I believe that to be true. It certainly is in this case, for a couple of warriors now know a little more of England and are happier men as a result.

The Real Thing?

I HEAR from a good authority that the B.S.A. Co. Ltd. intend to make the Sunbeam a replica of the old "John Marston" type, brought completely up to date. This is good news for the older rider or the professional man or woman who likes the best possible machine that will stand up to continual service in all weathers, and retain the appearance of high respectability for many years. The old type of oil-bath case is to be reinstated, I'm told; the gears, if any, will be the hub 3- or 4-speed, and the brakes will be the modern caliper type actuated by rod and lever. I do not know what the price will be, obviously a fairly high figure, for the Golden Sunbeam of immediate post-war No. 1 days was sixteen guineas, and there was no Purchase Tax then to reckon with. There is a call for this type of mount among riders who practise the good notion of dual or triple ownership, for then they have a machine at call to carry them through the rough weather with that silky slickness of running which only a leakless oil-bath case can give. My old Sunbeam has had years of that kind of treatment, and now that it has been rejuvenated I am surprised, every time I ride it, what a completely up-to-date appearance its quarter of a century of years exhibits. Candidly, I think if I had the luck to be going a long tour—especially in the fall, winter or spring of the year—it is the old Sunbeam I should select for the journey. For it goes shurring through the mud without a creak or rattle, it steers without effort—that's the 68 deg. angle—looks and acts the aristocrat in bicycles. High praise you may say; but after 25 years of personal use and numerous loanings, how can you say too well of a thing? If the B.S.A. Sunbeam equals, never mind excels, the old John Marston type, it will deserve well of the wheeling world and create a modern standard in cycling quality.

Sound People

THESE fellows who come back from the wars have very little to say about them. All I have met up to date are far more keen to talk on any subject except the one in which they were so dangerously engaged, and as most of them are old-time cyclists it is the countryside they want to know about, if so-and-so is still catering, and how does such-and-such a place look now that it has felt the impact of war by way of an aerodrome or camp. The toleration they exhibit towards their late enemies is wide and deep—never friendly—but that kind of feeling which makes one realise how small is the man who breathed fire and slaughter when he was safe from the firing line, as safe as modern war conditions allow a civilian to be. This is a good omen for the future, I think, and it is certainly a fine example to all of us to treat these lads and lassies with a similar toleration—only kindlier—with which they treat the defeated peoples. I like to think—and perhaps I am entirely wrong — that this happy trait in the nature of the returned warriors to whom I have talked and with some of whom I have ridden, is due in some degree to the fact that they were, and indeed are, cyclists, and their experiences have given them a wider outlook on many matters and a keener understanding that men count more than policies, and that nationalism is no excuse for bad behaviour. Certain it is that folk who love the country, its sights and sounds, and the way of nature have a background that seems to hold the elements of the eternal, and realise that the processes displayed today will be repeated again and again when they are covered with the dead level of obscurity. Under the moon of a calm November night I rode home with a man who left these thoughts in my mind. "Did it ever occur to you," he said, "how futile we are, and yet how lovely life can be for us in doing this?"

Too Bad

SOME months ago "The Hotel and Catering Management," in a note dealing with cyclists' behaviour, was a trifle severe, it seemed to me, on the young rider whose high spirits—and possibly war-time training or lack of it—had created for our movement a bad name. I hate to think there is some element of truth in the criticism, but am bound to confess from my observations since the publication of that paragraph that certain sections of our community do lack the decency to consider other people besides themselves. I called in for lunch at a well-known house not very long ago. The day was wet and I left my macs in the porch, which was easily sighted from the dining-room windows. Not so some half-dozen youngsters occupying the room. They were seated round the fire, their macs occupied a corner near, and some of them had their shoes and stockings hanging on several chairs with backs to the blaze. I did not need the warmth, as it happened, but no movement was made to invite me to share the flame, and it almost seemed as if my presence was resented. It was when the good lady of the establishment grumbled to me regarding the conduct of those boys that I found it difficult to defend their behaviour. I mention this now because the returnees from the Services can do much to cancel out the lack of manners both by precept and example. I know of one place where cyclists are not now welcome because of similar conduct. Now, we were well served by our caterers for many years, and surely we should return that service by the compliment of decent manners and the acknowledgement of many favours.

For Leisured People

I HAD an interesting letter from a retired friend, now living in Devon, who made a trip during the beautiful fall of the year through Central Wales for the purpose of a thoroughly enjoyable change, and to obtain a set of photographs of the wildest part of that wild land to complete his pictures of the area. "I am going by myself," he said, "and shall therefore have no one to worry me or hasten when I want to wait for the light, or climb the ridges to obtain a better perspective. And this lone travelling occasionally makes one intimate with many things when neither time nor miles have any lot or part in the day's performance. And then the inglenook at night with a book, or a quiet review of the hours spent and the hours to come, give you an association with life, via the bicycle, that becomes more compelling as you grow older." It is a very nice philosophy, and I should like to test it out more frequently than is possible in present circumstances. But I am bound to say that my pleasanter notions of cycling leisure—if that phrase is not a contradiction in terms—is to have the right companion on hand, the man who is in no hurry, who will take a chance if necessary, and whose silences on occasion can be as eloquent as polished phrases. For I believe enjoyment shared is enjoyment doubled, and the loveliness that two can see is greater and more distinctive to each than when alone. That I think is the common view, or surely we should not see the spectacle of people advertising for a cycling companion; and the only action I can think of more dangerous than this is advertising for a wife or husband. I like the tried and tested comrade, and if such is not available, then I prefer the lonely road. Yet I frankly admit that a few days of my own company make friendships seem all the sweeter.

Accommodation Troubles

CATERING and accommodation is going to be difficult in 1946, probably more so than during the war years, for there are more of us to go a-holidaying. I find it a little hard to make the lad home from foreign parts understand this, for when he left the country, many caterers, now out of business, were still functioning, and because the war is over for him, he thinks all the regulations are automatically cancelled or at least eased. As we who have been on the spot during the war years know full well, such is not the case; and I also know that many places are now full up for Easter and are swiftly filling all the summer dates. It is not surprising, except to the returnee, that circumstances are much the same as they were in 1919-20, when even a meal of sorts was often hard to come by. Camping and picnicking will become more popular than ever, and our return to "the straight tour" of the old days is likely to be delayed for at least another season.

Around the Wheelworld

By ICARUS

R.T.T. Council Meeting

THE agenda of the meeting of the National Council of the R.T.T.C. held on January 13th was a packed one, dealing with such diverse subjects as the date on which subscriptions should be due, the best all-rounder competition, national championships and, of course, massed-start racing.

One of the interesting resolutions by the Liverpool D.C. was to the effect that as soon as present clothing restrictions are relaxed, a standard regulation costume be introduced; and by the North D.C. that riders in time trials be allowed to compete in short-sleeved vests.

Tights, of course, which for so many years have represented the "inconspicuous attire" which the rule insists upon for racing cyclists, are going, and not too soon, for no one on the roads is more conspicuous than the racing cyclist dressed in tights.

It is noted that as old-timers pass on, their influence dies with them, and I for one am thankful for it, for too long have they exercised their pugnacity over a sport, merely because they want it continued on lines laid down in their youth. Most of the old men, who are endeavouring at the present time to direct a sport for youth, are merely useful as reference books. Their counsels are now unsound, warped and soured.

On the question of publicity, the National Committee proposed that Regulation 21 be deleted and the following substituted: "Promoting clubs shall not permit publication of preliminary notices specifying the intended date, time or starting-place of any event other than by the use of week-end numbers and course key-numbers. Subsequent reports of events must not disclose precise details of the course." Evidently the R.T.T.C. is determined in the year 1946 to continue the hole-and-corner, furtive methods of these frightened rabbits of the 1880's who were so scared of the police that they have been endeavouring to frighten cyclists ever since into the same frame of mind.

Massed-start Racing

ON the question of massed-start racing, the National Committee proposed: "That this Council is of the opinion that massed-start racing on the public highway, except as provided in the agreement with the N.C.U., is a source of danger and obstruction, and is likely to bring discredit upon the entire cycling movement. The Council continues to dissociate (as printed on the agenda the word *disassociate* is used !) itself from this form of racing and from the supporters thereof." Which is another way of crying sour grapes, for if they wanted to associate themselves with it they could not. Certainly no member of the B.L.R.C. is going to be worried about that. In my view, such a resolution is inviting a counter-resolution from the B.L.R.C. that in the view of the B.L.R.C., time-trials are just as dangerous or just as innocuous as massed-start races, and dissociating themselves from time-trials !

As neither the R.T.T.C. nor the N.C.U. has any experience of massed-start races, they are not entitled to express an opinion on it.

The C.T.C., on the other hand, does promote, through hard riders sections, massed-start events, and it is noted that the R.T.T.C. does not frame resolutions against such events, which are ridden at a higher speed, and without any controlling regulations, than massed-start racing. The National Committee in advancing this resolution, is merely endeavouring to prop up the jealous policy of the N.C.U.

The number of clubs, as at September 30th, 1945, affiliated to the R.T.T.C. was 480, but this does not include those clubs excused payments of subscription by district councils. It was decided that for 1945 the amount of the levy should be 3d. per rider for each event, as in 1944, but the National Committee ruled that the levies should not be payable by entrants in events where no awards, including certificates, are made by the co-ordinating body.

The National Committee are satisfied that the changes made in the conditions for the 1946 series of Championships, particularly so far as the effect of the British Best All-Rounder Competition is concerned, have had the effect which the Committee anticipated, in securing for the Championships a worthy and representative entry, and the decisions taken by the National Council meeting have proved to be sound and fully justified.

The Championships were allocated as follows:

25 Miles	..	Liverpool D.C.
50 Miles	..	North Midlands D.C.
100 Miles	..	Central D.C.
12 Hours	..	London North D.C.
Hill Climb	..	Manchester D.C.
25 Miles (Women's)		Midland D.C.

Since the National Championships were instituted it has been the aim of the National Committee that these events should serve as a model of efficient promotion. Whilst it cannot be claimed that the highest possible standard has been reached in every case, the experiences of the past season will be fully utilised, and new arrangements made where necessary, with a view to attaining the desired goal.

The following are the 1945 Champions:

25 Miles. Promoted by Liverpool District Council, June 17th, 1945.

Individual—C. Cartwright (Manchester Clarion C. and A.C.), 59.44.

Team—Calleva R.C. (A. E. G. Derbyshire, J. E. S. Simmons, D. S. Burrows), 3.8.8.

50 Miles. Promoted by Barnsley R.C. (N. Midlands District Council), August 12th, 1945.

Individual—J. Simpson (Barnsley R.C.), 2.5.57.

Team—Calleva R.C. (A. E. G. Derbyshire, L. C. Dunster, R. J. Brown), 6.31.33.

100 Miles. Promoted by Broad Oak R.C. (Central District Council), July 15th, 1945.

Individual—B. L. Smith (Yorkshire R.C.), 4.30.30

Team—Yorkshire R.C. (B. L. Smith, D. Heppleston, J. B. Cooper), 13.48.54.

12 Hours. Promoted by Polytechnic C.C. (London North District Council), August 26th, 1945.

Individual—D. Heppleston (Yorkshire R.C.), 241 miles 284 yards.

Team—Calleva R.C. (R. J. Brown, A. E. G. Derbyshire, W. A. Perkins), 701 miles 490 yards.

Hill Climb. Promoted by Manchester District Council, October 28th, 1945.

Individual—R. J. Maitland (Solihull C.C.), 3.0-2/5.

Team—Solihull C.C. (R. J. Maitland, R. W. Bowes, W. Moreton), 9.55-3/5.

Women's 25 Miles. Promoted by Wyndham R.C.C. (Midland District Council), July 1st, 1945.

Individual—Mrs. E. Sheridan (Coventry C.C.), 1.8.38.

Team—Pyramid R.C. (Miss J. Barlow, Miss E. Jones, Miss D. Cheetham), 3.39.53.

N.C.U. Activity in Scotland

IN a circular issued by Mr. A. P. Chamberlin, it is stated that the N.C.U. has been concerned for some considerable time at the lack of co-ordination of N.C.U. activity in Scotland. He recently paid a visit to Stirling, by invitation, and a number of clubs were represented. Arising out of this meeting it became apparent that Scottish clubfolk were indeed keen in every possible way, and only too anxious to keep the cycling game in a flourishing state in Scotland.

Arising out of his report, the whole question of Scotland was given the most careful thought and consideration, and the Committee have come to the following decisions, which they are prepared to recommend to the General Council of the Union at the forthcoming Annual General Meeting on March 23rd, 1946:

That the National Cyclists' Union in Scotland become an independent self-governing body within the framework of the parent body.

If the necessary arrangements could be come to, this would enable Scottish clubfolk to run their own events; handle their own finances; and, in fact, enjoy complete autonomy within the framework of N.C.U. rules.

Scotland would be able to run its own national championships; its own centre or area championships; fix its own centre boundaries to the best advantages, etc.

The membership fees would be apportioned as follows:

Club affiliation fee at 3/- per member; 1/6 to the Scottish body and 1/6 to the parent body.

Private members fee at 6/6; 2/6 to the Scottish body and 4/- to the parent body.

Family and junior private members at 3/6; 1/6 to the Scottish body and 2/- to the parent body.

Where the Associates are concerned, some arrangements will have to be come to, and details could be worked out when the scheme gets a little further ahead.

The National Cyclists' Union parent body, will, in return for its portion of the membership fees, do the following:

Pay full Third Party Insurance for each individual member.

Continue to give to affiliated clubmen and private members full legal aid as at present, together with full touring advice and assistance.

The private members will, in addition to the above, receive a free copy of the N.C.U. touring handbook.

Cyclists' Capes Not "Essential"

THE Board of Trade informs the National Committee on Cycling that cycling capes and leggings are not regarded as essential garments and are not included in the list of garments for which replacement coupons may be claimed when torn in road accidents.

"Unfortunately," states an official, "supplies are too short to allow coupons to be issued for the automatic replacement of all lost or destroyed clothing. Claims are only allowed, therefore, for the replacement of *essential* garments when the applicant's stock of remaining garments fall below a standard minimum level."

Take Off the Brakes

By R. L. JEFFERSON

A NATIONAL evening newspaper of recent date carried a headline of some significance to cyclists, to the effect that the Government were contemplating spending some money on sport, and even dabbling with the idea of nationalising it.

Unfortunately for us, cycling was not mentioned, which is perhaps not to be wondered at, the present condition of cycling sport being none too healthy on the tracks—if one may call them such. We have an organisation actively opposing any attempt at progress, or interest, by the man in the street, and on the road we have another organisation running time trials. These are more in the nature of specialist events for a group of conservative clubmen; the flattest courses are used, and the men enter with one ambition, a place in the B.A.R.

Now, this sort of thing is not calculated to further our cause with the public, or the Government. From an international standpoint it is fatal, and we have become as a cycling nation far too insular in our outlook.

The average young clubman can hardly be blamed for his lack of knowledge of international cycling; the conservative cycling Press seldom report foreign meetings, and if they do they very carefully leave out the attendance figures. The comparison with our own attendances would perhaps lead to awkward questions.

It will be admitted that we have now reached a period in history where isolation and all that it implies is as dead as the dodo. The wireless and the aeroplane have enabled people to hear and see things which were impossible only a short time ago, and the films have also done their part in enabling us to see how the other parts of the world live and play. As time goes on force of circumstances will make people of all nations draw closer to each other; the exchange of ideas is bound to be beneficial, and, above all, will have a broadening effect on our outlook.

Now, what can we as intelligent cyclists do to make our sport and pastime take its rightful place in the public eye of all nations?

Publicity Needed

Firstly, we need publicity. The only publicity cyclists have received in recent years was that accorded to the riders in the B.L.R.C. cycling marathon from Brighton to Glasgow last August. I think it is safe to say that the sport received more publicity during this five-day event than it has done for the past 25 years. To prove my point, I daily come in contact with scores of people who know I'm very keen on cycling, and many of these people during those five days asked me questions about gears, frames, angles, etc. The national newspapers had devoted some space to the event and these people were naturally interested. To them, as laymen, it seemed incredible that a bunch of cyclists could pedal from Brighton to Glasgow at all, let alone race. I took the opportunity to acquaint them with cycling facts and figures which astounded them; in fact, some had to be shown records in printed form before they would believe my statements.

Now, surely this is a very sad state of affairs from our point of view, and the remedy is to appoint a publicity agent who will see to it that our sport is fully reported in the national Press, and the public is encouraged to take an interest in it. He must also approach the trade and get them to back up the sport; also, he must be able to interest big sports promoters, men who are willing and able to promote events of international calibre.

Tracks and Stadium

Secondly, we need tracks. Can we honestly say that we have even one track on which the world's championship could be held? Definitely not. Herne Hill, for example, is badly placed, the banking and surface are inadequate for high speeds, the stands are antiquated, also dressing-rooms and other amenities.

What we need is a brand-new stadium centrally placed, with a cement track capable of taking motor-paced speeds, the spectators to be under cover, ample refreshment-rooms, dressing-rooms, car park, and all the other things which have come to be accepted as commonplace in every other sport except our own.

I personally believe that the B.L.R.C. can be the nucleus of an up-to-date organisation which can control cycling sport in a better and more modern manner than it has ever been conducted before. There is room for great improvement. When one looks around and sees the methods used to control our pastime it makes one sigh for a George Allison of cycling. People at present in control want things to continue as they have done for some years past. Now, if these organisations are supposed to represent cyclists over here, what are they going to do about getting back the prestige this country once had as a cycling nation?

Not all cyclists are bigots, or fools for that matter, and some of the youngsters look in the record tables and notice names such as Bailey, Meredith, Johnson, Marsh, etc. They note that these men have won world titles against all comers, some several times, and they also wonder why we don't seem to stand an earthly now in international events; we never will unless we get rid of the people who are throttling our sport.

There is now a gap of 23 years since we won a world title on the track, and since that time track sport has steadily declined until to-day it is little more than a farce, and utterly unrepresentative of this country as a sprinting nation.

It is only natural that such a long period without success must generate a definite inferiority complex in our riders who do compete against foreigners; they feel that they are licked before they actually start. Morally they are, as they've been so hidebound with ridiculous club events of no importance to anyone except the clubs concerned that when they do meet some real opposition with brains and speed they are hopelessly outclassed.

Ask any fair-minded clubman who saw a certain evening meeting before the war what he thought of it. The highlight of this particular meeting was a three-event match between Grassin, Grant and Paul Krewer. I think he will agree that he hadn't seen speed like that for years; as a matter of fact, the motor-pacers were nearly touching the railings in trying to get round the inadequate banking. Our own Harry Grant won after a wonderful exhibition of courage by Krewer, who punctured and then after changing machines almost caught Grant. The point I am trying to make in bringing up this particular meeting is that here was an Englishman competing on an English track against foreigners and beating them, *but he had to go abroad to learn how to beat them;* also, his world's hour record which still stands was made on a foreign track; there isn't one here on which he could do 56 m.p.h.

Controlling the Sport

We need people over here with big minds to control our sport, men like Harper, who is going to put Crystal Palace Football Club on the map; remember the opposition he had when he started to ginger things up. He was actually removed from the Board of Directors, but soon got back. Look at his club to-day, and *think*; if we can interest a man of that calibre he would soon get things moving for us. He had already shown the football fans one phase of cycling, bicycle polo, and they seem to like it; incidentally, the people who opposed him and his progressive ideas have been removed, and good riddance say the fans. These people who turn up each Saturday pay the piper and want results.

Constructive Suggestions

I expect readers will think I've done a lot of criticising and not offered many constructive suggestions, so here goes.

Let all cyclists interested in the sporting side get together, and have a debate, with no quarter asked or given. Get men like Bailey and Johnson to talk to you, and listen to *them*; *they* know, you *don't*. Results prove that. When you've thrashed the matter out appoint a committee of young-minded riders to demand a real track from your representatives, the N.C.U. If these people can't or won't give it to you join the B.L.R.C., and get them to form a track organisation of your own; the committee must then get the trade to finance the building of a suitable track in London; a professional class must quickly be built; the amateurs must train with the pros.; if necessary a continental coach would have to be engaged to teach us how to sprint. We may have to eat humble pie for a time, but if we persevere we will one day be able to lift our heads again and point the finger of pride at one of our own boys winning a world title.

I wonder how many cyclists know the kind of opposition "Major" Taylor had to contend with. He was bumped and pocketed in nearly every race he competed in, but he got through; he had that very necessary qualification we call "guts." One of the riders who was in a combination against the "Major," on being soundly beaten in company with his fellows, could not refrain after the event from shaking the coloured rider's hand and saying, "Mr. Taylor, you're the whitest man I've ever ridden against."

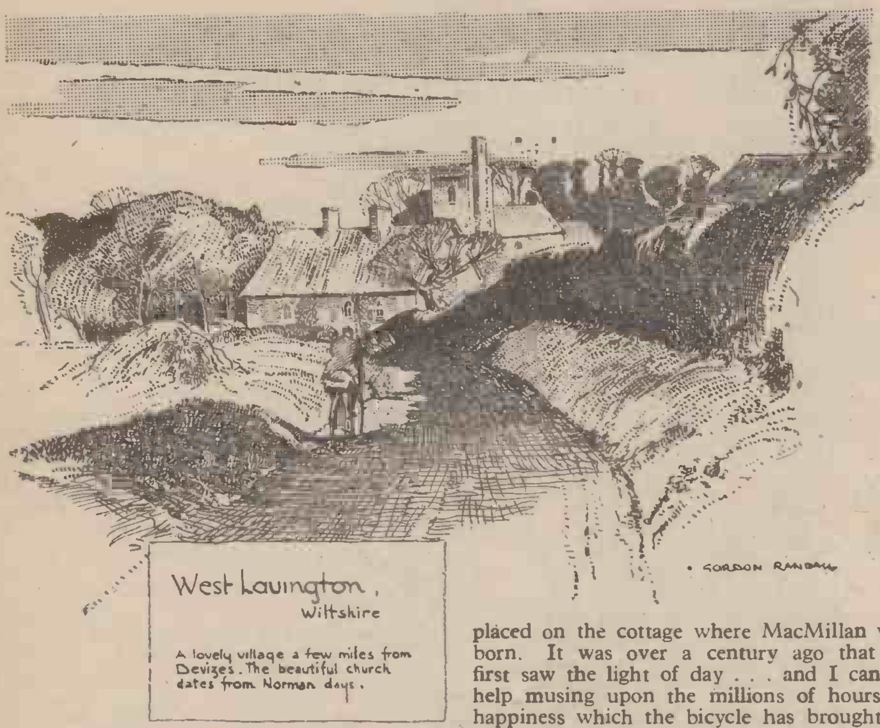
I have before me, as I write, the programme of the B.L.R.C. event previously referred to; each competing rider is given a little write-up, the events he has competed in are enumerated; and more than half the competitors have the ambition to represent this country abroad, and they are going the right way about it to do so. World titles on the road are decided on the massed start principle; the only way we will get anywhere internationally is to compete on these lines.

The trade will back up massed start racing if we promote it on a big enough scale; it's good business. They will also soon create a professional class, and can build the machines better than anyone in the world and, above all, they want our machines to be shown and sold abroad.

So let's all get together, and back up the organisation which is trying against odds at present to put us on the map. Join the B.L.R.C., and agitate for the things I have enumerated, and one day not very far distant the name of a "Tom Brown" of cycling will be as popular as Tommy Lawton of football.

CYCLORAMA

By H. W. ELEY



Enthusiasts for Winter

AS an old nature lover . . . in whatever her mood . . . I am always a little surprised when a cyclist, or a walker, or a swimmer, tells me that he or she is "packing up" for the winter. It presupposes that when colourful autumn says farewell, all the joys of the English countryside are over. Now, nothing could be farther from the truth! For the cyclist I vow that there is no more enjoyable ride than the one on a winter's morning, when the rime is on the hedges, when there is a real nip in the air, and when one may see the bare beauty of outline of trees lovely in their nakedness. And as a remedy against colds and chills and all manner of ailments, commend me to winter cycling—it puts warmth into your limbs, gets the circulation going, and is an antidote for all kinds of ills. The other day I met an old man, a life-long cyclist, who combined a love for riding with a love for a winter swim . . . and he recounted how, four mornings every week, he rode to a pool and had his before-breakfast dip. He was, he afterwards told me, 74 years of age! But he loved the winter, and would not hear of any theory that winter-time is less beautiful than spring or summer. "Each succeeding season has its charms," he said . . . and I shall long remember his stories of rides in the Chilterns when the valleys were blocked with snowdrifts and when the whole Buckinghamshire countryside was silent under a white mantle.

A Shrine in Dumfriesshire

YES!—it should be a shrine visited with veneration by many cyclists, for it is a cottage where lived Kirkpatrick MacMillan, who is accepted as the authentic inventor of the bicycle. There have, I fancy, been rival claims for the honour, but I also gather that the experts give the palm to the Scottish blacksmith whose name I have given; and if, indeed, he did give us the bicycle, then his memory should be honoured and kept green. And I have heard rumours that some time next year there may be a plaque placed on the cottage where MacMillan was born. It was over a century ago that he first saw the light of day . . . and I cannot help musing upon the millions of hours of happiness which the bicycle has brought to men and women, and boys and girls. We do well to honour MacMillan, as some few years ago we honoured John Boyd Dunlop, the inventor of the first practicable pneumatic tyre.

A Question of Diet

I HAD an interesting little chat recently with some cyclists about the best form of food to eat when out riding—doing fairly long distances. There seemed to be a firm opinion that one of the most sustaining foods, easily carried and handy to eat by the wayside, was cheese. Personally I heartily agreed, and my only lament in recent times has been that cheese has been hard to obtain. There is an increased ration now, but even so I find the small portion allowed me by my good wife as a "snack for the ride" pitiably inadequate. Seated under a tree, after a good ride, I could—in the old days—always dispose of a goodly portion of bread and cheese, and actually I have always considered this homely diet as good as any for riding on. True, I have found bananas and chocolate good and sustaining . . . and I still believe that munching two or three apples is a fine thing. But ideas on dietary vary enormously, and I should like to hear the views of those who, by virtue of studying the question from a scientific angle, are qualified to speak on the subject. As to drinks—well, on a hot summer's day I swear by barley-water, but I am afraid that the lure of the picturesque village inn is strong, and I have "kept going" many a time on a pint of good ale in a wayside tavern.

Those Tourists from Abroad

FROM all sides I hear talk of the thousands of visitors from abroad who are coming to England—to see the little island which stood alone when Hitlerism threatened to engulf the world. I'm told they will want to see the beauties, the curiosities, the hills and valleys, the castles and cottages of our ancient land. Well, I hope they will come . . . but I think that we ought to be thinking hard about how they will be received. Our hotels are shabby . . . due to the war. Our standards of catering leave much to be desired. Our methods of cookery are, in many cases, quite devoid of interest. The whole question of our tourist traffic from abroad wants overhauling if we are ever going into the business seriously. And why shouldn't this lovely land be the mecca of millions of visitors? What can compare with the green loveliness of England? Where are there more charming villages? Where more ancient hallowed ruins? But I do not know whether the Travel Association is alive to all that needs doing before these tourists will come . . . and want to come again! Anyway, why not make a special effort to attract cyclists? One can see England best of all on a bike!

The Villages Remembered

THERE seemed to be a double and deep significance about Armistice Day this year, and I was fortunate enough to be in a small village on the Sunday when the countless dead were honoured and remembered. Nothing like a quiet English village for a ceremony such as Remembrance Day! A simple little memorial, erected in the stone of the shire . . . splashes of colour from Flanders poppies and some wreaths of flowers from cottage gardens . . . and a short but powerful address from a padre who wore the ribbons of the last Great War on his surplice. And as I listened to his words I gazed over English meadows . . . kept free and unsullied by the heels of an invader, because Englishmen kept true and died.

Time Well Spent

YES!—when it is an hour or so spent on giving the old bike an overhaul—making everything O.K. for the times when the rains will come and the roads be muddy. I hate a mount that is not truly weatherproof, and I commend a bit of overhauling to any rider who, loving the roads in winter, wants to be sure that tyres are in sound condition, nuts tight, and all in order for the rides when the winds blow, and the rain beats down, and the smooth track of summer days has become the rutted route of the winter ride. Go to it!

No White Christmas

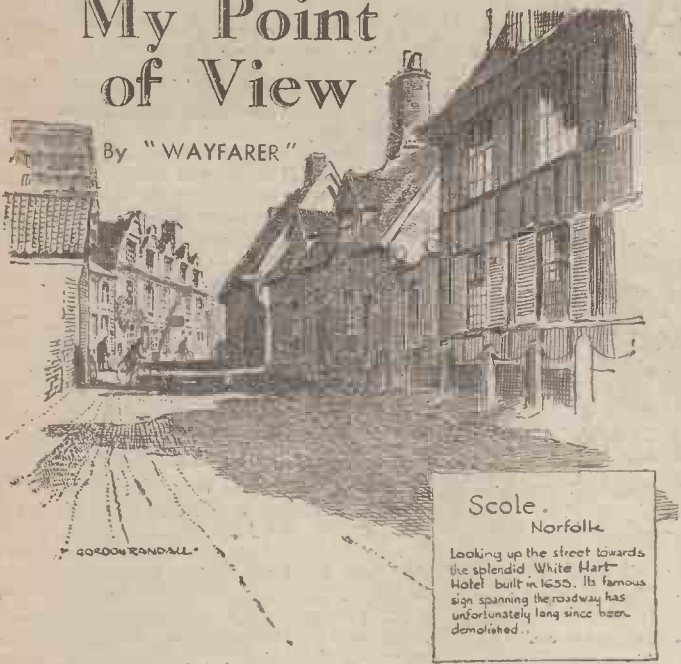
ALTHOUGH I spent Christmas in the good country on the fringe of the Peak of Derbyshire, where snow often comes so early and in such heavy falls, I did not have a "white Christmas"; there was a fair amount of rain, and the air was cold and raw. Striding across fields to pay visits to farmer friends, I was glad of my overcoat and stout country boots. But I enjoyed my stay in the country, gathered holly and ivy, walked the streets of ancient Ashbourne, and again came under the magic spell of grey Derbyshire . . . a hilly land for the cyclist, but one worth more attention than it seems to receive.

A Welcome Sign

A FRIEND of mine, some weeks before Christmas, asked me about the chances of buying a child's cycle . . . not a toy, but a *real* cycle. I am afraid my comments were not very optimistic, but I now learn that he obtained a cycle—just the right size—and so delighted one child's heart on Christmas morning. I mention the matter because it would appear that supplies are improving, and if the manufacture of juvenile bikes has been resumed, then we seem to be on the way to those good times when the "austerity ogre" will have been killed at last.

My Point of View

By "WAYFARER"



Scole. Norfolk. Looking up the street towards the splendid White Hart Hotel built in 1655. Its famous sign spanning the roadway has unfortunately long since been demolished.

A Closed Chapter

SO the chapter marked 1945 has closed, and a successor "reigns in its stead." Yet, to many of us, 1945 remains open and will continue to occupy that position "so long as memory holds its seat"—a vivid record of miles achieved and purposes accomplished, a sublime recollection of stormy and cloudless skies, of brilliant sunsets, of amazing colour schemes, of far-flung views, of pastoral scenes and rugged hills, of little rivers and regiments of trees, of difficult and easy journeys, of wettings and scorchings, of fast and delirious movement and of slow trudging up long banks; with, over all, a grand feeling of physical and mental fitness and a more strongly entrenched conviction that one's debt to the little old bicycle is irredeemable. I write on the first day of the new year, and these are some of my thoughts as I look back over the days that are gone, and ahead to the great occasions yet to be.

As for my personal record, I find that my total mileage for the year is very little short of 10,000, despite the fact that for the first two and a half months I did no cycling, thanks to a highly inconvenient but not dangerous and certainly not recurring (an unpleasant operation having seen to that!) spot of eye trouble. I find, too, that my average distance for the 39 cycling Sundays of 1945 was 65 miles, which is not too bad when a late start in the morning and an early return home in the evening form part of the programme.

The Yuletide Pause

WITH a generous Christmas holiday, I had three jolly good rides—and got wet on each occasion! The journey which stands out above the others was that accomplished on the afternoon and evening of the Monday (Christmas Eve). The morning was hopeless from the weather point of view, but I changed after lunch into my cycling regalia and "got on with it" through a soaking countryside. What a change came over the scene! It is some time since I saw such a riot of colour in the sky. There were great patches of royal blue, interspersed with streaks of silver and bronze and dabs of mauve and green and grey. Otherwise, it was a bleak sort of day, but how I enjoyed the stinging wind on my cheeks and the massive pageantry of the heavens!

After a farmhouse tea I made for home again, and most of the return journey (like, indeed, the run out) was done in lanes. Some of these were new to me but that did not matter, even in the dark, and even though I *had* to stop and ask my way. The stars made a brave showing in the sable sky, doing something to relieve the Stygian gloom, and lighted cottage windows, dumb throughout the war years, spoke a welcome to me. I went through a dark and lonely corridor which rejoices in the curious name of "Shut Mill Valley," and climbed over the hills towards home. Below me then I saw the lamps of towns and cities, and the glare thus thrown on the sky lightened the blackness for me. Out of the sable night I emerged into suburbia, and was soon home again. After a quick change back into my purple and fine linen I was ready, in every sense of the word, for a meal and for the festivities which followed, feeling well content with the cycling activity that day had provided.

Playing Safe

ON the last Sunday in December I carried out my usual journey (with variations) in order to have lunch in the country. A night's freezing had made travel somewhat tricky, but a generous winter sun gradually undid most of Jack Frost's work, and the roads became very wet, providing a dazzle which was painful to the eyes. Here and there was a fog threat. As I sat at lunch I decided that this was an occasion for playing safe. So far as an amateur weather-observer could discern, there seemed to be every possibility of the frost returning, with highly treacherous roads as the result, and with the added complication of a pea-soup atmosphere.

The red light (which may be called intuition) shone clearly, and I decided to cut out the rest of my programme and to make for home, which was duly reached at teatime. I missed the slippery roads and had only a taste of the dense fog which afterwards descended on the land and put a stop to most classes of traffic. How glad I was to have paid attention to the warning of the inner voice, for the 20-mile after-tea journey, which would have fallen to my lot had my original programme been adhered to, was not a nice thing to contemplate in the prevailing conditions. I dislike departing from plan, but I believe that discretion is the better part of valour. Moreover, at my time of life it does not do to risk being flung off your bicycle on treacherous roads.

Surprise-packet

I WAS asked, one day recently, to write a little article correcting the general impression that the outdoor life in the winter season is (to quote Shakespeare) "flat, stale and unprofitable." Taking as my text six words from J. W. Allen's "Wheel Magic," I proclaimed the truth that "winter is as fine as summer," and so developed the theme. Then, two or three days later, the climate came to my support.

It was an early December Sunday, and one of the most beautiful winter days I can remember. After a preliminary splash, the clouds dispersed and the sun came out, remaining on duty until its work was done. A late start limited my morning ride to 20 miles. The afternoon journey, ending in the dark, accounted for 25 miles, and another 23 miles after tea gave me a total of 68 for the day. The whole experience was a joy, reinforced by a colourful sky, so long as daylight lasted, by genial airs, by some inspiring views of distant hills, by a perfectly brilliant night sky and by lonely roads. The day underlined all that I wrote in the article referred to, and I remain convinced that "winter is as fine as summer": I remain convinced that those cyclists (and non-cyclists, for the matter of that) who give the country a miss during the winter months are deliberately depriving themselves of a great deal o pleasure and advantage.

Sound Scheme

ACCORDING to a biography I have just read, Rudyard Kipling's motto in life was "Never go back the way you came." This thought was in connection with the world-journeys he took, but it seems to me that we cyclists may fitly—on occasion—adopt the plan in respect of our own travels, which, of necessity, are shorter but very much more frequent than those carried out by R. K. I qualify my suggestion by interpolating the words "on occasion," holding that all roads should be traversed in both directions if they, and what they have to offer, are to be properly seen. One aspect is so different from the other.

That said, it is a sound idea not (I won't say "never") "to go back the way you came." It is an idea which I have been implementing for some time. A journey of 60, 70 or 80 miles may separate my front door from my front door, and not an inch of ground is covered more than once. Of course, this plan is helped by the fact that I live in a real cycling centre, it thus being readily possible not to return by one's outward route. So I set off due east and come back out of the west, having described a rough circle: I face south on leaving home, and am still looking in that direction when, later in the day, I return from the north. So ring the changes on the available routes, and, on occasion, don't go back home the way you came out.

Taking Cover

THE war brought us strange experiences, some of which, of necessity, will continue for a while. The other day, while cycling through suburbia, the sky suddenly darkened and I found that I was riding under the cover of aeroplane wings which were being conveyed on a motor lorry. There was no need for the instinctive "duck" which followed this discovery, for the wings proved to be well above my head.

Windscreen

ON a recent very cold day, when stopping for tea, I drew a sheet of brown paper from, under my waistcoat and put it aside, with a murmured apology for "undressing" in public. Somebody ejaculated: "That's a good idea: keeps the wind out, doesn't it?" The idea in question was evidently new to the speaker, though it is actually as old as the hills—some of the younger hills, anyway. A sheet of brown paper (or newspaper) makes an effective windscreen, and I have practised the dodge for many years. It is to be commended as an extra garment—couponless!

Road Safety Propaganda

MOST cyclists will have been watching with real interest the Road Safety publicity now appearing in the Press, and will be hoping that this effort will achieve much in connection with the curtailing of road accidents—still far, far too many. I have discussed the campaign with several advertising experts and, of course, there are varying views as to whether the right "approach" has been made. But when advertising men get together and discuss ways and means of "putting over" ideas, there are always many schools of thought, and one never reaches finality. But I hope that in conjunction with the Press advertising about road safety, there is an adequate campaign being carried out in the schools. It is there, I feel, that some of the most fruitful work can be done, and not all schoolmasters, or education authorities, give this vital matter sufficient attention.

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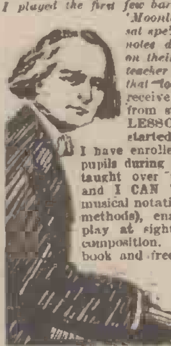

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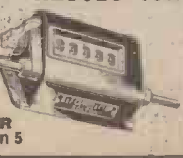

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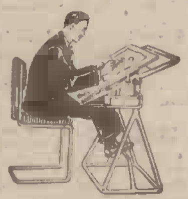

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