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THE MECHANICS OF METEOROLOGY

NEWNES

PRACTICAL MECHANICS

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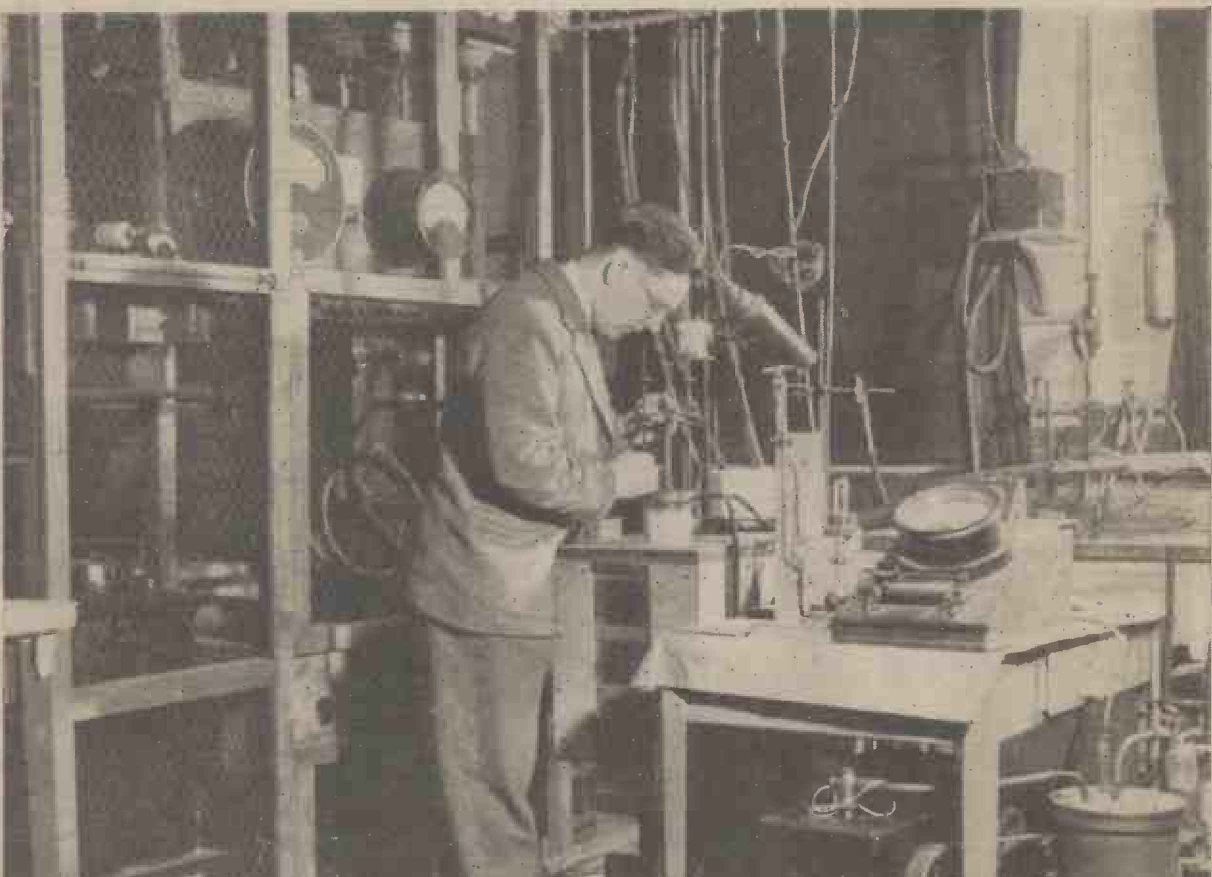
EDITOR: F. J. CAMM

DECEMBER 1945



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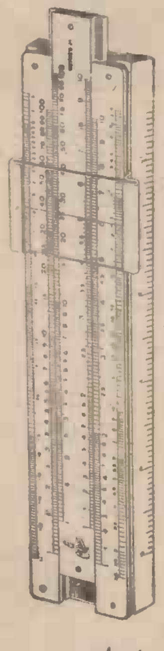

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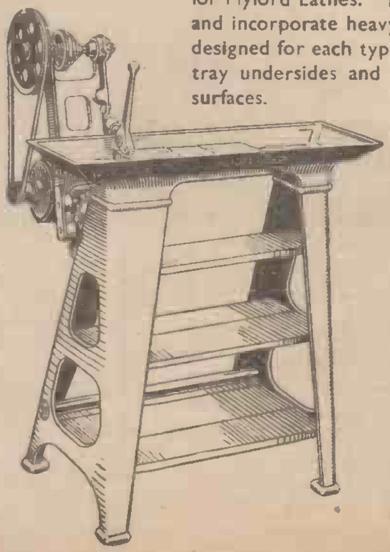

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PRACTICAL MECHANICS

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

Editor: F. J. CAMM

VOL. XIII DECEMBER, 1945 No. 147

FAIR COMMENT—BY THE EDITOR

Reconversion of the Radio Industry

DURING recent months the Board of Trade have been dealing with the problem of the reconversion of the radio industry to peacetime production. In normal times, receiving sets form the basic product of most firms in the industry, and much has been done under programmes already approved and licensed to ease the difficulties of manufacturers in the present transition period and to prepare the way for the resumption of their normal activities.

At present the manufacture and supply of receiving sets is controlled under the Musical Instruments and Wireless Receivers Order, 1944, S.R. and O. 658/45, and licences have been granted to some 70 manufacturers for the production of about 1,000,000 sets during the next 12 months. Of this quantity 400,000 are intended for export. Undertakings have been given by the industry that 50 per cent. by value of the production for the home market will be devoted to sets to be retailed at £15 or less, exclusive of Purchase Tax of 33⅓ per cent. on the wholesale selling price. With the cancellation of war contracts, the supply position in respect of the majority of the principal components required for civilian production has shown considerable improvement and adequate quantities should be available for the present programme for maintenance of existing sets and for export.

The supply of timber for radio cabinets, however, is not too good at present, owing to the many important claims on the limited quantities available. During the third quarter of 1945, releases were only about 50 per cent. of the industry's requirements, but the position is improving and substantial increases will be made in the fourth quarter. This improvement, together with the supplies of plastic materials which are available for cabinets, should go a long way towards overcoming the present difficulties.

Before the war, the average annual production of radio sets in this country was about 1.4 millions. Of this quantity the average export was 66,000. It will be seen, therefore, that the present programme visualises an overall production of about 70 per cent. of the pre-war figure, but places considerable emphasis on exports. If exports actually mature on the scale licensed, the industry will, in relation to its pre-war trade, be making a noteworthy contribution to the Government's policy of increasing export business.

Production of television receivers has not yet begun. Recommendations on the future of the service in this country have been made by the Government Committee set up under the chairmanship of Lord Hankey. The Lord President of the Council, Mr. Herbert Morrison, announced in the House of Commons recently that the Government had given general approval of the recommendations. The necessary action has been set in train.

Apart from sound and vision receivers, many firms are producing transmitters, communications equipment, medical and industrial electronic apparatus, and many other highly specialised products for which there is likely to be a heavy demand, both in this country and overseas. No manufacturing licences are required by firms engaged on production of this character, but every effort is being made by the Board to assist the manufacturers concerned in the reconversion of their production programmes to peacetime needs.

House Furnishing Designs

DINING-ROOM, bedroom and nursery furniture are included in the six categories for which prizes of £100 each are announced by the Central Institute of Art and Design for the best house-furnishing designs from men and women under 30.

There are second and third prizes of £40 and £20 in each section and 108 merit awards of £5, or £1,500 in all.

The Institute wants new designs for things at present in use or new ideas altogether. Service men and women are specially invited to help in making their future homes more comfortable and labour saving.

Peacetime Reconversion

AS stated in last month's issue, the Regional Boards have been not only most useful as a machinery for the coordination of regional activity, but in linking together central policy with local opinion and in dealing with a variety of unforeseen emergencies for which no regular procedure existed. In adapting the constitution and functions of the Boards to peacetime conditions the Government is anxious to preserve these benefits, but is satisfied that to do so in peacetime the Boards must be strictly advisory in character.

The Boards will in future exercise their activity over the whole field of productive industry. Under the new constitution the Boards have been renamed "Regional Boards for Industry." Each will consist of an impartial chairman, together with three representatives each of employers and trade unions, and the senior regional representatives of the Board of Trade, Admiralty, Ministries of Supply and Aircraft Production, Labour, War Transport, Fuel and Power, Food, Works and Town and Country Planning, and, in Scotland, the Scottish Office. Representatives of other Departments will attend meetings when matters in which they are interested are being discussed under their terms of reference, the Board will advise Ministers upon industrial conditions within the regions, and upon steps which may be necessary to bring regional resources in productive capacity or labour into fuller use.

They will keep local industry advised of Government policy in relation to industry and keep headquarters informed of the views of local industry. In doing so they will keep in close touch with other committees in the region whose work may affect industrial interests.

As in the past, Boards will not be entitled to deal with wages and employment, which are matters normally handled by trade unions and employers, nor are they authorised to go beyond the sphere of productive industry into that of mining, transport, agriculture, commerce, or of public uiilties, except in so far as the last named have a direct effect upon productive industry.

The new chairmen have been appointed by the President of the Board of Trade, to whom they will be responsible and will have the right of direct access. They have been selected from industrialists, trade unionists and others who are prominent and experienced men of standing in the Region. Similarly, the industrial members of the Boards will be men who are likely to be acceptable as representatives of industry generally rather than of any industry in particular. The appointments of both chairmen and industrial representatives will be for a period of three years.

Fireworks

THE Home Office and the Pharmaceutical Society state that they take a grave view of the accident rate arising from fireworks made by amateurs, and all chemists have received a circular asking them not to supply materials for such fireworks to children under 16, and the manufacturers of chemical sets for young experimenters are asked to withdraw from these sets all chlorates, nitrates, magnesium, potassium permanganate, sulphur, powdered aluminium and phosphorus.

It is for this reason that we have declined to give information to querists relating to experiments with fireworks and explosives. Will readers, therefore, please note that they should not send us queries relating to this subject?

The Mechanics of Meteorology

Atmospheric Pressure, Humidity, and the Why and Wherefore of Weather Forecasting

By G. A. T. BURDETT

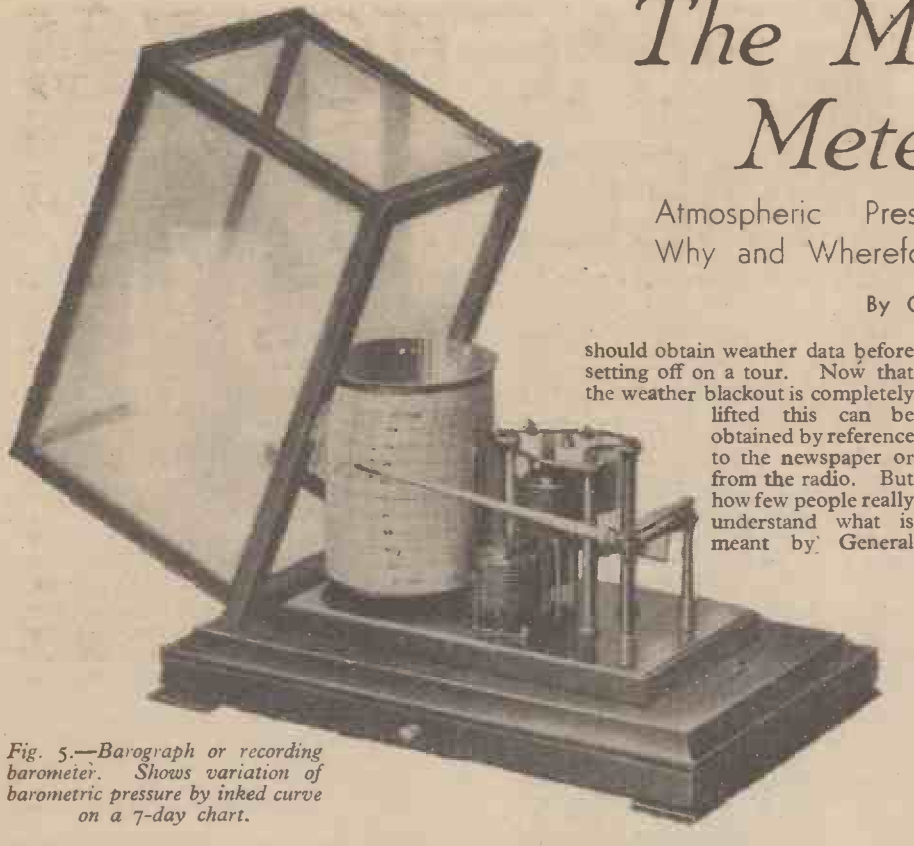


Fig. 5.—Barograph or recording barometer. Shows variation of barometric pressure by inked curve on a 7-day chart.

DURING the years of war in Europe, we were not aware of the weather which prevailed in parts of the country other than in our own locality, although after D-Day the blackout on weather was lifted with regard to the Straits of Dover. While residents of one district might have been enjoying dry weather, those in other parts of the country would be battling against snow storms. With the total absence of the broadcast of official weather forecasts, we could only make a rough guess of approaching weather.

In spite of this, the weather still appeared to be the opening topic of conversation between strangers, and even acquaintances of long standing. There is no doubt that everyone is to some degree interested in the weather. For example, a cyclist, motorist or hiker should obtain weather data before setting off on a tour. Now that the weather blackout is completely lifted this can be obtained by reference to the newspaper or from the radio. But how few people really understand what is meant by General Inference, Anti-cyclone, Depression, and so forth. Fewer still are able to make a weather forecast within any reasonable degree of accuracy.

Although forecasting covering a wide region over a fairly long period of time can only be made after many years of practice with the aid of special instruments in the hands of a number of expert observers stationed over a wide area, an amateur can make a reasonably accurate forecast provided he has studied and mastered the main principles of the science of weather, and has taken every opportunity of putting this book learning into practice.

Countrymen, farmers, shepherds and coastal dwellers are all weather experts to some degree. They have all made a long, but probably subconscious, study of prevailing conditions in their own localities; this without the aid of charts and instruments. In fact, most of the popular couplets and maxims have originated from such people, which is probably why so many bear relationship to the truth. Too much reliance should not, however, be placed on this weather lore, since the majority of couplets rely on one weather indication only and accuracy is often sacrificed to allow the couplet to rhyme.

Study Local Conditions

All who are interested in weather should know their own local conditions; for instance, the prevailing wind, the direction of True North from, say, the garden gate, the market square, and so forth. Surprisingly few people are aware of the direction of the main road or of the local railway lines. All of these points and many others, as will be seen later, are of direct importance in the study of weather.

The Atmosphere

The atmosphere is a belt of air surrounding the earth and rotating with it (Fig. 1). This belt is divided into two layers—an upper and a lower. The lower layer, which has a thickness or depth of approximately 11 miles at the equator and flattens off to approximately six miles at the poles, is known as the

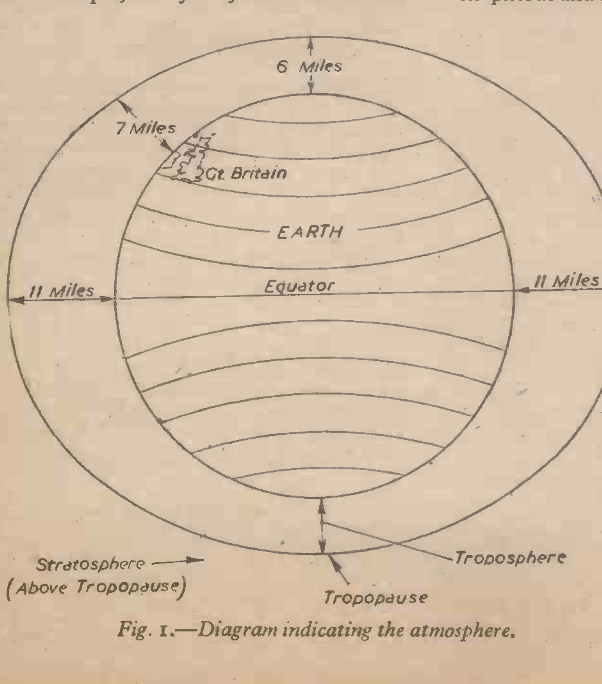


Fig. 1.—Diagram indicating the atmosphere.

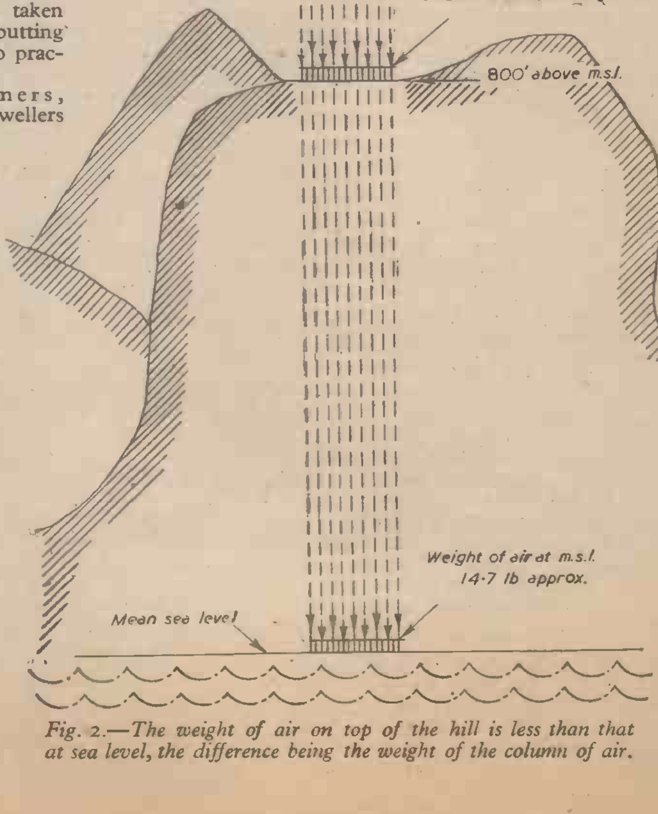


Fig. 2.—The weight of air on top of the hill is less than that at sea level, the difference being the weight of the column of air.

troposphere. Above the troposphere and divided from it by an imaginary line called the tropopause, we get the stratosphere. In the stratosphere weather conditions, as we know them, do not exist and we are not therefore concerned with it here.

As the depth of the troposphere above Great Britain is approximately seven miles the weather conditions dealt with in these articles relate only to that distance from the earth.

Atmospheric Pressure

The average pressure, or weight of air, in Great Britain, is 14.7lb. per square inch. This means that under average conditions if a two shilling piece, which has an area of 1 square inch, is laid on the beach, we may assume that the weight of air on its surface is equivalent to 14.7lb. This weight of air is not noticed because an equivalent weight of air is also pressing underneath it.

If we took our two shilling piece to the top of a hill or to any height above sea level we should find, if we could measure it, that the weight of air had now decreased. This is because there is not so much air pushing down on to the coin, Fig. 2.

If, instead of using a coin, we placed a quantity of mercury in a glass tube and turned this upside down in a vessel of the same liquid, Fig. 3, we should find that if the atmospheric pressure is 14.7lb. per square inch, the height of the mercury in the tube would be 30in. If this apparatus were taken to a high position, viz., on top of a hill, the column of mercury would then fall with the increase of height, because the lower pressure of air would then be unable to support such a high column as previously. This apparatus is thus a simple barometer and may be used for measuring changes in barometric or atmospheric pressure.

The inch is not a convenient unit of measurement to adopt for a barometer. Instead, a millibar, mb., is used; 1,000 mb. or 1 bar being equivalent to 29.531in. In Great Britain the average barometric pressure at sea level is equivalent to 1013.2 mb.

As the height of mercury in a barometer tube changes with height and as these changes are directly proportional, the barometer may be used for measuring height. For convenience in practice, a change of 1 mb. in the height of the mercury is taken as being equivalent to 30ft. Thus, if upon climbing a hill or ascending in an aircraft the barometer carried dropped by 3 mb., it could be assumed that a height of 90ft. had been achieved.

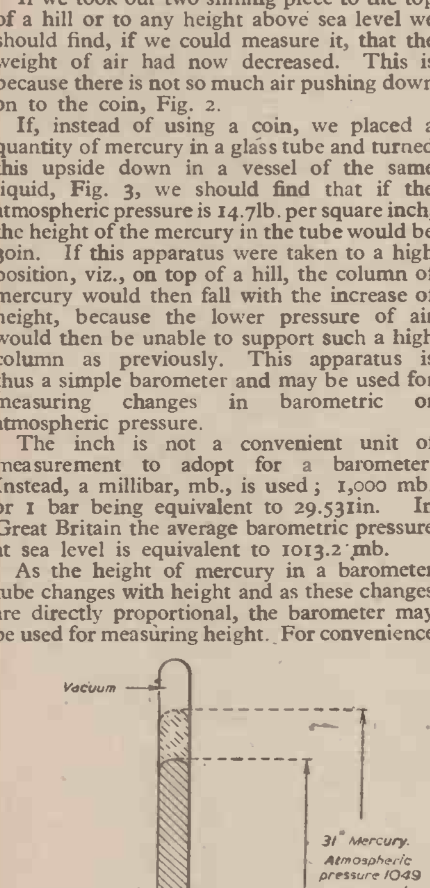


Fig. 3.—Glass tube is filled with mercury, inverted and placed in bowl of mercury. The variation of the pressure or weight of air on mercury in bowl varies with the height of mercury in tube. Pressure of 1015.9 mbs. supports 30in. column. Pressure of 1049 mbs. supports 31in. column.

Fig. 8.—Cumulus cloud. The most common cloud of the heap formation: normally a fair weather cloud.

Pressure Distribution

It is emphasised that the pressure of 1013.2 mb. is only the average pressure at sea level and not that necessarily found at any given time. Atmospheric pressure will vary depending upon the height, the time, the place, the weather and the air temperature. This variation in pressure, upon which the existing weather conditions largely depend, is always plotted at different places throughout the world. Identical pressures measured at different places are then plotted on a special map known as a synoptic chart and resemble the ordinary contour lines found on a topographical map, Fig. 4. These pressure contours, which at no point cross each other, but run almost parallel, are usually 2, 4 or even 6 mb. apart, depending upon the scale of the map. In Fig. 4 the isobars are drawn at intervals of 4 mb.

The Barometer

It has been shown that atmospheric pressure at a given point will vary considerably according to the weather. The barometer may be, and is, used for indicating weather conditions. As the mercury in the tube, Fig. 3, varies with height due to the change in pressure, it will also vary if the pressure changes for any other reason; for instance, the weather.

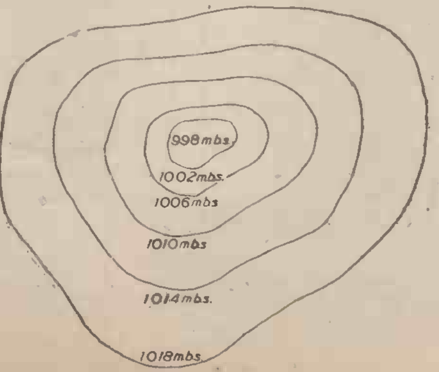


Fig. 4.—Pressure gradient. The lines represent isobars being drawn through points having equivalent barometric pressure.

We have now seen that the mercury tube or barometer will indicate two factors, change of pressure due to height, or due to weather. In the former case the barometer is called an altimeter and in the latter a barometer.

It will now be seen that this instrument can be unreliable for use as either, since it possesses at least two varying factors, height and pressure. As an altimeter the readings may not indicate true height, for the weather conditions and barometric pressure at a different place, or at the same place at a different time, may have altered and upset the altimeter readings. As a barometer, unless it is calibrated in accordance with the position of the place above sea level, the readings will again be inaccurate.

The barometer as a weather indication instrument is considerably overrated. Though its face is usually graduated as Fair, Rain, Stormy and so forth, rarely do these markings indicate the actual weather conditions. On the other hand, as an aid, and an aid only, to weather forecasting, the barometer is quite useful. For example, when a front or stormy and unsettled conditions are expected the "glass" will be unsteady, due to rapid changes in pressure during such periods. Settled weather is indicated by a steady glass, and when the glass is rising the approach of an anti-cyclone and fine weather is indicated.

Barometers should be sensitive to small changes in pressure and mercury barometers are sensitive, but the usual household type is of the aneroid principle which, although not very sensitive, is cheap and meets the requirements of the amateur.

Fig. 5 illustrates a barograph, or recording barometer, which shows variation of barometric pressure by an inked plot on a seven-day chart.

Temperature

The earth receives its heat from the sun by means of radiation, or insolation, as the meteorologist calls it. That is, the heat of the sun passes through the air to the earth and does not raise the temperature of the air through which it passes. Temperature is of the highest importance to the meteorologist for the heating of the earth is responsible to a large measure for the varying weather conditions in the troposphere. It is also responsible for the seasons as we know them, viz., Spring, Summer, Autumn and Winter.

Increase or decrease in the temperature of the earth's surface at different places depends not only upon the seasons of the year and upon the latitude of the particular place (Great Britain being situated in the temperate zone of the Northern hemisphere), but upon the heat capacity of the surface layers.

Heat is constantly received from the sun at the earth's surface. At the same time the heat is being dissipated, otherwise the temperature at the earth's crust would become so hot that everything would burn up and the lakes and sea would boil.

The surface of the earth, owing to the variation of heat capacity, does not heat up evenly even where the sun's rays are equally radiated upon it. For example, sand and ploughed fields heat up very quickly, woodlands and grasslands heat up more slowly owing to the absorption of the heat by the plants to give them life, and large areas of water such as the sea heat up even more slowly. This explains why the sands are often very hot when the water is comparatively cold. On the other hand, water gives up its heat more slowly than land. This will be noticed by a person going into the sea after sundown; the sands will be cold but the sea warm.

The heat absorbed by the earth usually goes down to a depth of a few feet, but most of the heat is dissipated owing to the cold air striking the ground, the temperature of the former being raised. As the air at ground level is heated up, so will it expand and, being lighter than the air immediately above, it will rise up into the atmosphere. The colder air, being heavier, then drops to replace it, and this in turn is heated up and rises again. These cycles of operations, called convection, are continuous as long as the temperature of the earth is higher than the air about it. An enormous air circulating system is thus produced, which results in the movement of masses of air (or wind) which have a direct bearing on the prevailing weather.

Since the ground, and not the air, is first heated and in turn heats the air, the source of heat, so far as heating the air is concerned, must be reckoned as the earth and not the sun; the sun being, of course, the primary heat source. This means that the temperature of the air at ground level is greatest but decreases with increase in altitude. Under normal conditions this decrease in temperature is at the rate of 5.4 deg. F. for each 1,000ft. increase in altitude, and is known as the *dry adiabatic lapse rate.*

This is illustrated more simply as follows.

A quantity of dry air, the temperature and density of which is that of the outside air, is enclosed in a balloon at sea level. This "parcel" of air is now taken to a height of 1,000ft. As the density (pressure on the balloon) of the air is now less, the air will expand and, upon expanding, will cool at the adiabatic lapse rate, viz., 5.4 deg. F. per 1,000ft. At the new altitude the air is now released from the balloon and, being of the same density and temperature as the surrounding air, it will mix freely with the atmosphere and will neither tend to rise or fall. This is termed *neutral* condition of the atmosphere since there is no movement of the air, Fig. 6(a).

The temperature of the air does not always decrease with height at the adiabatic lapse rate. Often the lapse rate is lower, Fig. 6(b).

If an identical "parcel" of air is now taken up to a height of 1,000ft., its temperature will be lower than that of the outside air. Upon releasing the air from the balloon it will tend to fall to a lower level.

These conditions are known as *stable* conditions, since the air will not rise unless by mechanical means, viz., rising currents of air or wind.

At other times the temperature lapse rate is greater than the adiabatic. Fig. 6(c) shows this at 8 deg. F. per 1,000ft. altitude. An identical "parcel" of air at 1,000ft. will now have a higher temperature than the outside air. Upon release, therefore, it will rise still further.

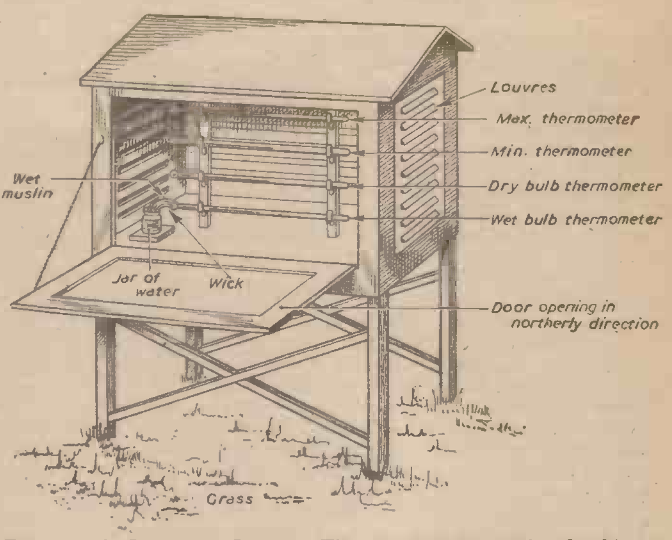


Fig. 7.—A Stevenson Screen. These screens are painted white to eliminate the sun's radiation. The louvred sides allow free circulation of air. To prevent errors, viz., radiation from ground, screens are mounted on stands at a height of 4ft. This height is adopted at most observation stations and is regarded as standard by many authorities.

These are known as *unstable* conditions, and when they exist there is a considerable movement of air.

As will be shown later, such unstable conditions do not exist for long, since changes in weather, viz., the development of thunderstorms, restore the atmosphere to conditions which are stable.

When the air is saturated, viz., below dew point, the lapse rate is then 2.7 deg. F. per 1,000ft. altitude, conditions which are termed the *saturated adiabatic lapse rate.*

The normal adiabatic lapse rate in the British Isles is approximately 3 deg. F. per 1,000ft. and most calculations are made with these figures.

Temperature Inversion

Under certain conditions, often when an anti-cyclone is stationed over an area, the change in temperature with height increases for the first few hundred feet, after which it decreases in the usual way, Fig. 6(d). This is known as a *temperature inversion.*

Humidity

Air, unless it is completely dry, contains a quantity of water. Air which has passed over large areas of the sea, viz., the Atlantic Ocean, contains an appreciable quantity of water. Conversely, air which has travelled over large tracts of land, such as deserts, will be very dry.

The amount of moisture contained in a given volume of air is known as its relative humidity, usually expressed as a percentage. The relative humidity of the air over Great Britain is approximately 70 per cent. that is, it contains 70 per cent. of the moisture of saturated air under similar conditions.

Saturation of Air

When warm air comes into contact with water of a lower temperature the warm air will cause the water to evaporate. This moisture then mixes with the air and increases its relative humidity. The amount of water which will be evaporated in this manner will depend upon the amount of moisture the air can hold before it is saturated. The saturation point, which depends upon the temperature of the air, is reached when the air can contain no more water and has then a relative humidity of 100 per cent.

The higher the temperature of a given

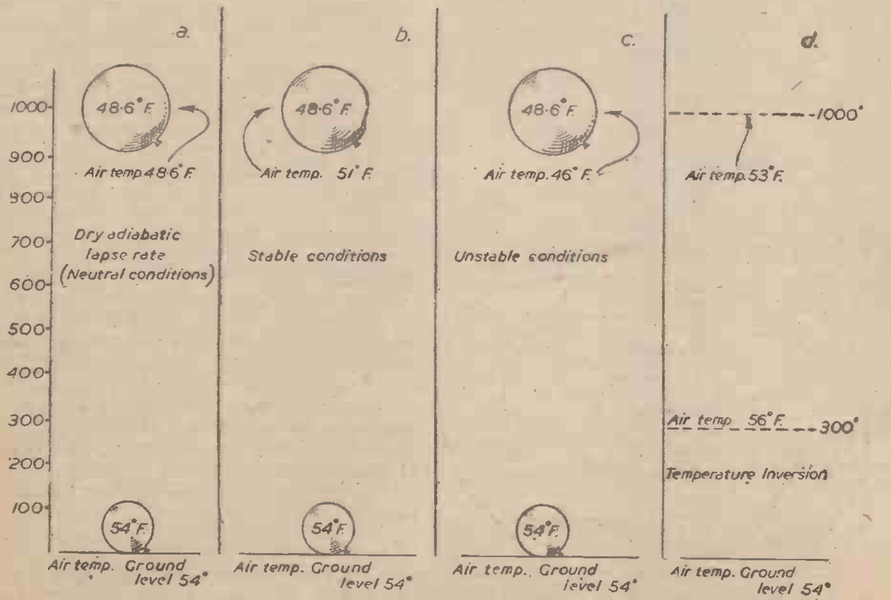


Fig. 6.—As air rises it expands and cools. Air enclosed in a balloon will, as it rises, expand the balloon until it bursts. The illustration shows how a parcel of air, viz., in a balloon, not necessarily of the same temperature as the surrounding air, reacts depending upon whether the air is stable, or unstable.

volume of air the more water it will hold before becoming saturated. If, therefore, a volume of air is saturated when it has a temperature of 60 deg. F., further heating will lower its relative humidity from 100 per cent. and allow it to take more water. If, on the other hand, the temperature of that volume of air is decreased below 60 deg. F., it will be unable to retain its moisture and will release it in the same manner as a saturated sponge when squeezed in the hand.

Measuring Relative Humidity

The instruments, dry and wet bulb thermometers, are normally used by meteorologists for measuring relative humidity. These comprise two exactly similar thermometers which are mounted in a wooden box with louvred sides. This box is known as a Stevenson Screen, Fig. 7. The thermometers are thus protected from the direct rays of the sun, while at the same time the outside air may circulate inside the box.

The dry bulb is exposed to the air (inside the box). The wet bulb is covered with wet muslin which receives its water from a container, by means of a special wick.

Unless the air is saturated, that is, its relative humidity is less than 100 per cent., the moisture in the wick will evaporate. The dryer the outside air the more rapid the evaporation. Now, evaporation of a liquid causes cooling, and is proportional to the rate of evaporation, viz., the principle of refrigeration. Therefore, the dryer the air the greater the rate of evaporation and therefore the greater the cooling of the bulb inside the muslin. This coolness will register on the thermometer by a drop in temperature.

The result is that while the dry bulb will register the air temperature, the reading on the wet bulb will be low, depending upon the rate of evaporation.

Using the two readings, the dryness of the air, or its relative humidity, is at once determined. No simple formula for this is as yet devised, owing to complications, but charts are available from which relative humidity can be derived direct.

When the air is saturated (relative humidity of 100 per cent.) there is no evaporation from the muslin, and the temperatures recorded by the two bulbs are identical.

Maximum and minimum temperature thermometers are often placed in a Stevenson Screen. These readings are taken at regular intervals and the instruments then have to be reset.

Other devices are used for measuring relative humidity, though many of them are hardly accurate, and indicate only the moisture content of the air.

Catgut is known to expand when it absorbs moisture, hence violin strings slacken. Ingenious "weather gadgets" are based on this principle. One type comprises a model house, in the doorways of which are positioned figures of a man and woman. These are controlled by a "lever" of catgut which, as it expands or contracts, changes the relative positions of the figures in the doorways.

People collect seaweed, which absorbs moisture and indicates the relative humidity of the atmosphere, but not necessarily the weather conditions, viz., fine or wet.

For instance, a ground fog at night during a spell of good weather, when the air is saturated, would also saturate the seaweed and expand the catgut, but it certainly does not in these circumstances indicate the approach of rain.

If other conditions favourable to the formation of radiation fog exist, but there is no wind, dew instead will form. This is, of course, a particular characteristic of fine weather.

When a warm front is approaching and low stratus cloud is expected (Fig. 8), very great importance is attached to the relative humidity, particularly on aerodromes. Each hour, and often at more frequent intervals, readings of the wet and dry bulb thermometers are taken. Once the relative humidity (R.H.) reaches a high figure or ascends rapidly, pilots are notified and flying arranged to ensure that pilots can return to their bases or be deviated to others at short notice.

Relative humidity is only one additional item of knowledge which the meteorologist uses to complete his weather picture.

(To be continued.)

National Exhibition of Design

THE President of the Board of Trade (Sir Stafford Cripps) announced recently that the Government had accepted a proposal from the Council of Industrial Design to hold in the summer of next year a national exhibition of design in all the main ranges of consumer goods—clothing, household furnishings and equipment, office equipment and civil transport. The exhibition would be held in London, would open not later than July 1st, and would be on a considerable scale.

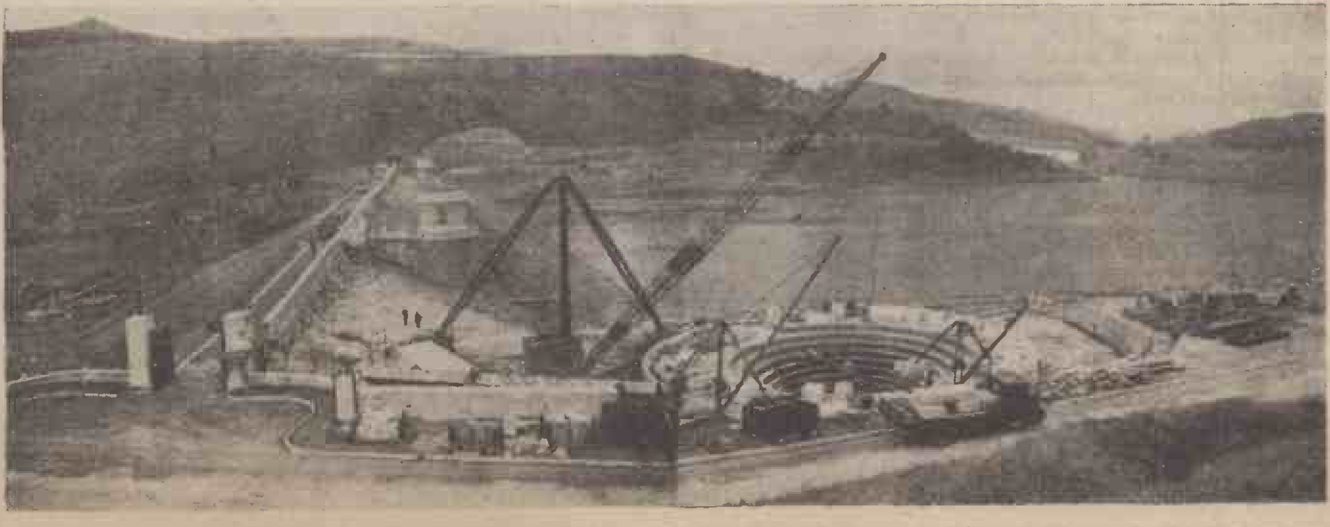
"It will not be anything so vast or all-inclusive as a commercial exhibition or Trade Fair, and space will not be sold," said Sir S. Cripps. "It will represent the best and only the best that modern British industry can produce, largely the new post-war designs, but not excluding those good designs of the years immediately before the war which will be going into production again.

"This exhibition will be British industry's first great post-war gesture to the British people and to the world. I confidently believe that it will demonstrate the vigour, freshness, originality and skill with which our manufacturers are setting about their task of serving the home consumer and capturing a great share of the export trade. The British public will see what industry has planned for the living rooms, bedrooms, and kitchens of the post-war home: the world overseas will discover that the brains, ingenuity and taste which long gave Britain her place as a leader of world industry have not deserted her, and that her lead will be kept.

"One main purpose of the exhibition is to enable our industries to give a lead at home and abroad: it would be a mistake to wait too long. In 1947 the British Industries Fair will take up the running, performing its normal function as a trade exhibition."

Within a short time the Council intend to approach the various representative trade associations concerned, to seek their help and discuss ways and means with them. The exhibition would cover clothing and accessories; furniture, glass and pottery; heating, lighting, cooking and other domestic equipment; hand and garden tools; radio and television; office equipment; toys, cameras, watches and clocks; pens and stationery; leather and travel goods; musical instruments; packaging and printing and transport.

Besides peacetime goods, the Council wanted, with industry's help, to show the public as much as possible of the achievements in war production of industries normally making consumer goods, and the way in which wartime developments in manufacturing technique and processing had led on to the new designs and types of goods which post-war industry would produce. In fact, the keynotes of the exhibition would be the changeover from war to peace: its title would be "Swords into Ploughshares: British goods for the new age."



A panoramic view of the Ladybower reservoir, of the Derwent Valley Water Board, recently opened by the King and Queen. The huge earthwork dam is 1,270ft. long, and 665ft. thick at the base.

Fluorescent Lighting

Its Operation and Adaptability for Commercial and Domestic Uses

By P. SEYMOUR

ONE of the latest forms of commercial lighting to become available for public use is fluorescent lighting. Many readers will no doubt be familiar with the daylight effect given by this lighting, and with the return of more normal supply conditions we can expect a great increase in the numbers of users of these lights.

What is Fluorescent Lighting ?

First of all, what do we mean when we speak of fluorescent lighting ? The dictionary definition of fluorescence is "a coloured luminosity which certain substances exhibit when the sun's rays fall on them." To use the sun's rays for fluorescent lighting is obviously impracticable, so we have to produce artificially those of the sun's rays which have the greatest effect on fluorescent materials.

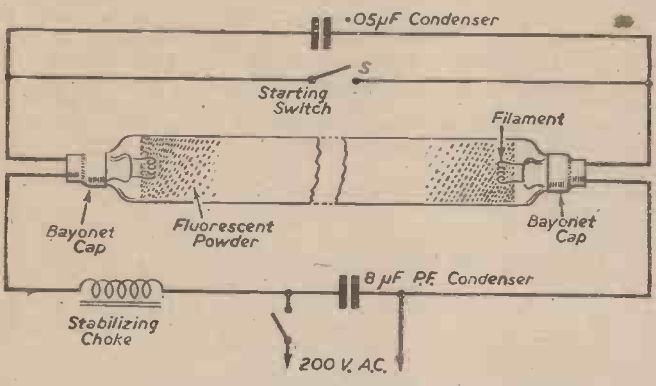


Fig. 1.—Connections for 80-watt lamp on 50 c.p.s. mains.

The rays which we use are ultra-violet rays, which cannot be seen by the human eye, and are therefore of no use to us as a source of illumination. The ultra-violet rays being of a shorter wavelength than visible light, we need a frequency changer which will bring the emissions within the visible spectrum. For this purpose we use materials which exhibit fluorescence when excited by ultra-violet rays. The principle of the frequency changer can be seen easily when it is stated that the fluorescent radiation is always of longer wavelength than that of the radiation that causes it. As ulra-violet radiation has a shorter wavelength than any of the visible spectrum, it is natural to assume that fluorescent radiation will fall within the visible spectrum.

The Ultra-violet Source

Many readers will be familiar with the green-blue light given by mercury arc street lighting. These lamps are of the high-pressure mercury vapour discharge lamp type, and are designed to give the maximum amount of light obtainable from the arc itself. They are, however, only about 10 per cent. efficient, as only 10 per cent. of the total input energy is converted into light in the visible spectrum and 1 per cent. of energy into ultra-violet radiation.

If the pressure of mercury vapour inside a discharge lamp is reduced to less than 0.1lb. per square inch, the visible radiation from the arc falls to about 1.5 per cent. of the total input energy, but the ultra-violet radiations increase to 60 per cent.

This is the reason for low-pressure mercury vapour in the 80-watt fluorescent tube, whose mercury vapour pressure when cold is less than 0.1lb. per square inch, and which remains almost constant at this value, with a very small increase in pressure, while the lamp is burning.

The 80-watt Tube

The 80-watt tube itself consists of a glass envelope, 5ft. long, 1½in. in diameter, sealed at both ends, and having two electrodes, each consisting of a coiled filament and two metal fins, supported in a glass pinch, one at each end of the tube.

The filament projects about 1¼in. into the tube, and the metal fins, which act as anodes for the arc, so reducing volt drop, are placed one on each side of the filament, and in the same plane, i.e., at right-angles to the axis of the tube. The two filament leads are sealed in the end of the tube and go out to a standard bayonet cap, one at each end of the tube.

The Fluorescent Powder

The whole of the inside of the glass envelope is coated with a white powder that produces the fluorescent effect. This powder consists of a mixture of compounds, each of which exhibits fluorescence on its own, but all of which have a different colour content.

It is very important that these powders should be entirely free from impurities, and this brings about a number of manufacturing difficulties, especially as the powder has to be furnaced to a high temperature.

The powders usually used in the tube consist of zinc sulphate, zinc beryllium silicate, cadmium chlorophosphate, cadmium borate, magnesium tungstate and several others, all carefully mixed to resemble as closely as possible the colour content of neon sunlight.

Apparatus Needed for 80-watt Lamp

In order to run the 80-watt lamp from a normal supply voltage, say, 200 volts 50 cycles/sec. alternating current, we require, in addition to the lamp, a stabilising choke to drop the line voltage to the correct level, a starter switch, and an 8 mfd. condenser for P.F. correction.

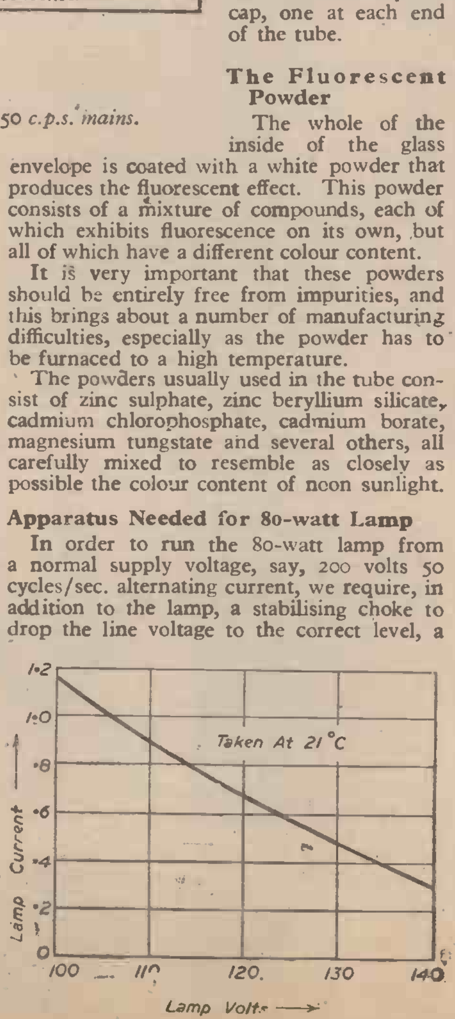


Fig. 2.—Lamp resistance characteristic.

Lamp Characteristic

One of the peculiarities of the fluorescent lamp is that it has a negative resistance characteristic, i.e., when the current in the lamp increases, the voltage across the lamp decreases. This is due to the increased ionisation of the mercury vapour due to the increase in current, causing the arc to have a lower resistance. The extent of this effect can be seen on the accompanying curve (Fig. 2).

The average current in the lamp itself is 0.85 amps., and may vary between the limits of 0.6 amps. and 1.2 amps. Another thing that has an effect on the lamp is the ambient air temperature. As can be seen from Fig. 3, a working range of temperature from 50 deg. C. to 30 deg. C. produces a change of plus or minus 15 per cent. in the average lamp voltage. The current range due to the variations in ambient air temperature will be seen to be from 0.68 amps. to 1 amp., and the remaining part of the permissible current range down to 0.6 amps. and up to 1.2 amps. is taken up by variations in the supply voltage, characteristics of the choke coil and the lamp.

It is clear, therefore, that the careful adjustment of the choke is of great importance, and manufacturers supply chokes with a series of tappings which will accommodate any line voltage from 190 volts to 250 volts. The effect of ambient air temperature has been taken into account in the selection of these tappings.

Starting

These fluorescent lamps for use on 50 c.p.s. A.C. require a special method of starting. When the supply voltage to the lamp is switched on, the filaments must be made to glow at red heat in order to ionise the vapour in the tube, and then a voltage surge produced across the lamp to strike the arc from one filament to the other.

The heating of the filaments is achieved by shorting the lamp out, i.e., closing the switch S. (Fig. 1). When the supply is switched on, a current flows through the filaments, causing them to glow. The switch S is then opened after an interval of about two seconds, and a voltage surge of approximately 1,000 volts is produced across the lamp by the collapsing flux in the stabilising choke. This strikes the arc between the filaments and causes the current to flow through the tube, giving rise to the ultra-violet emissions which create the light.

This complete switching operation is done

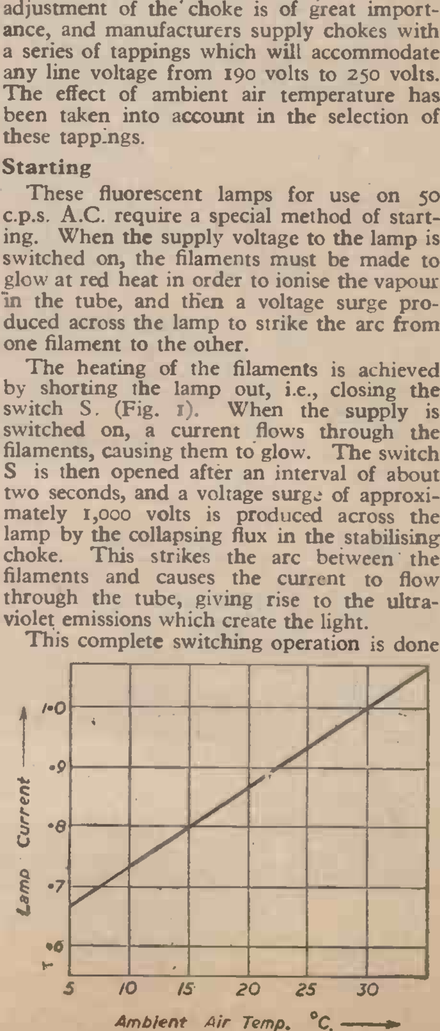


Fig. 3.—Showing the effect of ambient air temperature on lamp current.

automatically by the starting switch which is housed with the control gear. It consists of a small bimetal arm which is heated by a coil placed in its proximity. When cold, the bimetal arm makes contact with a fixed metal strip and is connected across the filaments, creating the starting condition. The heating coil is connected in series with the main lamp current as shown in Fig. 4.

When the supply voltage is switched on the operating coil heats up and causes the

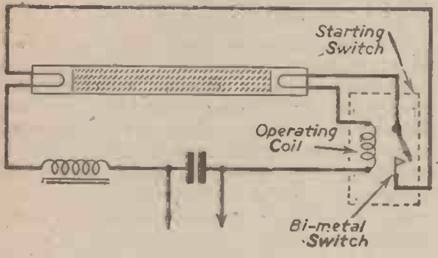


Fig. 4.—Starter switch connections.

bimetal arm to move away from the fixed strip, opening the circuit across the lamp and striking the arc as described above.

When the lamp is burning, this switch remains open, due to the lamp current still passing through the operating coil, but as soon as the supply is switched off the bimetal arm cools and returns to its original position, remaking the circuit across the lamp in about two seconds. The switch is then ready to repeat the complete operation of starting.

The bimetal switch and heating coil are housed in a nitrogen filled glass bulb, which is fitted with a moulded plastic plug having four contacts. This plug fits into a plastic socket in one way only, making wrong connections impossible. The starting switch assembly can be easily withdrawn from the socket for inspection.

Radio Interference Suppression

A small condenser is usually placed across the lamp to aid in radio interference suppression. This is usually of 0.05 mfd. capacity with a peak working voltage of 1,500 volts.

The voltage across the arc is very much distorted, as can be seen from Fig. 5, and has many higher harmonics with a large percentage amplitude. A larger suppression condenser, although desirable, cannot be fitted owing to the high current peaks resulting from the high harmonics.

The lamp current (Fig. 5) is very nearly a sine wave.

Efficiency

The 80-watt fluorescent tube has a high efficiency in light output, which is about 27 lumens per watt. An ordinary filament lamp of the same voltage has a light output of only 10 lumens per watt, making the fluorescent tube nearly three times as efficient as an incandescent lamp.

The reason for selecting a length of 5ft. for standard fluorescent tubes can be seen when efficiency in light output is plotted against length of tube. Up to about 4ft. lengths, the efficiency rises rapidly, but after that the rate of rise falls off, and an increase of many feet above 5 is required for a small increase in efficiency.

Without a P.F. correction condenser, the overall P.F. of the circuit is about .5, and with an 8 mfd. condenser fitted the P.F. becomes .9, thereby reducing the input watts.

Flicker

Another noticeable feature of fluorescent lighting when operated from 50 c.p.s. A.C. supplies is that a stroboscopic flicker is obtained when an object is moved rapidly in the light of the lamp.

This is due to the almost complete absence of thermal inertia in the lamp, i.e., ability to store energy in the form of heat. When the A.C. voltage falls near its zero level, as it does 100 times/sec., the light output falls very low and the lamp nearly goes out.

A fluorescent lamp reaches an outside temperature of about 35 deg. C. but an incandescent filament lamp of similar wattage produces a much greater amount of heat—about 200 deg. C.

To combat this flicker, luminous powders are introduced into the fluorescent compound, but the amount used is limited by the colour content of these powders. The luminous powders tend to store light and give a more continuous light output.

High-frequency Operation

In the previous paragraph we discussed the stroboscopic flicker effect and the method used to combat it. Another, but more unusual way of eliminating flicker, is to operate the lamps from a high frequency supply. This has the effect of increasing the frequency of the flicker, which has twice the frequency of the fundamental supply frequency, to such an extent as to make it unnoticeable. The frequency of the supply should be at least 500 c.p.s. in order to eliminate the flicker completely.

At increased frequencies the size of the stabilising choke is greatly reduced owing to the reaction of the choke increasing with the frequency. The characteristic of the lamp is made slightly more steep at high

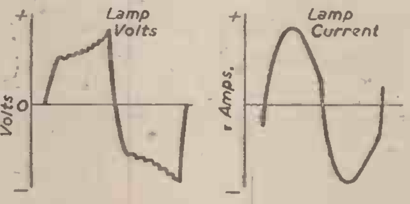


Fig. 5.—Waveform of lamp voltage and current on 50 c.p.s. (from an oscillograph film).

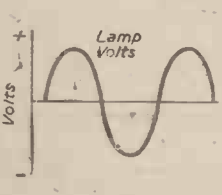


Fig. 6. — Waveform of lamp voltage on 500 c.p.s. supply.

frequencies, but this does not affect the working range of current, limiting only the voltage.

With a 500 c.p.s. supply, the value of the P.F. correction condenser would become about 2 mfd., thus creating a saving in size on that component.

High-frequency Starting

When operating lamps from high frequencies, the normal method of starting can be used, making use of the same starter switch as is used for 50 c.p.s. operation.

It can be seen from Fig. 6 that the lamp voltage at 500 c.p.s. becomes much more sinusoidal, that is, much less distorted, and the absence of high current peaks due to higher harmonics in a relatively large condenser connected across the lamp makes a different form of starting available.

A condenser of fairly large capacity may be placed across the lamp in place of the starting switch (Fig. 7). The value of the condenser is chosen to give partial resonance with the stabilising choke at the supply frequency and to produce a high voltage across the condenser.

Let us say, for example, that an 80-watt lamp equipped for 500 c.p.s. working, has connected across it a 1.5 mfd. condenser. When the supply is switched on, the current flowing through the lamp filaments is about 1.5 amps., and there will be 750 volts across the condenser. The filaments will glow, and as soon as they have produced sufficient ionisation within the lamp the high condenser voltage will cause the lamp to strike.

The lamp will virtually short out the condenser, and the voltage across it will be the same as the lamp voltage, approximately 100 volts, and a correspondingly small current will pass through the condenser, actually about 20 per cent. of the total current.

This method of starting eliminates all moving parts, such as the starting switch, and is therefore very suitable for traction work.

This method is only practicable where a high frequency alternator is available, and any intending users of the H.F. scheme are recommended to submit their plans to the lamp manufacturers.

Vibrators have been experimented with, but it has been found that even a small ripple or modulation of the vibrator output is sufficient to cause the lamp to display a flicker.

D.C. Operation

Fluorescent lamps may be successfully operated on direct current after some changes have been made to the control gear, but there is one big objection.

This is, that after several hours' running on D.C., the positive end of the tube begins to blacken and cuts down the light output quite considerably. The blackening may extend up to quarter way along the tube, and is caused by the diffusion of mercury at the cathode end of the tube. This is known as electrophoresis.

The blackening may be overcome by reversing the polarity of the tube every three or four hours, but this is very inconvenient in a commercial installation.

Instead of using a choke for lamp stabilisation on D.C. operated units, a resistance of about 140 ohms is placed in series with the lamp. This resistance is suitable for a 200-volt supply, and must be altered according to variations in the supply voltage.

D.C. Starting

Lamps operated from D.C. supplies still need a high voltage surge across the lamp in order to strike the arc, and for this purpose a small choke is placed in series with the stabilising resistance. The same automatic starting switch can then be used, as the collapsing flux in the choke will produce a high voltage surge across the lamp when the starting switch opens.

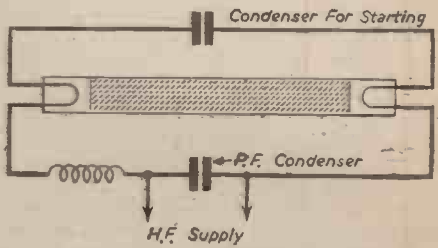


Fig. 7.—Diagram of starting circuit for H.F. use.

Efficiency of D.C.-operated Lamps

The efficiency of lamps operated from D.C. is greatly reduced, the input watts being greatly increased for the same light output as on an A.C. operated lamp.

For example, the 80-watt tube run on A.C. current at 50 c.p.s. uses 80 watts for the lamp and 12 watts for the choke, making the total wattage 92 watts. The efficiency is therefore $\frac{80}{92} \times 100 = 87$ per cent.

The D.C. lamp with resistance stabilisation takes 80 watts on the lamp, and 53 watts on the resistance, making a total of 133 watts. The efficiency is therefore $\frac{80}{133} \times 100 = 60$ per cent.

This means that the input for the same amount of light is, for D.C. operated lamps, 45 per cent. greater than for A.C. operated lamps.

Lamps may be used for A.C. and D.C. operation alternatively, but this would lead to unnecessary complications.

Choice of Lamps

As readers will be aware, 5ft. fluorescent lamps are now available in two distinct colours, one of these being "daylight" and the other, and more recent, is called "warm white." The choice of these lamps is important.

The "daylight" lamp has for its fluorescent coating inside the tube, a mixture of powders, the light from which contains the primary colours in almost the exact proportions as does noon sunlight. This tube is therefore best used when daylight conditions are required when artificial light is in use.

The "warm white" tubes emit a rather pink shade of light, which, after a few hundred hours of burning, resolves into a pleasantly warm light. This tube is most suitable for domestic lighting.

Fittings of various types have been designed for use with 5ft. tubes. The industrial fitting may consist merely of a long reflector, housing the lamp and the control gear and making one separate unit, or several may be joined together to form a continuous trough. These reflectors may contain more than one lamp placed side by side.

For domestic lighting various fittings have been evolved, some types having a decorative reflector and others concealing the tube by means of frosted glass.

The initial cost of fitting fluorescent lamps is high, many times higher than for incandescent filament lamps in fact, but they are economical to run and have a long life, which may be as long as 4,000 hours or more.

The life of the lamp is reduced by excessive switching, such as on flashing signs, but for domestic use switching has a very small effect on the life.

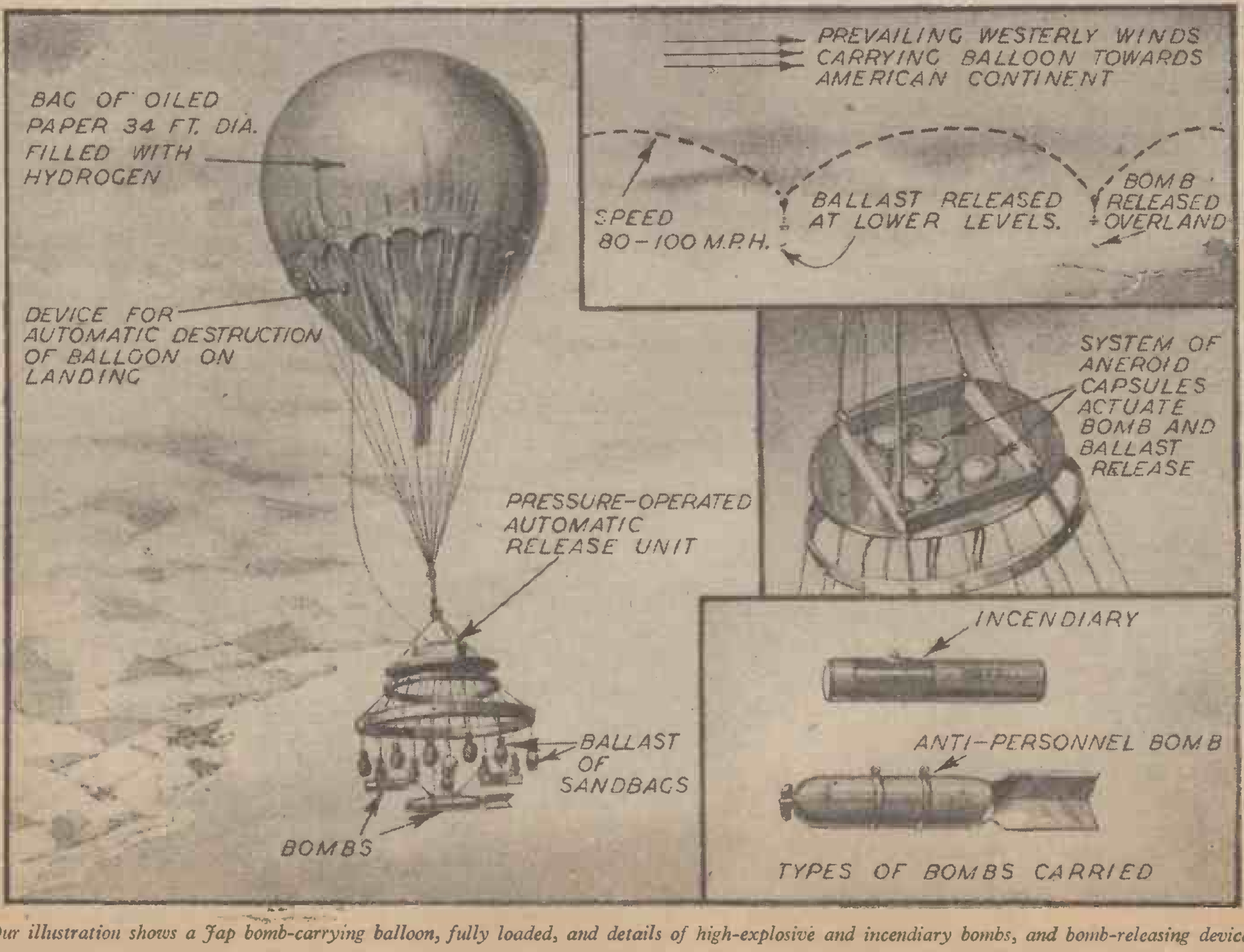
Conclusion

We may in the future hope to see fluorescent lamps of various sizes and colours used in many forms. Some residents in London have already had a glimpse into the future of fluorescent lighting when they saw the District Line railway car fitted with an experimental set-up of 2ft. lamps.

This is only one direction in which the fluorescent lighting experts are turning their energies in order to turn our nights into a simulation of day.

Jap Bomb-carrying Balloons

During the latter part of the war with Japan many Americans were aware that certain V-weapons were reaching some of the Western States, but news of this development was withheld until comparatively recently. According to a report received from America the balloons travelled at a great height on wind currents moving at a speed of 80 m.p.h.: these high-speed currents always travel from west to east. The balloons were grey-white, or greenish-blue in colour, and were made of oiled paper.



Our illustration shows a Jap bomb-carrying balloon, fully loaded, and details of high-explosive and incendiary bombs, and bomb-releasing device.

The Foundations of Thermodynamics—2

The Mechanical Equivalent of Heat, and Conservation of Energy

IN 1849, half a century after Count Rumford had made his famous cannon-drilling demonstration of the relation between heat and mechanical work, the first reliable estimation of the numerical relation between the work spent on and the heat developed in a substance appeared when Dr. James Prescott Joule, a Manchester brewer and scientist, published an account of his six years' research into the problem in a paper communicated to the Royal Society under the title "The Mechanical Equivalent of Heat." The results of his experiments are embodied in the celebrated equation W = J.H., where W and H represent respectively those quantities of work and heat which are equivalent in the sense that when one comes into existence the other goes out of existence. J is a constant which expresses the rate of exchange operating between the energy forms of heat and mechanical work, and is called the "Mechanical Equivalent of Heat," or, more simply, "Joule's Equivalent."

The apparatus built by Joule to make his measurements involved the principle that water can be warmed by shaking or stirring it. It is illustrated in Fig. 3. Water was stirred in a churn consisting of a cylindrical copper vessel fitted with a brass paddle wheel having eight sets of blades which worked between four sets of stationary vanes rigidly attached to the inside wall of the vessel. A doubled cord passing horizontally over pulleys, and kept in tension by means of slabs of lead suspended from the axles of the pulleys, was wound upon a vertical shaft which carried the paddle wheel at its base. The uncoiling of this cord as the masses descended under the force of gravity set the churn into motion by turning shaft and paddle. Continued rotation was maintained by making repeated descents of the masses through a measured height of about 5ft. At the end of each fall the paddle was disconnected from the shaft by withdrawing the taper-pin C and the system rewound in readiness for the next descent without disturbing the water, by turning the crank handle at the head of the shaft. The passage of the blades past the closely fitting vanes brought the water into a state of thorough agitation without swirling it round in bulk, and the frictional action of the paddles on the liquid produced heat which registered itself as a rise of temperature in the water and metal of the churn and paddle. Joule made precise measurements of the heat generated and the mechanical energy spent in friction with the water, and discovered the relation between them by evaluating the quantity J.

Calculation of Quantity J

Each descent of the masses M_1 and M_2 through a measured distance h, released for consumption in the apparatus a quantity of potential energy $(m_1+m_2).g.h$, where g represents the acceleration due to the earth's gravitational field. A total of n successive descents, where n is some integer, therefore made available an amount of potential energy $n.(m_1+m_2).g.h$.

This energy could be consumed by the apparatus in the following ways:

(1) As kinetic energy of translation of the masses and cords moving in linear directions. (Denoted by T.)

(2) As kinetic energy of rotation of the pulleys, shaft and paddle. (Denoted by R.)

(3) In overcoming frictional resistance in the pulley bearings, and viscous drag of the surrounding air on the moving parts of the apparatus. (Denoted by F.)

(4) In the production of heat in the churned water. The greater part of this heat (denoted by W) was recorded by the temperature rise of the churn and its contents. A smaller part (denoted by Q) was lost to the surroundings by radiation, convection and conduction, in the process of cooling.

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

(Continued from page 46, November issue)

If it is assumed that the energy is conserved in its quantity when it changes its form, the following relation must exist between the above quantities:

$$n.(m_1+m_2).g.h = T+R+F+W+Q$$

whence

$$W = n.(m_1+m_2).g.h - T - R - F - Q$$

The quantity T was calculated from the standard formula for kinetic energy, viz., $\frac{1}{2}.(m_1+m_2).v^2$ where V represents the end velocity of the masses and cords at the end of a descent, and (m_1+m_2) includes the masses of the cords in linear motion. The quantity R was calculated from the standard formula for rotational kinetic energy, viz., $\frac{1}{2}.I.w^2$, where I = the moment of inertia of the rotating body, and w = its angular velocity. Since the various rotating parts, pulleys, shaft and paddles possessed different moments of inertia, the total rotational kinetic energy was expressed by a summation of terms $\Sigma\frac{1}{2}.I.w^2$.

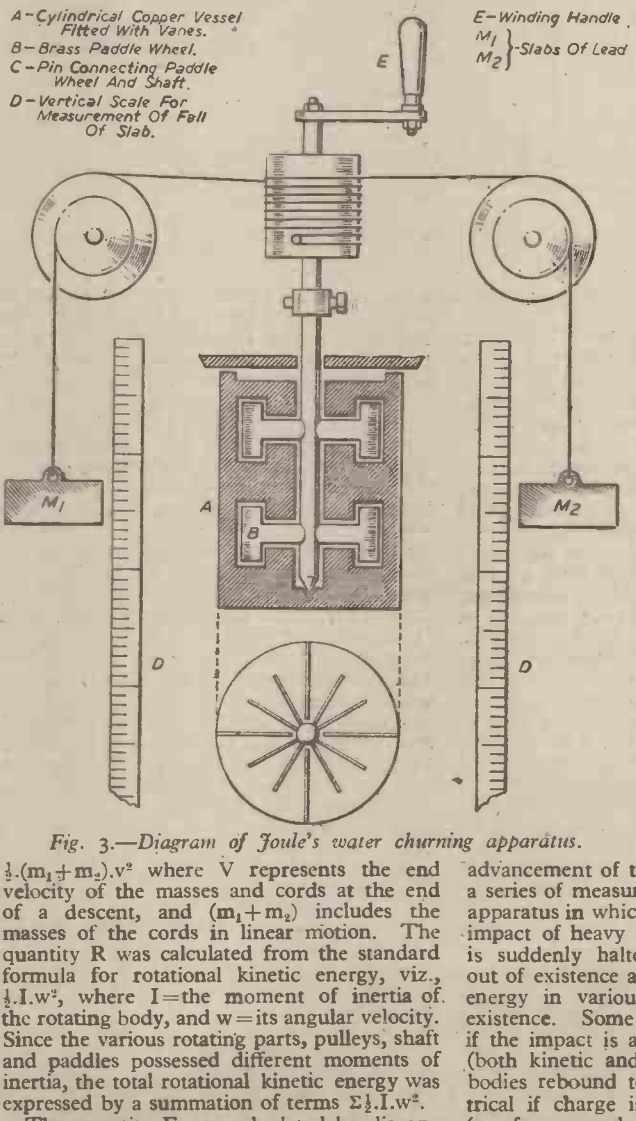


Fig. 3.—Diagram of Joule's water churning apparatus.

The quantity F was calculated by disconnecting the paddle wheel from the shaft by removing the pin and rewinding the cord about the shaft so that a descent of one lead slab caused a simultaneous ascent of the other slab, and noting the additional small mass b which, when attached to the descending slab, kept the system in uniform motion. Thus F = n.b.g.h.

The quantity Q was calculated in the standard manner by plotting a cooling curve for the water in the churn, and W was then found from the equation

$$W = n.g.h.(m_1+m_2) - \tfrac{1}{2}.(m_1+m_2).v^2 - \Sigma\tfrac{1}{2}.I.w^2 - n.b.g.h. - Q$$

The amount of heat H generated in the churn and contents and causing a temperature rise of t degrees, was calculated from the standard relation H = M.t, where M represents the water equivalent of the churn and contents. But J is defined by the equation W = J.H, and thus it can be calculated from the relation

$$J = \frac{W}{H} = \frac{n.g.h.(m_1+m_2-b) - \frac{1}{2}.[(m_1+m_2).v^2 + \Sigma I.w^2] - Q}{M.t}$$

Joule found in his carefully conducted tests that by giving W different values and measuring the corresponding yields of H, their ratio J, as calculated from the foregoing formula, always remained the same. This discovery was of major significance. It indicated that the initial assumption made in the above calculation that a given amount of mechanical energy could be totally converted into heat was justified, and, furthermore, that the conversion rate was universally constant. For otherwise, if W and H were only partly and haphazardly interchangeable, or to take the extreme case, not related at all, a series of different values of J would be obtained from a series of experiments in which W was assigned different values.

The value obtained by Joule for the constant J has since been confirmed by many other investigators. Some repeated the experiment with apparatus similar to that used by Joule himself, others used devices designed to work on a different principle. In 1858 Gustave Hirn, an Alsatian engineer, whose steam engine tests at a later date made a useful contribution to the advancement of thermodynamics, carried out a series of measurements of J with a piece of apparatus in which heat was generated by the impact of heavy solids. When a moving body is suddenly halted, its kinetic energy goes out of existence and an equivalent amount of energy in various other forms comes into existence. Some of this energy is acoustic if the impact is audible, some is mechanical (both kinetic and potential) if the colliding bodies rebound to new levels, some is electrical if charge is developed on the bodies (as, for example, when silk strikes glass), some is luminous if the shock produces sparks or a glow, and some, and as a rule the majority, is heat energy because of the extra agitation conveyed to the atoms or molecules of the colliding substances. It is for this reason that the water in a pool at the base of a waterfall is a little warmer than the water passing over the top of the fall.

Hirn's Impact Apparatus

Hirn selected the metal lead as the material to receive the impact, since the properties of this substance are such that most of the lost kinetic energy reappears in it as heat. Its softness makes a blow almost inaudible, its small elasticity produces little rebound in hammer and anvil, and its low specific heat gives a large temperature increase from the heat developed by the friction of its molecules while it is being deformed. His apparatus is illustrated in Fig. 4. A massive rectangular block of stone serving as anvil and a heavy solid cylinder of iron acting as hammer were suspended by means of parallel ropes from the cross-beams of a rigid wooden frame. A cylindrical vessel of lead was held with its base against an iron plate at the end of the stone anvil, and received the impact of the iron hammer released from its position 1 to swing down through a measured height h_1 into its position 2. In the recoil the hammer and anvil rose through small measured heights h_2 and h_3 respectively. The lead cup, released by cords immediately after impact, was then partly filled with a measured amount of ice-water and the rise in temperature of the water in the warm lead cup recorded.

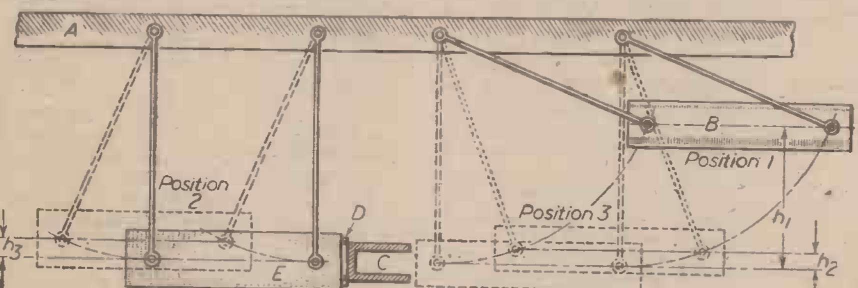


Fig. 4.—Diagram of G. A. Hirn's impact apparatus for the measurement of the mechanical equivalent of heat.

Let the masses of iron hammer, stone anvi and lead cup be denoted by m_1, m_2, m_3 respectively. Then the potential energy $m_1.g.h_1$ of the poised hammer is converted into kinetic energy during its downward swing, and as such is delivered to the lead cup by impact. A small part of this energy is used up mechanically as the hammer and anvil recoil through small heights h_2 and h_3. At their recoil peaks their potential energies are $m_1.g.h_2$ and $m_2.g.h_3$ respectively, so that a balance of energy $m_1.g.h_1-(m_1.g.h_2+m_2.g.h_3)$ is left to reappear in the lead as heat, if small energy losses due to noise of impact, viscous drag of air, friction of supports and so forth are disregarded. If t_1 deg. C. is the temperature of the lead immediately before the collision, t_2 deg. C. the final temperature after pouring in a mass m_0 of ice-water, and S is the specific heat of lead, then the heat developed in the lead is given by $m_3.S.(t_2-t_1)+m_0.t_2$. A value of J may then be estimated from the ratio

$$\frac{m_1.g.h_1-(m_1.g.h_2+m_2.g.h_3)}{m_3.S.(t_2-t_1)+m_0.t_2}$$

Whereas it was recognised that Hirn's experiment could yield no more than a very approximate value of the mechanical equivalent of heat because of the experimental error inherent in the apparatus, considerable importance was attached to the fact that a value of J in reasonable agreement with that obtained by Joule had been obtained by a method totally independent of that employed by Joule. It was a result which added further confirmation to the belief that the mechanical equivalent of heat was a universal constant. The principle of Hirn's apparatus has since been adapted by Whiting to the familiar laboratory method of making a rapid estimation of J by measuring the rise in temperature produced in a few grammes of mercury or fine lead shot enclosed in a long sealed glass or cardboard tube which is reversed several times from the vertical position. The lead or mercury is heated in this case by its impact on the tube end after falling through the length of the tube.

Searle's Friction-cone Apparatus

A more modern form of laboratory instrument designed by Dr. G. F. C. Searle for the measurement of the mechanical equivalent of heat is illustrated in Fig. 5. In this apparatus heat is developed by friction between the slightly lubricated surfaces of two closely fitting, hollow conical cups of brass which turn, one within the other, about a common axis of rotation. By means of pins protruding from its base, the outer cup is fitted to an ebonite seat in a brass holder which is mounted on a vertical spindle set in bearings in the base of the apparatus. The spindle is turned by means of a belt which passes round the spindle-wheel, over a pair of guide pulleys to the hand-wheel used by the operator to set the apparatus in motion. The inner conical cup carries two vertical pins on its lip which fit into a broad wooden disc. A cord with one end attached to the rim of this disc passes over a pulley and holds a mass in suspension at a fixed level when the apparatus is in operation. A heavy iron ring pinned to the top surface of the disc presses the cups together and provides a suitable force of friction when they rotate. In performing the experiment the hand-wheel is turned at such a rate that the friction between the inner and outer cups is just sufficient to prevent the former from rotating under the tension in the cord which carries the suspended weight. Careful control of the turning of the hand-wheel is needed to keep the weight suspended at a constant level. The heat developed by friction distributes itself throughout the brass of the two cups and the water in the inner cup, and the rise in temperature produced by a counted number of revolutions is registered by a thermometer in the water. Adequate thermal insulation of the heated part of the apparatus is provided by the ebonite seat and collar which hold the cups, so that only a small percentage of the heat generated is lost by conduction, convection and radiation to the surroundings.

By turning the outer cup at such a rate that the force of friction is balanced by the tension in the cord attached to the disc, the inner cup remains motionless, and the same amount of mechanical work is used up as would be used if the outer cup were kept at rest and the inner one rotated at the same speed. Thus the work spent in making n revolutions of the outer cup is the same as the work which would be spent if the inner cup were to make n revolutions under the motive force of the descending suspended mass. From the Poncelet definition of work, W is then given by $W = 2.\pi R.n.m.g$, where R denotes the radius of the wooden disc, m the mass suspended from the end of the cord, n the number of revolutions and g the acceleration due to gravity. Further, if A represents the mass of the two brass cups, S the specific heat of their material, B the mass of water in the inner cup, and T the observed rise of temperature, then the heat developed by the friction (if small losses are neglected) is given by $H = (A + B.S).T$. The mechanical equivalent of heat may then be calculated from the formula

$$J=\frac{W}{H}=\frac{2\pi R.n.m.g.}{(A+B.S).T}$$

The discovery that when work is converted into heat and heat into work, the transformation is complete, and is governed by a universally constant rate of exchange J, is sometimes called the First Law of Thermodynamics. This rule has since been generalised as subsequent investigations into the exchange rates between other forms of energy have shown that they all conform to the same general principle, and it is now customary to state the first law of thermodynamics as follows: When energy of one sort goes out of existence an equivalent amount of energy of another sort comes into existence so as to leave the sum total of energy unaltered.

Conservation of Energy

The proof that heat and mechanical work were two different aspects of the same thing was but one link in a wide chain of experiment and reasoning which led to the founding of the doctrine of the conservation of energy. This doctrine was not the outcome of the work of any single individual, nor was it a discovery made suddenly at a certain time. In the history of physical science there are to be found many instances of discoveries of outstanding principles and phenomena which have associated with them a definite date of discovery and a single name of a discoverer. Notable examples are Clerk Maxwell's electromagnetic theory of light (1865), Planck's quantum hypothesis (1900), Einstein's relativity principle (1905), and Rutherford's nuclear theory of the atom

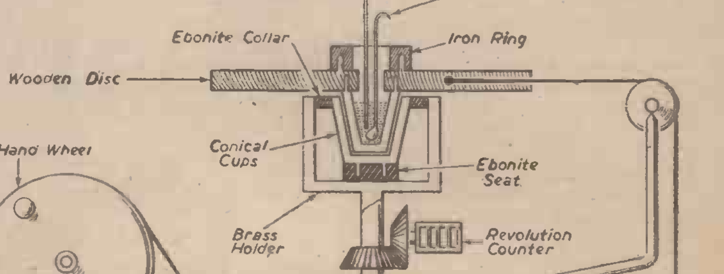


Fig. 5.—Diagram of Searle's friction-cone apparatus for the measurement of the mechanical equivalent of heat.

(1911). The principle of the conservation of energy does not belong to this category. It is a theory which has evolved slowly over a period of many years, and the evidence on which it rests has been collected by many people. In 1688 Wallis and Huygens in their study of the motion and impact of solid bodies discovered the principle of the conservation of momentum. The unpublished notebook of Sadi Carnot, examined after his death in 1832, showed that he believed that energy was conserved in amount during its heat and work transformations. In 1843 Sir William Robert Grove delivered a lecture at the Royal Institution on "The conservation of physical force," in which he outlined the theory of energy conservation in general. In the same year Ludwig August Colding, a Danish engineer, communicated a paper to the Royal Society of Copenhagen on the conservation of force. At intervals from the year 1841 to 1851 Robert Mayer, a German physician, published papers on the conservation principle written from the point of view of biological physics as well as pure physics. In 1847, while Joule was making his historic experiments, Ludwig von Helmholtz, philosopher and man of science, published a paper entitled "The Conservation of Force," in which he attempted to extend the principle of energy conservation to all known branches of science. In 1853, at the Hull meeting of the British Association, Waterston proposed the doctrine in general terms, and in the following year it was taken up and greatly amplified by William Thomson, afterwards Lord Kelvin.

Almost all of this work, carried out by different investigators during the first half of the nineteenth century, seems to have been done independently. There is little evidence to show that ideas were freely exchanged on the subject until the time of the British Association meeting in 1853. No single date can be named as the time from which the doctrine was universally believed in, but it is probable that shortly after 1853 it was generally known and accepted in scientific circles. Just how fundamental a principle really is may be judged from the extent of its applications, and by this test the principle of conservation of energy ranks first on the list of generalisations in science and occupies, as a consequence of its generality, a key position in the structure of physical theory.

(*To be continued*)

High-power Short-circuit Testing–8

Measuring and Computing the Power Factor

By S. STATON

(*Continued from page 57, November issue*)

BEFORE proceeding to discuss a final record of standard test duties on a circuit breaker, the method of measuring and computing power factor and the equivalent steady R.M.S. value of current from a short time test will be described.

Measurement of Power Factor

Prior to carrying out a short-circuit test, the power factor of the circuit can be obtained from the known circuit constants for the particular test set up.

If R is the resistance of the test circuit and X is the reactance, then the power factor may be obtained by the formula:

$$\text{Power Factor} = \frac{R}{\sqrt{R^2+X^2}} = \text{Cos. } \phi$$

where ϕ = the angle of lag or lead of the current vector with respect to the voltage. The value of power factor as calculated above can be checked from the oscillograph record of the phase currents.

This is done by calculating the time constant of the D.C. component curve from one of the phases in which the current is asymmetrical. The method is as follows: Fig. 21 shows an asymmetrical current wave. The D.C. component curve is indicated by the line A—B.

This curve is reproduced in Fig. 22, and it will be seen that the curve follows a decremental law given by the equation $i = I_e - \frac{Rt}{L}$ where i is the value of the D.C. component of the current at any instant t.

I is the initial value of the D.C. component of the current.

e is the naperian log base = 2.7183.

R is the circuit resistance.

t is the time measured from the commencement of the short-circuit.

L is the circuit inductance.

The values of I – i and t may all be obtained from the oscillograph record as shown in Fig. 21. These can then be substituted in the above equation, leaving the values R and L as unknown. By cross multiplying the equation we get:

$$\frac{i}{I} = {}_e - \frac{Rt}{L}$$

Inverting both sides we have

$$\frac{I}{i} = {}_e \frac{Rt}{L}$$

Take logs, then,

$$\log_e \frac{(I)}{(i)} = \frac{Rt}{L}$$

then

$$\log_e \frac{(I)}{(i)} = \frac{R}{L}$$

Now time constant for the circuit $= \frac{L}{R}$,

therefore $\frac{L}{R} = \frac{t}{\log_e} \frac{(I)}{(i)}$.

Since, as stated above, the values of t, I and i are known, it is merely a matter of arithmetic to obtain the time constant $\frac{L}{R}$.

The angle ϕ can now be determined from the formula:

$$\phi = \tan.^{-1} \quad 2\pi f \times \frac{L}{R}$$

where $\pi = 3.14$ and f = the power frequency,

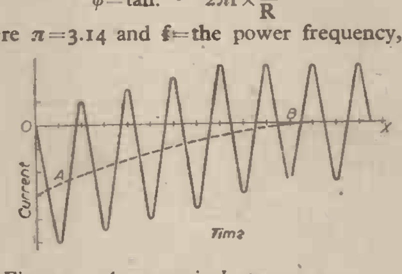


Fig. 21.—Asymmetrical current wave.

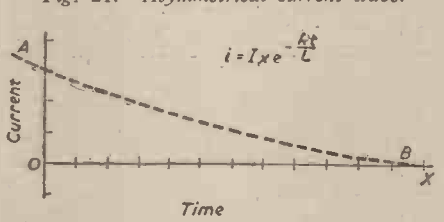


Fig. 22.—Reproduced D.C. curve from Fig. 21.

the power factor is then obtained by observing the cosine of the angle ϕ from a set of tables.

Measurement of Short Time Current

Reference to the short time current carrying test was made in Article 1. It was stated that the short-circuit current was passed through the circuit breaker for intervals of one and five seconds.

Fig. 23 shows an oscillograph record of a short time test on a 3-phase circuit breaker.

The red phase trace is reproduced separately in Fig. 24.

The lines A—B and O—G are the current wave envelope.

O—X is the current zero line and E—F is the displaced zero due to current asymmetry.

The current wave is split up into 10 equal portions by drawing in vertical ordinates as shown numbered 0—10 inclusive.

The asymmetrical R.M.S. value of the current is calculated by the formula:

$$I \text{ asy.} = \sqrt[2]{\frac{K^2}{2} + J^2},$$ as described in article 6, at the instant of each ordinate.

The 11 values so obtained are then plotted on the record to scale and the line C—D dotted in.

They are then summated to give the equivalent steady R.M.S. value of current over the test period by the formula:

$I_{R.M.S.}$ eqv. =

$$\sqrt[2]{\frac{1}{30}\left(I_0^2 + 4(I_1^2 + I_3^2 + I_5^2 + I_7^2 + I_9^2) + 2(I_2^2 + I_4^2 + I_6^2 + I_8^2 + I_{10}^2)\right)}$$

where I_0—I, and I_2, etc., are the asymmetrical values of current at each ordinate.

Complete Record

A complete tabulated record of a short-circuit test is shown in the accompanying table. All figures are set together for a series of test duties as set out in BSS/116/37. Notes on the performance and condition of the breaker during the test duties are logged in the last column. This record should be compared with the standard test conditions and limits set out in Article 1 (page 271, May issue). A few brief comments will serve to explain the significance of the figures recorded.

Performance and Condition

After all test duties had been carried out, the breaker was still fit for normal service. No excessive burning of the contacts took place and only moderate smoke and oil emission.

The arcing times are reasonable as compared with most circuit breakers, and well up to standard when compared with similar types of circuit breaker of the same capacity.

Power Factor

The power factor limit set out in Article 1, is 0.15 for a breaker of this capacity.

The values of 0.06 and 0.058 for this test are a very good indication of the margin of severity of the test circuit. These low values have a bearing on the recovery voltage as explained in Article 1.

Test Duty	Phase	Making Current in Kilo Amps.	Breaking Current: Symmetrical Kilo Amps.	Breaking Current: % of D.C. Component	Breaking Current: Asymmetrical Kilo Amps.	Recovery Voltage: Value in Kilo Volts	Recovery Voltage: % of Rated Kilo Volts	M.V.A. Broken: Per Phase	M.V.A. Broken: Total	Power Factor	Arcing Time in Seconds	Remarks on Physical Behaviour
TEST No. 1. 10% OF RATED SYMMETRICAL BREAKING CAPACITY. BREAKER FULL OF CLEAN OIL. NEW CONTACTS FITTED.												
Break	Red		1.81	7.0				11.584			0.040	
	Yellow		1.80	7.2				10.98			0.040	
	Blue		1.80	7.0		11.20	101.5	12.42	34.984	0.063	0.030	
3 Minutes												
Break	Red		1.82	9.1				12.012			0.030	Slight emission of oil. Arc contacts moderately burnt.
	Yellow		1.81	7.0				11.946			0.040	
	Blue		1.80	6.8		11.35	103.2	11.610	35.568	0.059	0.050	
3 Minutes												
Break	Red		1.82	8.2				12.210			0.040	
	Yellow		1.82	9.0				11.961			0.040	
	Blue		1.80	9.1		11.70	106	12.40	36.571	0.060	0.040	
TEST No. 2. 30% OF RATED SYMMETRICAL BREAKING CAPACITY. OIL TOPPED UP. CONTACTS FILED.												
Break	Red		2.30	9.2				15.870			0.050	
	Yellow		2.31	9.7				16.100			0.040	
	Blue		2.30	9.0		11.80	107.4	15.961	47.931	0.061	0.040	
3 Minutes												
Break	Red		2.33	10.2				15.990			0.050	Slight emission of oil and smoke. Arc contacts moderately burnt and pitted.
	Yellow		2.31	9.3				16.201			0.050	
	Blue		2.31	9.4		11.70	106	16.122	48.312	0.061	0.040	
3 Minutes												
Break	Red		2.30	9.3				15.881			0.040	
	Yellow		2.30	9.3				16.000			0.050	
	Blue		2.30	10.0		11.80	107.4	16.214	48.095	0.060	0.060	
TEST No. 3. 60% OF RATED SYMMETRICAL BREAKING CAPACITY. OIL CHANGED. ARC CONTACTS RENEWED.												
Break	Red		4.81	11.1				31.220			0.050	
	Yellow		4.80	10.8				30.890			0.050	
	Blue		4.80	10.5		11.20	101.5	31.060	93.170	0.060	0.050	
3 Minutes												
Break	Red		4.81	11.6				31.771			0.050	Slight emission of oil and smoke. Slight burning marks on arc contacts.
	Yellow		4.82	11.0				30.910			0.050	
	Blue		4.82	9.0		11.20	101.5	30.861	93.542	0.061	0.060	
3 Minutes												
Break	Red		4.82	7.6				31.611			0.050	
	Yellow		4.80	8.3				31.723			0.040	
	Blue		4.81	9.0		11.30	103	30.990	94.324	0.061	0.040	
TEST No. 4. 100% OF RATED SYMMETRICAL BREAKING CAPACITY AND 100% RATED MAKING CAPACITY. OIL TOPPED UP.												
Break	Red		9.10	9.8				61.611			0.050	
	Yellow		9.10	6.3				61.403			0.060	
	Blue		9.10	5.9		11.60	105.2	61.221	184.235	0.061	0.060	
3 Minutes												
Make-Break	Red	18.0	9.10	9.7				61.400			0.060	Slight oil emission. Moderate smoke emission. Main contacts pitted. Moderate burning of arc contacts.
	Yellow	21.4	9.0	9.9				61.201			0.050	
	Blue	22.0	9.15	9.1		11.75	106.2	62.331	184.932	0.061	0.050	
3 Minutes												
Make-Break	Red	21.5	8.9	7.6				60.721			0.050	
	Yellow	22.0	9.0	7.3				60.812			0.050	
	Blue	23.0	9.0	8.7		11.20	101.5	60.660	182.193	0.060	0.050	
TEST No. 5. 100% OF RATED ASYMMETRICAL BREAKING CAPACITY. OIL CHANGED. CONTACTS RENEWED.												
Break	Red		9.0	52.7	9.50			61.21			0.050	
	Yellow		9.1	60.0	12.00			61.171			0.040	
	Blue		9.1	60.0	12.00	11.80	107.4	60.911	183.292	0.061	0.050	
3 Minutes												
Break	Red		9.1	71.0	12.80			61.161			0.060	Moderate smoke and oil emission. Main contacts pitted. Arc contacts moderately burnt. Breaker fit for normal service.
	Yellow		9.2	67.2	12.65			61.371			0.050	
	Blue		9.1	51.0	11.20	11.80	107.4	60.211	182.743	0.061	0.050	
3 Minutes												
Break	Red		9.1	52.0	11.30			62.010			0.050	
	Yellow		9.0	50.9	9.70			61.321			0.040	
	Blue		9.0	55.0	9.85	11.80	107.4	61.000	184.331	0.061	0.050	

TABULATED RECORD OF SHORT-CIRCUIT TEST ON OIL CIRCUIT BREAKER.
BREAKER TYPE B. 150 M.V.A. RATING. 11,000 LINE VOLTS. 3-PHASE. 50-CYCLE.

Recovery Voltage

It will be noted that the recovery voltage never fell below 100 per cent. of the rated line volts, so that the limit in BSS/116/37 of 100 per cent. is well covered. In Test No. 5 it rose to 104.6 per cent., which figure more than covers the requirements.

D.C. Component

The severe conditions of test on this breaker are further borne out by the figures obtained for the D.C. component. Conditions are laid down that for a symmetrical test the D.C. component must not exceed 20 per cent. of the A.C. component, and for an asymmetrical test it must not fall below 50 per cent.

M.V.A. Broken

The M.V.A. broken is well in excess of the rated capacity of the breaker. It should, of course, be noted that when a test circuit set-up is being made, it is only possible to set the M.V.A. figure to within approximately 5 per cent. of the rated capacity, and consequently the tester allows a margin in excess as a factor of safety.

Restriking Voltage

The subject of restriking and active recovery voltage is one that has occupied a prominent place in the minds of switchgear engineers for many years. Its implications and bearing on circuit breaker performance has been the subject of many technical papers, etc., but the writer, in his experience and perusal of the subject has failed to find any work which sets the matter out in a simple way for the benefit of the general engineer, it will, therefore, be the effort here to explain the matter in the simplest possible way. To begin with, the reader should bear in mind that it is with the permanent extinction of the current arc across the circuit breaker contacts that we are mainly concerned. It will be recalled from our studies of oscillograph records that the arc is always interrupted on or about the instant of zero current. Consider now what is happening immediately before the arc interruption; the current is very quickly decreasing in value. In other words, the "rate of change of current" has a very high value. At the instant of zero current, the arc is interrupted and hence the current ceases to flow. This means that the "rate of change of current" has been suddenly reduced from a very high value to zero. This sudden reduction in the rate of change of current gives rise to an oscillating voltage across the circuit breaker contacts. Such a voltage is termed "restriking voltage," because it tends to restrike the arc.

Frequency

The frequency of the restriking voltage depends upon the test circuit constants, viz., inductance and capacitance, and in actual fact is equal to the natural frequency of the test circuit. It does not depend upon the normal power supply frequency from the test generator.

Rate of Rise

The rate of rise of the restriking voltage is obviously determined by the frequency, and it is this rate of rise that determines whether or not the current arc is permanently interrupted. This will be understood when we recall the statement in Article 1, that permanent interruption of the arc can only take place if the rate of rise of dielectric strength of the insulating oil between the contacts exceeds that of the voltage across them.

Amplitude

The amplitude of the restriking voltage oscillations depends upon the instantaneous value of the recovery voltage, at the instant of sudden rate of change of current or arc

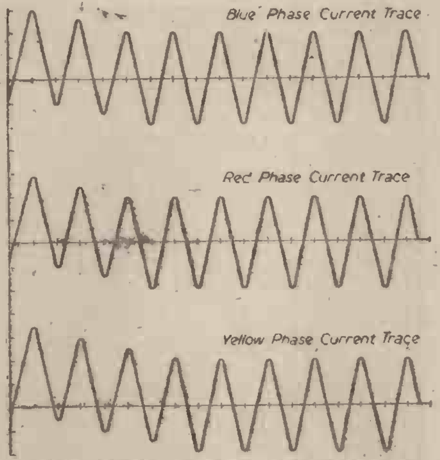


Fig. 23.—Oscillograph record of 3-phase short time test.

extinction; and if a short-circuit is interrupted at the instant of zero current the amplitude is equal to that of the instantaneous recovery voltage.

The Bearing of Synchronous Plant on Restriking Voltage

From what has been explained about the rate of rise of the restriking voltage, and its bearing on the restriking of the arc, it will be gathered that when a circuit breaker is in service, its ability to permanently interrupt a short-circuit depends much upon the type of generator supplying the line and the characteristics of any synchronous plant between the generator and the point of short-circuit. It would, of course, be out of line to discuss the characteristics of electrical machinery in these articles, but it is fitting that some attention be drawn to their effects on the subject in question. Whatever may be included in the system, the circuit can be reduced to three components, viz., resistance, capacitance and inductance. Resistance and capacitance are constant, but the sudden changes in current value cause corresponding changes in the flux linkages and hence the inductance of transformers, reactors and any rotating machinery.

Active Recovery Voltage Definition

It has been stated that the amplitude of the restriking voltage oscillations depends upon the instantaneous value of the recovery voltage. It is this instantaneous value divided by $\sqrt{2}$ that is termed "active recovery voltage."

Bearing of Current Asymmetry and Power Factor

The value of the active recovery voltage depends upon the system power factor and the degree of asymmetry of the current wave. This is illustrated in Fig. 25, in which is shown an asymmetrical current wave and the corresponding phase voltage wave. If the current arc is assumed to be interrupted at the instants of zero current, it will be seen that at each such instant the voltage wave has a different amplitude. These corresponding voltage values, divided by $\sqrt{2}$ represent the values of active recovery voltage at the particular instants. It will be appreciated that the lower the power factor of the system, the higher will be the value of the active recovery voltage since a zero point in the current wave will correspond more closely with a maximum point in the voltage wave. If the first two or three cycles of the current wave are examined, it will be noted that the degree of asymmetry is considerable, and that the values of voltage indicated by V_1 and V_2 are very far apart. At the other end of the wave, however, where the current is more symmetrical, the values of voltage indicated by V_4, V_5 and V_6, are substantially the same.

Relevant Provisions of BSS/116/37

The foregoing serves to explain the control of recovery voltage, test circuit power factor, and the degree of asymmetry in Part 1 of BSS/116/37. These provisions were outlined in Article 1. It will have been noted that when commenting on the provisions of voltage and power factor in Article 1, it was stated that for circuit breakers of larger breaking capacities than 500 M.V.A. the value of the recovery voltage must be as near to 100 per cent. of the rated service voltage as possible. This, in effect, leaves the matter uncontrolled, and it is now opportune to give some explanation for this. A circuit breaker of 500 M.V.A. capacity and upwards would only be installed at a point in the supply system where a large power is to be handled. Such a point is obviously at the head of the system, or in other words, near to the generating plant. If a short-circuit occurs near to the latter, the short-circuit current will be relatively high because of the comparatively small amount of line and plant reactance in between the generator and point of short-circuit. This, in turn, will effect a correspondingly large drop in voltage, and hence the value of the recovery voltage will be comparatively low.

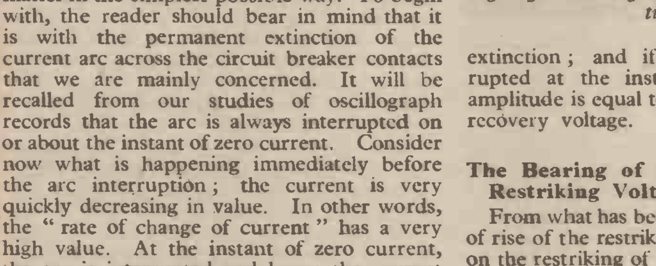


Fig. 24.—Reproduced red phase current trace showing method of measurement of short time current.

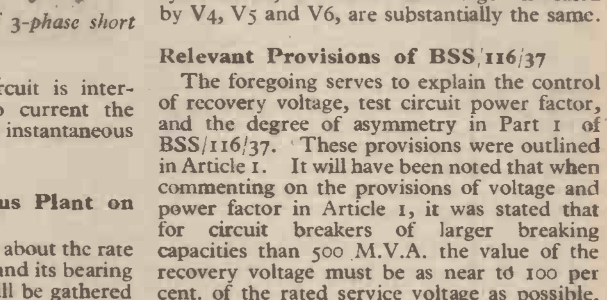


Fig. 25.—Curves showing recovery voltage values for various instants of current zero.

The Annals of Electricity—8

Alessandro Volta, Discoverer of the Electric Current

MORE than any material monument could ever do, that universal designation of the simple unit of electrical pressure or potential, to wit, the *volt*, has enshrined in perpetuity the memory of Alessandro Volta, the Italian physics professor, who first discovered the electric current towards the end of the eighteenth century.

Volta's lasting fame and celebrity is a deserved one, for it was he who, through the "invention" of the electric current, made the first really practical stride towards the day-by-day utilisation of electrical energy which we see around us in modern times. It was, indeed, this pioneering discovery of Alessandro Volta which paved the way for the host of important electrical discoveries and applications which came after him.

The epoch-making discovery of the electric current was intimately bound up with the "frogs' legs" business of Volta's countryman and contemporary professor Dr. Luigi Galvani, whose life-story formed the theme of our last article of this series.

Galvani, it will be remembered, had nailed his colours to the mast of "animal electricity," and perhaps because of that he had died a disappointed man. He had maintained that the convulsive twitchings of frogs' legs, when dissected and touched at certain points with metallic conductors, were due to inherent electrical charges *within* the animal muscles. Volta showed that such a hypothesis was simply not true, and because Volta, at that time, was professor of Physics in the University of Pavia, and, so to speak, Galvani's "opposite number" in the Italian academic world, a controversy arose which at one period seemed to rock the very fundamentals of science.

Electricity from Dissimilar Metals

It was because Volta had been able to demonstrate the fact that the characteristic twitchings of the dissected legs of frogs were due to the influence of two dissimilar metals in the presence of moisture and traces of mineral salts derived from the flesh and muscles of the amphibians that the same investigator was led to experiment with the effect of salt solutions on dissimilar metals, and, as a result, not only finally and conclusively to confute Galvani's theorems, but, more important still, to introduce to the world for the first time a controllable means of generating a continuous flow of electricity—in other words, an electric current.

Alessandro Guiseppe Volta was born at Como, Northern Italy, on February 18th, 1745, the year of the "Bonny Prince Charlie" uprisings and their ruthless suppression in England.

Alessandro was the child of parents who were "down on their luck." Indeed, the child himself seems, as a youngster, to have been

Alessandro Volta, discoverer of the electric current.

afflicted with some of his parents' bad luck, for at four years of age he was unable to speak, whilst a year or two later he was considered to be an imbecile. But after attaining the age of ten his wit suddenly quickened and a flood of intelligence came upon him. He went to the Jesuit school in Como, and within five years he was the school's leading scholar.

"I had a diamond in my house," remarked his father on one occasion, "but I failed to realise it."

Latin Poems on Chemistry

At the age of nineteen, Volta was composing Latin poems on various chemical subjects, a fact which tells us that the growing chemical science of the day must have claimed him as a close adherent.

Finishing his education at the Royal Seminary in Como, Volta settled down to the humdrum life of a teacher. However, he seems not to have taken too kindly to the monotony of this career. Stirred up by the experimental writings of the famous Abbé Nollet, of France, he began experimenting for himself in the realms of frictional electricity. He entered into a voluminous correspondence with the learned Abbé, as well as with other pioneer electrical experimenters, including the famous English electrical and chemical pioneer, the Rev. Joseph Priestley, discoverer of oxygen.

The Electrophorus

In 1775 Volta announced his discovery of the "Electrophorus," the principle of which he hit upon when studying the insulative properties of oil-impregnated timber.

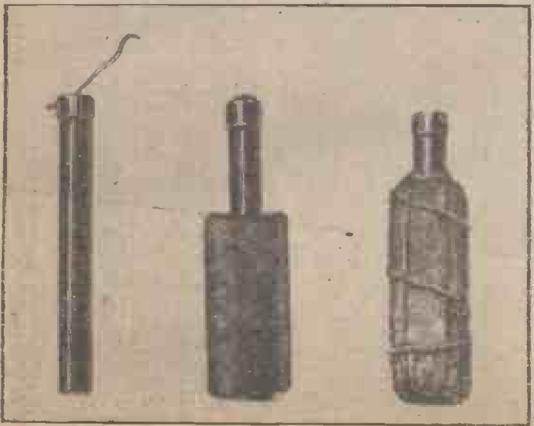
The electrophorus (or "electricity-bearer") comprises a circular moulded cake of resin suitably mounted on wood. Resting on its upper surface is a metal disc provided with an insulated handle.

The resin cake is electrically excited by rubbing a dry fur over it, after which the metal disc is placed in firm contact over it. The disc is then momentarily touched with the finger, and it is subsequently lifted out of contact with the resin. It will then be found to be heavily charged with electricity, so much so that it will be capable of emitting sparks.

At the same time, the cake of resin retains its charge, and it will induce a second and even a third and successive charge in the metal disc whenever the latter is allowed to make contact with it.

The explanation of the electrophorus's action is simple. The resin cake is charged negatively by the rubbing. On placing the metal disc on its surface the disc becomes positively charged on its lower or under surface and negatively charged on its upper surface. A mere touch of the finger provides a leakage path for the whole of the upper-surface negative charge, the disc retaining only its positive charge which is capable of giving rise to sparks and to other static electrical phenomena.

Here, therefore, was a simple means of generating relatively strong static charges without continuous frictional rubbing, for once the resin cake was frictionally electrified the metal disc could again and again be charged up without much diminution of the charge on the resin base.



The elements of the modern dry battery cell which has developed out of Volta's discovery. (The outer zinc casing forming the cell is not shown in this illustration.)

A modern reproduction of Volta's "Crown of Cups." From this primitive device, the primary battery was developed.

Invention of the Condenser

Volta gave a good deal of thought to the improvement of his electrophorus apparatus. In consequence of his ensuing experiments he not only improved the ordinary gold-leaf electroscope but he also devised an electro-nometer, or static potential measurer. More important still, he was led to the invention of the electrical condenser.

The principle of the condenser is so widely known that there is no need to occupy valuable space in again describing it. Let it be said, therefore, that Volta gave a long description of his plate condenser in the Royal Society's *Philosophical Transactions* for 1782 (about three years after he had originated the device), and that by means of this simple yet fundamental appliance he was for the first time able to store up minute electrical charges until they were able to produce plainly demonstrable effects.

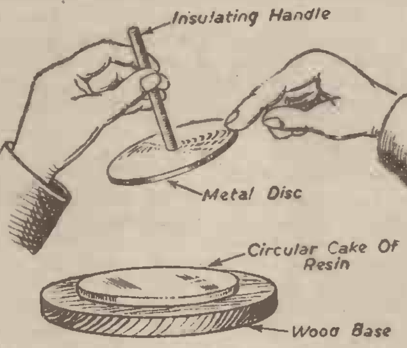
In 1779 Alessandro Volta was appointed to the vacant professorship of Physics in the University of Pavia. It was an important teaching and academic post, for Pavia had become a noted centre of Italian learning, and it had gathered a name for itself in respect of its advanced scientific teaching.

A year or two after his installation as professor of physics Volta made an extensive tour of the Continental centres of experimental science, coming into close contact with various investigators and, incidentally, collecting much apparatus for the enlargement of his own physics and electrical laboratories at Pavia. He travelled as far as London, demonstrated some experiments to the Royal Society, and then departed homewards. The Royal Society Council elected him an F.R.S., and, some three years later, awarded him its greatest honour, the Copley Medal, in recognition of his pioneering work in electrical science.

Returning to Italy and to his professorship at Pavia, Volta married. The lady in question was one Teresa Peregrini, a woman of noble birth but of no estate or fortune. She made Volta an excellent wife, assisting him in his researches and taking off his shoulders a good deal of the necessary routine work of his calling.

It was now that Alessandro Volta started on his immortal investigations which, in the end, led him to the discovery of the electric current and of a simple means of generating it.

Another simple primary cell—zinc and carbon elements immersed in a solution of sal-ammoniac (ammonium chloride). From this was developed the well-known Leclanché battery.



The electrophorus, Volta's invention, whereby strong electrical static charges are induced in a circular metal plate.

Galvani versus Volta

Galvani, who had caused such a stir in continental scientific circles with his discovery of so-called "Animal Electricity," was, at that time, a professor of Anatomy in the University of Bologna. He had made his name celebrated by his theories of animal electricity, and there were few who were likely to dispute his contentions.

But Alessandro Volta, with his improved electroscopes and electronometers, with his newly constructed condensers and his superior electrical knowledge, was able to repeat the "frogs' legs" experiments of Galvani with a greater scientific exactitude.

The simplest voltaic cell-electrodes of copper and zinc immersed in diluted sulphuric acid.

Volta obtained the same results as Galvani, but, as we have seen, his basic interpretation of them was altogether different. In short, Volta entirely refuted the theories and contentions of his contemporary, Galvani. Thus began an urgent scientific controversy, an academic contest during which feeling seemed, for a period, to run dangerously high on both sides, but which in the end concluded with a decisive victory for Volta's experiments and Volta's reasonings.

This strenuous contention between the professional anatomist and the professional physicist was no mere storm in a teacup. It raged throughout Europe. It penetrated into British scientific circles as well, splitting the scientific world of the day into two sometimes bitterly opposed factions, the *Galvanists* and the *Voltaists*.

Experiments on Criminals

An entire volume could be written on the subject of this early scientific controversy. But such a volume has not yet appeared. It would, however, tell of the manner in which the Galvanists applied their experiments with considerable ingenuity to the bodies of cows, calves, sheep and pigs in order to contort the limbs of these dead animals into life-like movements through the agency of "animal electricity." It would relate also the gruesome experiments on the bodies of executed criminals whereby dead limbs were made to execute mysterious contortions and even decapitated heads to produce horrible, convulsive grimaces.

But all such experiments, accurate and logical as they may have been, were all perfectly explainable on Volta's thesis of the electricity's origin. In a word, Volta discovered that electricity made its appearance whenever two dissimilar metals came into contact, particularly in the presence of salt solutions.

The "Crown of Cups"

In order to prove his contention that electricity can be produced by the action of mineral salt solutions on dissimilar metals Volta devised his now famous and classical "corona," or *Crown of Cups*.

The "Crown of Cups" was the world's first electric battery, the first current generator ever made. In it plates of zinc and silver (afterwards zinc and copper) were immersed in pairs, one zinc plate being soldered up to the adjoining silver (or copper) plate in the adjacent cup. The cups were filled with a solution of common salt. On joining up the two end electrodes of the series of cups (i.e., the silver and the zinc plate) a steady supply of electricity was drawn from the cups.

Owing to what we now term the "polarisation" of the electrode plates, the action of the Crown of Cups was not very satisfactory, but about the year 1800 Volta gave to the world his famous "Pile," the product of eight years' work on the "animal electricity" controversy.

Volta's Pile

Volta's Pile was described in a letter which was read before our Royal Society in June, 1800. In this letter Volta says that his

Volta's Pile, the world's first current generator.

newly invented pile "consists of several dozen discs of copper, brass or silver, and an equal number of discs of tin or zinc of the same size. Between each pair is a cloth disc damped with salty water, the whole forming a pile or column. First copper, then zinc, then cloth and so on, being careful to complete the pile with a metal disc different from that which began it."

Here was the practical outcome of Volta's theories on the generation of electricity by the contact of dissimilar metals in the presence of salt solutions.

The pile was enclosed in a light frame of wood or glass uprights. A wire was attached to its top disc and another wire to its bottom disc. On joining the two wires together a continuous current flowed through the circuit. Moreover, the current flow was constant, and it could be increased or decreased by varying the number of discs in the pile.

The Voltaic Cell

From the simple Crown of Cups and the Voltaic Pile, it was but a short step to the Voltaic cell made by placing a zinc and a copper plate in a vessel containing dilute sulphuric acid. But this was the last of Volta's discoveries. Indeed, from a point of view of discovery, Volta's increasing fame seems to have been his downfall. The principle of the cell was enormously developed in England at the hands of Davy, Wollaston, Cruikshank and others. It was used for the electrolysis of water, for the liberation of new metals by electrolytical means, for the production of the electric arc and for various other uses, yet never an interest did Volta himself seem to take in these British advances.

In 1823 he suffered an apoplectic seizure, from which he never really recovered. The end came, nearly four years later, when, on March 5th, 1827, he died after a day or two's illness.

What Do You Think?

Further Comments on Some Interesting Subjects

By Prof. A. M. LOW

I HAVE been sitting in a garden. I cannot help feeling that Omar Khayyám and other poets have missed a great deal, for they write almost entirely of sensual pleasures. Wine, food and other subjects are in the ascendancy. Is there no one who can tell me about things which last longer? Now, I am not an astrologer, but I do not believe in chance, and when I see a dandelion, so beautifully designed to catch the air, dashing towards a brick wall which might well kill it, and bouncing off the pressure belt which has been created by the breeze, I begin to wonder whether its final resting place is really due to chance.

Perhaps our wishes have some effect. If I think very hard that I want a headache to vanish, it often does so, and it is not inconceivable that the pigeons' feathers I noticed on the garden path were designed in this way. Examine them. They are an unbelievable example of aerodynamics, strong, tapering to nothing at the tip, releasing air at the right point, and even provided with an automatic repair mechanism which puts a perfectly fitting sleeve where torsion or bending might interfere with strength.

The Hovering Fly

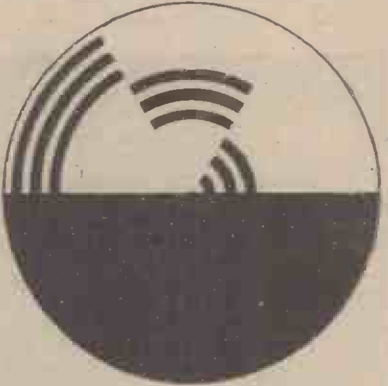
Then there are what children call "pointers." Various kinds of fly which hover absolutely still, even in the wind, ground speed zero and the full power of a far better wing than was ever made by any war department applied without any throttle lag as they dart to and fro. Under pressure these wings are screw-like in section, which reminds me that anyone who took the trouble to watch them with a high-speed cinema could have designed a very fine aircraft centuries ago. Bacon did so, I believe, but unfortunately no one had noticed that petroleum, the modern equivalent of gunpowder, could be used to drive a mechanism.

Cosmic Rays

I read only the other day that rockets are teaching us a great deal about rays which reach this earth from various planets. Even now we know nothing of so-called cosmic emanations. But if it is logical to say that they affect this earth, and that is true because nothing is without purpose, it does not seem quite so mad for someone with a bastard Latin name to profess to describe our mental attitude by looking at the stars. The only reason why I personally deny the truth of such prognostications is that I am quite sure of two things. First, that we have no instrument sufficiently delicate to detect these minute forces, and second, that our brains are far too like those of dogs and monkeys to have the faintest chance as yet of deciding the meaning of cosmic effects, even if we were able to observe them at all.

The Glazier's Diamond

Let us now be entirely practical. Take a diamond and think what it can have to do with noise. Diamonds are, of course, used in many measuring instruments which themselves combat noise. But I was thinking of an



Disc for illustrating a peculiar property of the human eye.

ordinary glazier's diamond which we hold at a certain angle on the glass for it best to cut. At the correct angle, if you will bend your ear to the surface, an extraordinary chirruping is heard for all the world like a nest of fledglings. I do not know what this is, so I must use some apparatus which is better than my ears for recording, and I may find, as they say in the Law Courts, that it is due to slight penetration at the surface of the glass and to the vibration which results from movement of the hand to a minute extent. Try it yourself. Keep the diamond quite still and listen.

Supersonic Sound

Half the interest of science is supplied by devices which improve our senses. Thus, supersonic sound can kill fish or even flies, and everyone knows of the high-pitched whistle which can only be heard by a dog. One should live all the time trying to imagine that we have more than our mere human senses.

You must have noticed that the speed at which anything happens makes an enormous difference to its impact upon our senses, or even upon the result. Grains of sand will damage an airscrew if the speed of meeting is sufficient. Water is very hard at high speeds, and there is a water jet in a continental public garden into which it is impossible to put your walking stick because the pressure of the jet is so high that the water acts like solid rod. When engineers design inlet pipes for gas they bear this deciding factor of speed in mind, for they know that the gas acts more like treacle when the cubic feet per second flow is high.

It is in problems of this kind that our senses can be aided by the high-speed cinema. I recollect a case where an ordinary shoot of convolvulus was able to force its way through six inches of concrete. The pressure was maintained for so long that the result was that of a hard steel rod boring into butter.

Dream Phenomena

The queerness of speed and time is rather well illustrated by the dream in which you purchase a ticket to India, arrive, hunt the lion and finally shoot it, waking up in alarm to find that the bang of your rifle was really a tap on the door with your tea. For the noise in your dream and the noise on the door to synchronise it is clear that you must have traversed the whole period during the fraction of a second between the knock on the door and waking. More wonderful is it that for these two noises to coincide the story seems to have been constructed backwards in your brain!

The Human Eye

The eye is notoriously easily deceived, and one of the reasons is that, considered as an optical instrument, it is very badly made. Should we think of purchasing a photoelectric cell which took an appreciable part of a second to recover after activation? Yet it is due to this very fact of retentivity that we are able to enjoy the pictures, sitting at great expense in pitch darkness while one frame succeeds another without our being any the wiser.

The miracle of the separate portions of the eye which see colour and shape is well known to everyone who has discovered that they can tell the time in a darkened room by not looking straight at the clock. But the colour and shape parts of the eye seem to be connected, or else one can irritate the other. Make yourself a cardboard disc about four inches diameter, and marked as in the accompanying sketch. Spin it slowly in a bright light and watch. It is only black and white, but just wait and see if you see what *I* see.

High-speed Problems

High-speed sense observation is rather fascinating. When people ask if the rifling in a gun should be reversed when the weapon is to be used in Australia, I always reply by inquiring whether baths run out with a specific whirl at the plug dependent upon their geographical situation. Talk a little about jumping higher on the Equator, which is quite true, and most people are thoroughly confused.

High-speed cinemas show that the bath vortex depends upon what the plumber's mate did or the position of small particles of soap, and that the whorls depend upon much the same phenomena as those which we see as we watch smoke rising from an extinguished candle. Try this too, and use a revolving mirror, so that your eyes can speed up and down as if you were a monkey, a cat or a fly.

Rocket Propulsion

Rocket Propelled Aircraft; Research with Models

By K. W. GATLAND

(*Continued from page 51, November issue*)

THE outbreak of hostilities, too, had much effect on the activities of the other British groups—the Manchester Astronautical Association and the Astronautical Development Society (the latter was not given a title until 1941, being originally a small local group)—and although it did not cause their disbandment, there was an immediate curtailment of active research under the Defence Regulations Act, 1939, which made the preparation and firing of rockets during the war illegal.

Thereafter theoretical research became the vogue, and much valuable work has been conducted during the war years of which detailed reports have been published on the following subjects: (a) The fundamental design of rocket aircraft; (b) The design development of meteorological sounding rockets; and (c) An investigation of reloading systems in "solid" fueled rocket units.

Rocket Aircraft

In the first issue of the Manchester Association's Journal, (*Spacewards*, Vol. 1, No. 1, August, 1939), were published the initial sketches of a single-seat rocket aircraft, suggested by the M.A.A. Research Committee (Fig. 41). This conception was intended merely to form the basis for a report of the engineering and aerodynamical problems involved in the development of high speed, high altitude aircraft, and as such the actual design was not pursued in detail. It was, however, necessary to carry out a preliminary design procedure in order to estimate the essential dimensions and weights for the purpose of approximating the performance.

The machine in question (Fig. 41) differed in many ways from the orthodox. A high-wing aircraft, its fuselage was short and stubby, with horizontal surfaces swept back well beyond the rear. The vertical stabiliser, fin and rudder emanated from just aft of the nose cabin and, similarly, swept beyond the fuselage, while the main-plane—of low aspect ratio, two-third ellipse plan-form—was positioned almost centrally along it.

Instead of the conventional landing wheel arrangement, a double skid alighting gear was attached beneath the fuselage.

A small pressure control cabin was situated at the nose, and in the space immediately below, two small tanks, one oxygen, the other alcohol—intended to feed a small rocket motor firing forward and downward—were fitted. This unit was provided for flight manœuvring and landing.

A battery of propellant tanks occupied the space behind the cabin, and at the extreme rear was fitted the rocket propulsor.

Three-quarter front view of the M.A.A. flying scale-model rocket aircraft. Note the radial air intake cowling over the rocket jets.

The Propulsion Unit

The driving motor was something quite new in rocket units, and solved the propellant feed problem very simply. Instead of employing a gas charging system, or pressure pumps, which would necessitate an auxiliary driving motor, a fuel injector system was devised in which the oxygen and fuel were centrifugally fed to a multi-chamber propulsor under the axial rotation of the complete unit. The centrifugal injector is shown in Fig. 42. It is an example of an entirely self-feed arrangement

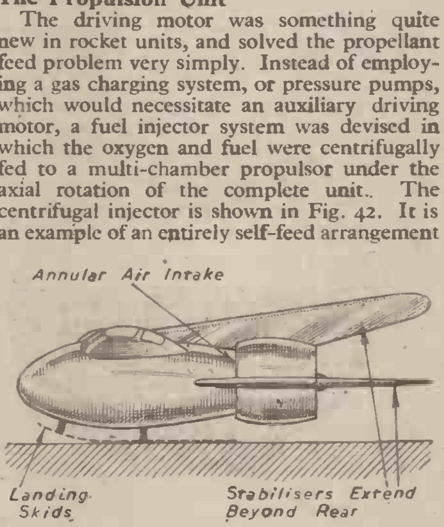


Fig. 41.—Suggested scheme for an air-augmented rocket aircraft. Air is injected over exhaust jets and expanded to increase the mass effluent.—M. A. A. (1940).

and apart from the initial priming of propellant, the unit is completely automatic in operation, requiring no additional power services.

With reference to the figure, the rotary portion of the injector consists essentially of the centrifugal feed unit, and a number of reaction chambers, which are axially offset, and equally spaced around it. The system is designed to function as follows: A few seconds continuous supply of fuel and oxygen are initially primed to the reaction chambers by means of auxiliary pressure chargers. These are housed within the conical tail fairing. The ignition circuit is then closed and the rocket chambers fired, causing the unit to rotate due to the offset thrust. This immediately affects pressurisation of the fuel tanks through the rotation of the oxygen feed shaft, and the pump geared from it; at the same time the oxygen feed valve is automatically released, permitting the fuel and oxygen to pass to the centrifugal unit where delivery is made to the reaction chambers in correctly metered proportion, and at constant and high pressure.

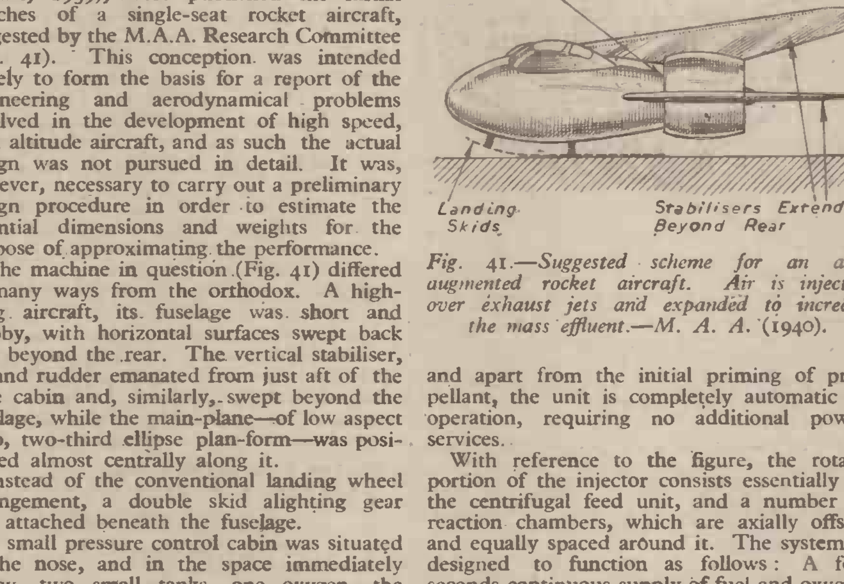


Fig. 42.—Sectional diagram giving details of the M.A.A. centifugal feed rocket-motor (1940).

Model Research

Several models of the aircraft were constructed, mainly for the purpose of gaining some idea of its stability, but, unfortunately, only the initial flight trials of a first powder driven model were possible owing to its completion only a few weeks before the outbreak of hostilities.

At that time plans had been formulated for the construction of a large oxy-alcohol powered model, but the war left this particular project unstarted.

A later model was fitted with a thrust augmenter located behind the centre of gravity and the centre of thrust, attached over the propelling jets. Gliding trials, however, proved this arrangement unsatisfactory in that it had a detrimental effect on stability. Although the augmenter maintained the model on a direct course during sustained flight, this ideal condition remained even when the machine nosed downward for landing, when such a condition became by no means ideal as the 'plane was incapable of levelling out. The obvious remedy was to provide the intake for the augmenter forward of the centre of gravity and thrust, and modifications were made to the basic design to provide for this.

Shortly after the cessation of hostilities in Europe, the improved model was flown under power, and showed itself capable of rapid and well stabilised flight.

The propulsion unit in the models comprised, in each instance, eight individual powder charges. Four of these were termed "primary" and the remainder "secondary," being alternately placed on a circle in order to balance the thrust, and slightly inclined to impart axial rotation.

The primary charges are, of course, provided for the initial acceleration, and the secondaries for maintaining level flight once the requisite height has been attained. To achieve this, the primary units were provided with a more energetic powder composition than the secondaries, each firing phase being a duration of four seconds.

Complete references to the calculations arrived at of the machine's performance are

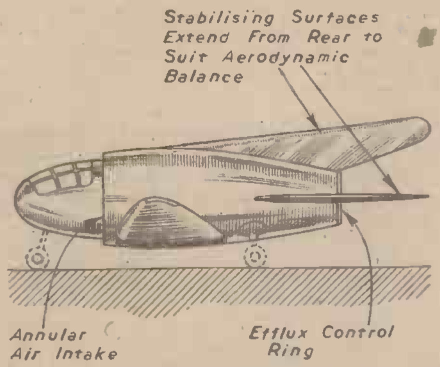


Fig. 43.—Suggested layout for an air-augmented rocket aircraft. Air is inducted and expanded by the exhaust stream in a secondary "expansion chamber."—A. D. S. (1941).

given in the journal, *Spacewards*, January to October, 1940, Vol. 1, Nos. 2, 3 and 4, Vol. 2, No. 1.

The Astronautical Development Society

This is a convenient stage to introduce the work of the Astronautical Development Society, as its early researches were very much akin to those of the Manchester group.

The A.D.S., formed in July, 1941, by the writer and Mr. H. N. Pantlin, around the nucleus of a small local group at Surbiton, Surrey—whose activities date back to the summer 1938—was originally an independent organisation.

In January, 1942, however, contact was established with the M.A.A., and within a short while, in August of the same year, the two societies were provisionally amalgamated. This resulted in an agreement to the effect that, in order to facilitate a more "localised" programme of research for each group, the M.A.A. should govern the rocket interest of northern England and Wales and Scotland, while the A.D.S. administered to the southern counties.

The membership total of the Manchester group at that time was the very low figure of 13, while that of the A.D.S. was little better at 25. The war brought about a severe reduction in members, and both groups had definitely seen better days. The increased strength arising from the merger, however, had almost immediate effect and, by 1943, the total membership was over 100. That year, too, saw the issue of a combined journal and bulletin; the title of the former remaining *Spacewards*.

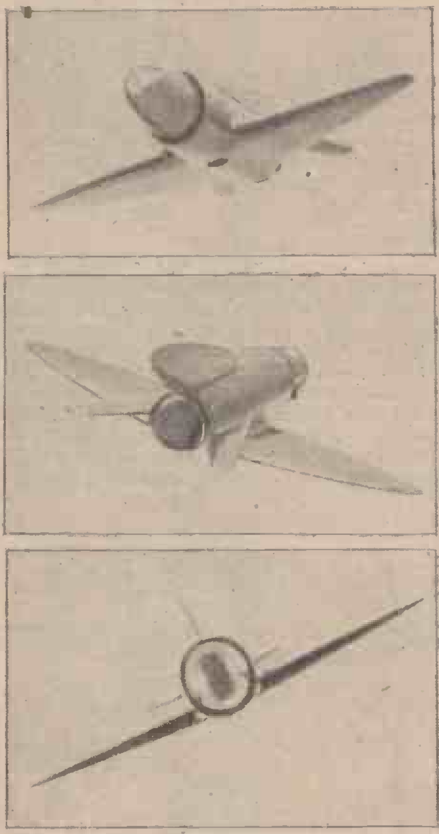
Although the pre-A.D.S. local group carried out free-flight tests of small powder rocket units, these were, in essence, very similar to those conducted by the Manchester groups, and were very largely pure duplication.

The first really significant work of the society proper was the investigation of problems associated with the development of rocket aircraft, and this survey was commenced in complete ignorance of the very similar research which was being pursued, at the same time, in Manchester. When notes were compared later, it was found that almost identical principles had been evolved by the two independently working groups.

The M.A.A. concluded its rocket 'plane investigations shortly after the amalgamation, to commence a mathematical survey of sounding rocket trajectories, leaving the A.D.S. to continue the original line of work.

Unlike the M.A.A. rocket 'plane conception, the A.D.S. model (Fig. 43) had a low wing and an augmenter intake placed near the nose. Its only outward similarity was the tail assembly, which comprised two horizontal stabilisers, and a single dorsal fin, swept back beyond the rear fuselage. These surfaces were intended purely as *stabilisers*, and as such they were not fitted with control aerofoils. Instead, directional control was effected by the simple procedure of providing an efflux discharge ring within the nozzle mouth, free to swivel—at the control of the pilot—in any direction, up, down, or sideways, so that the exhaust impinged, thereby causing offset thrust and controlling the 'plane's flight with the same effect as rudder and elevators. The wing was fitted with ailerons in the usual way.

The cabin formed the nose of the aircraft, and a large clear-view Perspex type hood was fitted in keeping with the nose contour, intended to afford a wide angle field of vision.



Three views of the original air-augmented rocket 'plane model developed by the A. D. S., and built by a member of the society, Mr. D. Ashton. Photographs by Mr. H. J. Kendrick, Surbiton.

The propellant tanks were well dispersed about the centre of gravity; the main fuel tank being immediately behind the cabin, while two additional containers were placed just outboard of the wing roots. A large cylindrical liquid oxygen tank extended from the nose fuel tank to the motor at the rear end of the fuselage.

A Turbo-thrust-feed Motor

The liquid fuel motor provisionally developed for the original A.D.S. model was, too, somewhat unique in design, and as with the M.A.A. "centrifugal injector," the propellant feed problem was solved quite simply. Similarly, once set in function, the unit would operate continuously at a constant feed pressure until the propellant was exhausted.

The feed system in the A.D.S. motor (Fig. 44) was arranged through a turbine driven pump, the turbine being fitted directly inside the combustion chamber at the back, and functioned by the thrust pressure of the expanding gases. A hollow shaft, fitted through the axis of the turbine, passed out through the rear wall of the chamber, and from this was geared the oxygen and fuel pumps.

The end of the shaft fitted into the oxygen delivery tank, in which it rotated on a sealed bearing, allowing the oxygen to pass through the shaft to the combustion chamber. The oxygen pump served to pressurise the liquid oxygen tank, and thus it was ensured that the oxygen entered for combustion at a high and uniform pressure.

The fuel—similarly forced from its tanks under pressure from the pump—prior to entering the chamber was utilised in cooling the nozzle. After passing through the jacketed portion, having been conveniently vaporised by the absorbed heat, it was fed for combustion, entering from two inlets placed behind the turbine.

On the reverse side of the turbine was fitted a centrifugal impeller blade system intended to fling the fuel out into the chamber from the back of the turbine vanes, and in this way the oxygen issuing from the shaft was isolated from the chamber walls until the propellant was adequately mixed. Thus, the danger of oxidation, the main cause of earlier motors' disruption, was thought to be largely eliminated.

A multi-chamber liquid-fuel motor—designed on the same principle as the M.A.A. "centrifugal injector"—was later proceeded with and in this it was arranged to feed the propellant centrifugally through rotating the complete unit by offset thrust. In view of the large masses involved, however, and the likelihood of excessive torque, a model of the unit was not constructed, although a model aircraft employing a similar powder system was successfully flown, prior to the official formation of the society.

Rocket Aircraft Development

The conclusions derived from the M.A.A. and A.D.S. investigations, covering the

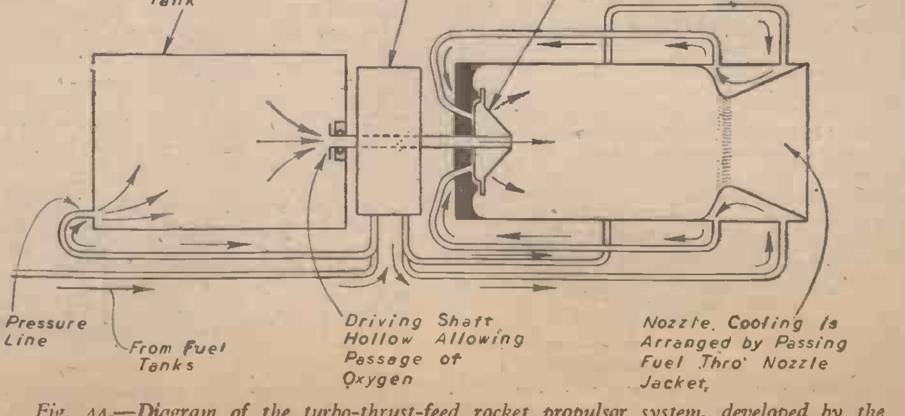


Fig. 44.—Diagram of the turbo-thrust-feed rocket propulsor system, developed by the Astronautical Development Society, 1941.

essential disadvantages and advantages of the rocket system applied to aircraft, may be jointly summed up as follows: For reason of a limited duration of power, due to the heavy rate of propellant consumption, the aircraft powered by what we may term "chemical rocket propulsion," is not likely to realise commercial application. Against this, however, there is the implication of *controlled* atomic power.

The "uranium bomb" has given dramatic illustration of the vast powers available in atomic disruption, and clearly, once this energy can be harnessed for direct *reaction*, we will have at our disposal a highly powerful and economic propulsor agent, not only adequate for all terrestrial uses; but also capable of fuelling the most enterprising "interplanetary space-vessel."

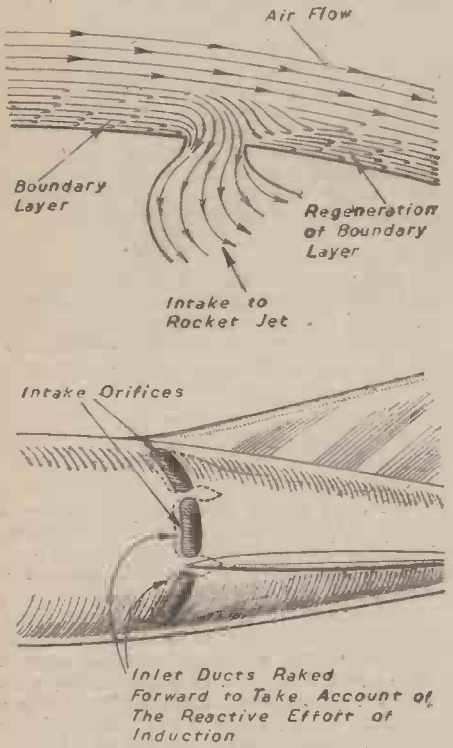


Fig. 45.—Diagrammatic view and section showing abstraction of boundary layer.

Many technical difficulties remain, however, before the liberation of this energy can be moderated; and there are also several associated problems which will invariably arise in its application—principally, the very high temperatures and pressures that are likely to be raised in an "atomic generator," and the necessity for providing suitable screening against the harmful radiation emitted in the bombardment of the radio-active U-235 isotope.

This subject is too vast in its possibilities to pass over hurriedly, and a more detailed account will be given in a later article.

The Thrust-augmenter

Apart from the high fuel consumption in chemical rocket units, the second disadvantage, directly associated with the first, is their inability to function without profuse waste of energy at low speeds, and within the atmosphere. Hence the importance given to the *thrust-augmenter*, which aims to increase the mass flow while decreasing the speed of ejection. The need for providing entry for the augmenter forward of the C.G. and C.T. has already been mentioned, but it is obvious that this involves a large area of ducting, which naturally would add materially to the drag due to friction. The better solution would appear to be the use of inlets flush to the skin, and, in this form, stability would not be impaired even though they were located in the rear fuselage. Not only would this arrangement solve the intake problem, but it would also bring about a useful increase of the form efficiency due to the removal of *boundary layer.*

Boundary Layer Control

The total drag of an aircraft is made up in two components: (a) skin friction, and (b) the formation of a turbulent wake. The form of the aircraft, of course, determines the character of pressure distribution about its surface, and, with careful streamlining, these changes in pressure can be arranged to take place gradually, so that the transition of laminar flow into turbulence is close to the rear of the body, and results in a narrow wake. Under such conditions the resistance due to turbulence composes only a very small part of the total drag, the remainder being due to surface friction; the boundary layer, which has effect over almost the entire surface.

The boundary layer is formed as the result of frictional forces which arise between the surface and the air, represented by the resistance which each particle offers as it moves past others. The air particles immediately adjacent to the surface adhere, while those of subsequent layers, less able to resist the air flow, progressively obtain the speed of free air, the degree of frictional retard diminishing as the distance from the surface increases. This results in the formation of a thin layer of vortices over the surface, which, at the point of transition, suddenly effects a change, and the air particles in the boundary layer assume a vigorous swirling at right angles to the direction of flow, causing the turbulent wake.

The location of the intake is, therefore, most effective just forward of the point of transition, so that the depth increment of the boundary layer is reduced and the separation into turbulence delayed. Investigations have shown the most efficient intake arrangement for this purpose to be simple, wide slots, set at right angles to the skin contour, and flush in the surface, as shown in Fig. 45. The diagram gives some idea of the boundary layer formation in this region, and indicates the method of abstraction to the rocket propulsor.

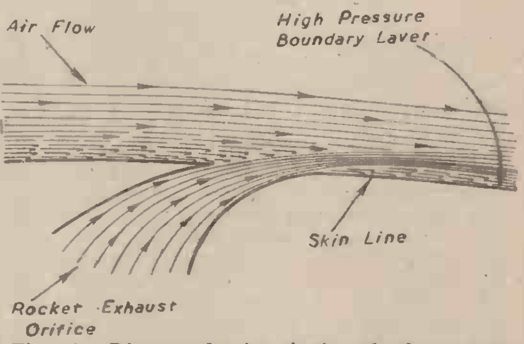


Fig. 46.—Diagram showing ejection of exhaust on to skin surface. This action accelerates the boundary layer and delays separation of flow.

It is also a possibility to discharge the combustion effluent on to the outer surface in order to speed the boundary layer as a further means of delaying the separation. In this instance, the expulsion orifice is most efficiently arranged with its leading edge fined sharply to blend with the skin line, so that the gases are ejected tangentially to the skin curvature (Fig. 46).

These methods of controlling the boundary layer are, of course, most beneficial when applied in thermal-jet, and air-augmented rocket systems, because of the large volume of air to be exercised in the propulsors, and the large mass flow available in ejection.

(*To be continued*)

From Bombers to Furniture

Another British factory is switching over to peacetime production. In the illustration workmen in the background are assembling parts of a Mosquito fighter-bomber, while others in the foreground are making utility furniture in one of the assembling bays of the Walthamstow factory of F. Wrighton and Sons.

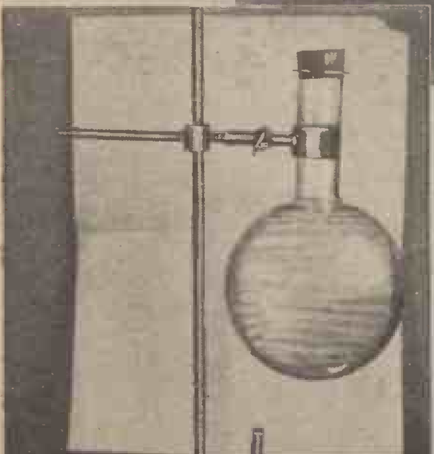
Winning the World's Iodine

A Modern Industry of the Highest Importance

NOT only is the element Iodine essential to civilisation, but it is also vital to life itself. For in the absence of the trace amounts of this active element which we daily consume in association with our foods, our thyroid glands, those small yet enormously potent iodine-regulated organs which are situated in the front of our necks and at the base of our throats, would cease their body-control functions. The thyroid glands would no longer discharge *thyroxine*, which is a complex iodine compound, into the blood. Physically, therefore, we should all go to pieces, for it is the thyroid secretion which controls the well-being of the body and the tempo of its processes, and, worse still, we should, in time, become a race of idiots.

There are, too, not many important modern industries which are not influenced by iodine or its compounds in one way or another. Dyes, photography, medicines, antiseptics, metallurgy, chemical manufacturing, synthetic reactions, colours, oils, gases, preservatives, cosmetics, soaps, and pigments—all these and many other branches of manufacture, together with their multifarious side products, contact at one point or another the usage of iodine.

In modern life, iodine has become one of the indispensable elements like iron, oxygen, nitrogen, sodium and, perhaps, copper. Yet it is an element which has only been purposely used in civilisation's activities for a little more than a century.



A single iodine crystal placed in a large flask and gently heated fills the flask with a brilliant violet vapour.

Iodine takes the form of shining greyish-black metallic-looking flakes which have a characteristic and a not unpleasant "antiseptic" smell. These flakes possess the remarkable property of turning into a vapour or a gas (even at ordinary temperatures) without passing through the liquid stage. If you want to melt iodine you have to melt it under sulphuric acid, which prevents the solid material from vaporising.

The vapour of iodine is of a striking brilliant violet colour, on account of which fact the element originally derived its present name—from the Greek *ioeides*, "violet."

The ordinary "tincture of iodine" of the pharmacist is merely a solution of iodine in diluted alcohol. Sometimes it contains a certain percentage of potassium iodide, which increases the solubility of the iodine and so enables a stronger solution to be made up.

Another view of the Chilean nitrate desert showing hills composed of nitrate deposits.

Iodine in Seawater

Most readers will be well familiar with the fact that iodine is present in the sea. There is only about one-thousandth of an ounce of iodine in every ton of seawater, yet marine vegetation is able to extract these iodine traces and to concentrate the iodine in their stems and leaves.

That is why seaweed was at one time the only commercial source of iodine. The weed was collected at certain seasons of the year. It was carefully burned at the lowest possible temperature in low-built stone kilns. The resulting greyish-white ash, termed *kelp*, was extracted with water and the resulting extract, after concentration, was distilled with suphuric acid, whereupon iodine was liberated and subsequently collected in cooled receivers.

Roughly broken nitrate deposits awaiting collection in the Chilean desert.

At a later period the seaweed was carbonised or charred in closed retorts. This method prevented the escape of iodine vapour, and was consequently more efficient than the older method of kelp burning, which had been practised for centuries, in view of the fact that seaweed ash or kelp was at one time our sole source of soda.

Nevertheless, it took, on an average, about 20 tons of fresh seaweed to make one ton of kelp, and from this latter material only a little more than 30lb. of iodine could, with very careful working, be expected.

There is still about 20 per cent. of the world's annual output of iodine obtained from marine weeds, but, in these days, the remaining 80 per cent. of the world's yearly iodine quota comes from an altogether different source, a source which is not only remarkable for its nature and mysterious origin, but also, for its peculiar georgraphical location.

This is the iodine which is now commonly derived from the famous natural nitrate fields of Chile, that strip of maritime land which runs down the western side of the South American continent.

The Desert of Death

In the north of Chile, between the sea and the majestic snow-topped peaks of the Andes mountains, there exists, some 3,000 feet above sea level, a strange tract of tableland which is approximately 500 miles long and 100 miles broad.

It is a veritable desert of death, this hard, treeless, sun-baked stretch of almost soilless country. Rarely does it have rain. The top soil is so scant, that vegetation is unable to obtain root there. No wild animals are seen in the district. Even the very ground under one's feet is strange and forbidding, for, after a foot or two of light sand and rock debris, it consists of nothing more nor less than a vast accumulation of sodium nitrate (or "Chile saltpetre," as it is often termed) existing uninterruptedly down to depths of 50 or 60 feet, or even more.

How this enormous quantity of nitrate got into its present position is one of the earth's natural mysteries which no one has yet solved. At no other place of the surface of our globe is there anything like the Chile "Nitrate Desert." It is an entirely unique phenomenon.

One theory of the origin of this nitrate desert has it that it is of volcanic origin. Another theory ascribes the desert as being due to the action of nitrifying bacteria on a decaying land vegetation such as existed in Europe during the Coal Age. But none of these hypotheses really satisfactorily accounts for the existence of Chile's nitrate desert. The clue to this great and engrossing natural mystery is still missing.

The "receiver" of an iodine still with its end removed. Note the mass of iodine crystals lining the interior.

It was about the year 1840 that the presence of iodine was first detected in the Chilean nitrate deposits. Yet it took many years to commercialise the extraction of this valuable element from such deposits, the main reason for this delay being the exceedingly difficult climate of the place. Even at the present time there is only one company working the iodine deposits and nitrate beds, and this company has had to spend several respectable fortunes in endeavouring to make the fringes of the nitrate desert habitable for its workers.

Nitrogen Fixation

Before the coming of the electrical processes of atmospheric nitrogen which, in our generation, have been much developed in Britain and Germany, the world's supply of nitric acid for nitrate explosives was located in this strange Chilean desert. Had Germany not been in possession of nitrogen-fixation plants, she could never have started the 1914 war, let alone the 1939 one, for at once our Navy would have stepped in and prevented all supplies of the much-valued Chilean nitrate from entering Germany, and all other enemy countries.

The advent, therefore, of synthetic nitric acid production by means of the electrical abstraction of nitrogen from the air has resulted in a decreased demand for the Chilean nitrate as such. On the other hand, however, the world's consumption of iodine, which in 1941 was nearly 1,500 tons, is annually on the increase. Chile nitrate is becoming more and more the one steady, reliable source for iodine, and it is likely to remain so until chemical science can improve on the tactics of the common seaweeds and economically concentrate this valuable and indispensable element from its high dilution sources in seawater.

Not all the Chilean nitrate desert has the same iodine content. On the contrary, the iodised nitrate deposits seem to be concentrated within a stretch of land measuring about 300 miles long and some 20 miles wide. Here the territory consists for the most part of masses of nitrate material containing as contaminating impurities various chlorides, sulphates, borates, perchlorates, and iodates of sodium, potassium, magnesium and calcium.

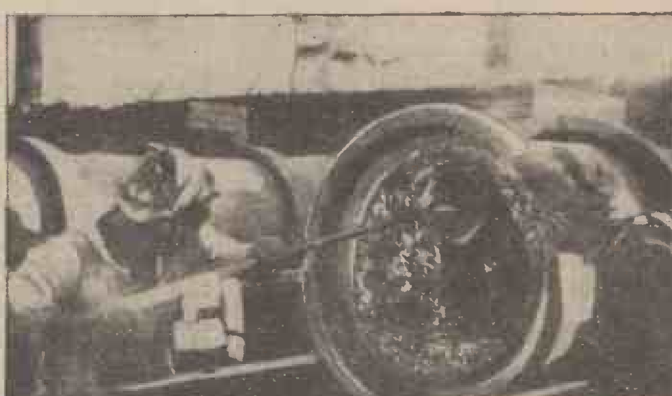
Caliche and Costra

The higher grades of this nitrate material are termed *caliche*, whilst the lower grades receive the name of *costra*. *Caliche* holds, usually, about 0.15 per cent. of iodine, *costra* normally containing some 0.05 per cent. of the same element. Hence, for iodine production, *caliche* is always preferred on account of its higher content of the desired element.

The modern industrial process of winning the 80 per cent. of the world's iodine supply from *caliche* is not very complicated, although, naturally enough, in the hot, trying and exhausting climate of the Chilean desert the process can become tedious in the extreme.

The process starts with the crushing of lumps of selected *caliche* by means of mechanical disintegrators. The powdered material is then loaded into an extraction plant in which it is treated with hot water to dissolve out all the soluble salts.

By this means a clear-cut separation of insoluble rock-like matter and soluble nitrates (and iodates) is obtained. The water extract is filtered and run into tanks to cool. Sodium nitrate crystallises out from the solution. The "mother liquor" (i.e., the liquid from which the nitrate has crystallised) contains practically the whole of the iodine. This is returned to the extraction plant, and in this manner it is used over and over again for extraction with fresh batches of *caliche* material.



Removing iodine crystals from the interior of the receiver.

At each extraction of the *caliche* the mother liquor grows correspondingly richer in iodine, which accumulates in the form of soluble iodates of sodium, potassium and magnesium.

Liberating the Iodine

When the iodine concentration in the mother liquor reaches the order of about 10 grams of iodine per litre of liquid (this being ascertained by chemical test) this liquid is diverted to what is known as the "iodine plant." Here it is run into a large tank in which it is very carefully treated with a solution of sodium bisulphite, which is mixed with it in accurately calculated amount.

The action of the bisulphite is to change the iod*ate* into iod*ide*. Iodate contains oxygen; iodide is free from oxygen, so that the function of the bisulphite is that of a "reducer" or oxygen remover.

We will not go into the precise technical aspects of this deoxygenating process. Suffice it to mention that the bisulphite addition calls for very high chemical skill and experience, for if too little bisulphite is added some of the iodate will remain unchanged, and will thereby be wasted, whilst if too much bisulphite is incorporated some of the iodine will be converted into the very soluble sodium iodide from which free iodine cannot conveniently be recovered.

Hence, the bisulphite must be added in precise amount, so that there is just a sufficient amount of it to do its work, and no more. This quantity is, of course, calculated on the results of a chemical analysis.

The correct addition of the sodium bisulphite results in five-sixths of the iodate being converted into iodide. The iodate and the iodide then interact in solution with the liberation of free iodine. During the process the tank liquid is agitated by means of blowing in compressed air, or by means of mechanically-driven wooden vanes.

The liberated iodine sinks to the bottom of the tank. When it has done so completely, the top liquid is syphoned off and the crude iodine is run out into canvas filter-bags, in which it is washed well with cold water in order to get rid of soluble material. The iodine bags are now placed in a press so that, after the application of light pressure, the material is obtained in the form of "cakes," which contain about 80 per cent. of iodine, 5 per cent. of soluble nitrates, and 15 per cent. of adhering water,

A few crystals of pure iodine, slightly magnified.

Purifying the Iodine

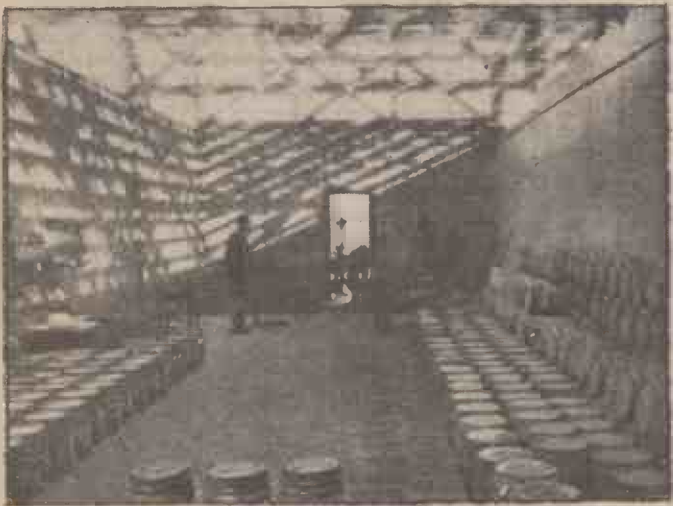
We have already observed that iodine vapourises easily and, curiously enough, without going through the liquid stage. This property of the element is applied to good effect in its purification.

The "cakes" of impure iodine are broken up into small pieces and are then charged into small cement-lined retorts, which are directly heated with fires underneath. The retorts are connected to a system of earthenware pipes which act as receivers. Each pipe is about four feet long and a couple of feet in diameter. From six to ten of these are placed in connection with the iodine retorts, the joints being luted with a compound of sacking and native mud.

In the lower part of each joint a small hole is made, through which the water which has been admixed with the iodine can drain.

The iodine vapour enters the pipe-like "receivers" and condenses or "sublimes" on the interior walls thereof in the form of long, irregular crystals. The admixed nitrates and other impurities remain in the retorts in the form of an ash which is subsequently removed.

The entire iodine purification process by means of vapourisation and condensation takes several days, but after the receivers have become quite cold their ends are removed, and the iodine crystals are extracted by means of wooden shovels.



Barrels of purified iodine awaiting shipment to Europe.

Iodine crystals prepared in this manner contain at least 99 per cent. of pure iodine, the remainder being moisture.

The Packing Room

In the packing room of the iodine factory the purified iodine is immediately run into small, thick-walled wooden kegs or casks, each cask holding about 70 kilograms of the material. Fresh cow hides are used to cover the tops and sides of the kegs, these having been found to be the most serviceable form of material for this purpose, for the hide, on drying, contracts, and uniformly grips the sides of the keg, thereby making an effective seal through which the contents cannot escape by volatilisation during transport through hot climates.

In this condition, the iodine of the Chile nitrate desert, the seeming "Desert of Death," is shipped normally to the four quarters of the earth, there to be chemically processed and converted into a variety of compounds in accordance with the varying and increasing demands which are being made upon it.

Compared with ordinary seawater, the Chilean nitrate deposits are some 8,000 times richer in iodine.

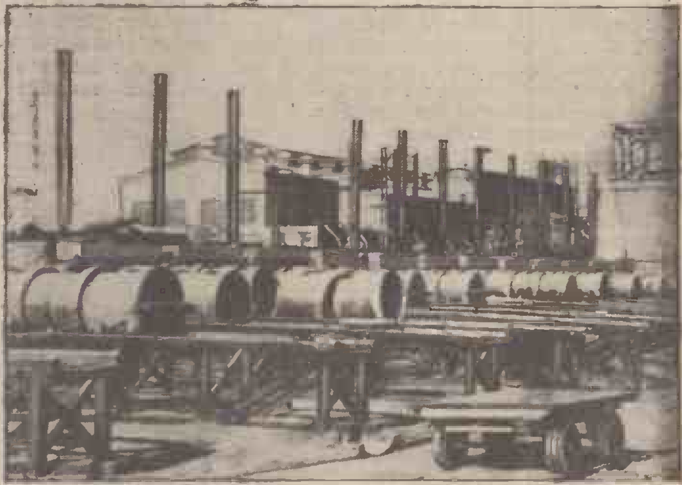
Will the Chilean nitrate desert ever become exhausted? One supposes that such will be the case in the distant future in much the same way as the coal fields of our own country will, surely in time give out.

But we of the present generation need hardly worry about such facts, for, despite ordinary seawater containing only about a thousandth of an ounce of iodine per ton, yet, calculating on this approximate figure, there must be something like 100 tons of iodine in every cubic mile of the ocean.

Weighing refined iodine into casks for transport.

Until some discovery on the above lines happens, the world must necessarily depend more and more on the Chilean nitrate desert for its iodine. Little known to the majority of mankind, this great nitrate desert constitutes one of the world's priority supply centres, from which a continuous iodine traffic radiates to all the centres of civilisation.

(The illustrations pertaining to iodine production are reproduced by courtesy of The Director of the Iodine Education Bureau, London.)



An "iodine plant." The tall narrow chimneys are the flues of the iodine stills, whilst the horizontal "receivers" in which the iodine is collected are to be seen in the foreground.

Blinding the Nazis' Radar "Eyes"

HOW the blinding of the Germans' radar "eyes" along the coast of Europe—an operation which played a large part in the success of the Allies' invasion—was planned, can now be revealed.

Methods of putting out of action the chain of enemy radar stations along the northern coast of the Continent were devised by civilian scientists at R.A.F. Fighter Command headquarters and put to such excellent use by Fighter Command and the Second Tactical Air Force that maximum tactical surprise was achieved on D-Day.

The scientists started to investigate the problem in July, 1943. So secret were their experiments that only four copies of their reports were made, each guarded as "top secret."

To determine the most damaging method of fighter attack on radar stations, the scientists built a dummy installation, and fighters used many different types of ammunition in firing trials. They even secured a German radar station's complex aerial array and put this up for firing tests, using among other types captured German ammunition against it.

Most German coastal radar installations were well protected by sandbag emplacements, and when these conditions were duplicated at the dummy station built "somewhere in England" it became clear that ordinary ground-strafing by fighters would not inflict crippling damage.

The scientists' final recommendations were that sandbag-protected radar stations should first be attacked by rocket-firing fighters to blast a breach through the protective barrier. Cannon-fighters should follow, pumping explosive shells through the breach to wreck the delicate apparatus inside the stations.

These recommendations were put into immediate effect, and German radar defences from Brest to Heligoland were subject to effective attack.

Our operations proceeded "according to plan," and the "boffins" at Fighter Command, the civilian scientists, went quietly on with their back-stage work.

The Story of Radar—2

The Operational Development of Chain Coast Stations

(Continued from page 44, November issue.)

A modern radar equipment used for controlling the fire of A.A. guns somewhere on the British coast.

IN July, 1936, the Director of Signals at Air Ministry was so concerned about the need for early warning of aircraft approaching the coast that he wished to ensure that any device conceived by the Air Ministry research group at Bawdsey should be immediately applied to operational use within the Royal Air Force, and accordingly initiated arrangements to train any personnel necessary for maintaining and operating R.D.F. equipment, so that immediately anything was made by the scientists, the Royal Air Force could use it.

In February, 1937, a training school for R.A.F. personnel was opened at Bawdsey. Its first members included selected flight-sergeants and other non-commissioned officers who have given distinguished service to radiolocation.

It was decided that the best way in which the instructors could learn the intricacies of R.D.F. equipment was to build a training device which simulated the echoes obtained in actual observation of aircraft and could be used for training purposes without having to fly aircraft, so as to train operators in the routine processes of taking readings. The first "trainer" caused the scientific staff some mild amusement, but it served two purposes. Firstly, it taught those who made it quite a lot about the mechanics of R.D.F. equipment, and secondly, it demonstrated the value of synthetic training equipment, which has been used so extensively throughout the development of radiolocation. A second air exercise was flown in April, 1937, with the students of the school participating; in May the Air Ministry Station at Bawdsey became fully operational as the first prototype of the stations which were in the meantime to cover the Thames Estuary; Dover followed in July, and Canewdon (near Southend) in August.

Centralising the Information

It had long been clear that the information from a chain of stations, necessarily so placed that several of them could independently locate the same aircraft (to ensure gapless cover), would require some reconciliation and interpretation, since none of the observations would be perfectly accurate. So in August, 1937, an experimental "Filter Room" was opened at Bawdsey, to extract the most probable facts from the incompletely concordant reports of the three Estuary stations, and to report expeditiously to the Operations Room of the Headquarters, Air Defence of Great Britain, the inferred tracks of observed aircraft formations. This first filter room played a very important part in establishing filter-room technique, in co-operation with the Bawdsey scientists, who recognised that this part of their work was no less important than that of getting the primary observations.

The process of filtering that was adopted at Bawdsey was devised of necessity rather than choice, so that the best use could be made of the accurate range of information, but inaccurate angular measurements, that could be derived from the equipment then in use.

After the first air exercise using R.D.F. had been flown, and the filter-room technique had been foreshadowed, the Engineer-in-Chief of the G.P.O. visited Bawdsey to investigate what facilities the Post Office could offer. A G.P.O. engineer was seconded to Bawdsey to co-operate with the scientific staff.

A network of specially designed communication lines was needed to link all the Air Ministry radiolocation stations with each other and with R.A.F. Fighter Command Headquarters, and elaborate security precautions taken to safeguard the precious information and to preserve continuity in the event of damage by enemy attack. This contribution of the G.P.O. cannot yet be fully revealed because other, at present secret, uses are being made of it, but there is no doubt that this teleprinter network was an important factor in the success of the Air Ministry Radiolocation Chain, and of our operational control during the Battle of Britain (when 185 enemy aircraft were brought down during the single day of September 15, 1940.)

A third R.A.F. exercise, now using the three interim radiolocation stations, was flown in August, 1937, with that variety of experience which is familiar to all experimental developers. The difficulty was to combine frequent practical trials, under constant operational conditions, with research, which demanded almost continual alteration and adjustment of the apparatus. One of the operationally serious but experimentally negligible faults was the distortion of bearings which could only be corrected by extensive calibration on targets flying over known positions. There was no time to carry out these calibrations before the exercise, and to the research workers the errors were of little consequence, since the cause of them was well understood.

The Air Staff had not waited for this exercise, nor were they deterred by flaws in the R.D.F. performance. In July, 1937, orders were placed for the first commercially designed and produced transmitters and receivers for radiolocation, and immediately the exercise was over the orders were made to cover equipment for a chain of twenty stations of hitherto undreamt-of power and sensitivity. The transmitters were entrusted to a leading British electrical engineering company, selected largely because of their work on demountable transmitting valves giving very high power output. The receivers were developed by another British company whose research staff had done much for television development and now were the producers of the most suitable cathode-ray tubes for the new application.

Finding Sites for Stations

The equipment design was only one part of the technical problem to be solved before an operationally valuable coastal chain could be provided. The finding of twenty sites to give, even and unbroken, an invisible radio frontier out at sea, 40 miles out at 3,000 feet flying height, 140 miles out at 30,000 feet (more or less) from Solent to Firth of Tay, was a maze of difficulty and compromise. A site on a high cliff rising sheer from the sea favoured long range detection and plan location; it was quite unsuitable for good height-finding. A site well back from the coast, with a smooth slope between it and the sea, gave good height-finding and a good range—there was a rule by which one knew how far inland it was worth going to gain height above sea-level. But irregularities of ground were inevitable, and these distorted the height-finding properties and also gave "permanent echoes": hills sent back radiolocation echoes just as if they were big aircraft flying low. The chosen sites had to be accessible for heavy engineering works, they had to have suitable soil to carry 350ft. steel towers, they had to be moderately convenient for electric power supplies, they had to be habitable by station crews, they had to be secure against naval bombardment, and they also had to be as inconspicuous as might be from the air.

"The Fruit Machine"

The inevitable imperfections of siting caused errors in direction-finding and in height-finding which could be measured once for all by calibration flights of aircraft, or balloons towed by ships, over known positions. There were never enough calibration flights operationally possible to satisfy the demands of the experimentalists. But the usual scientific method of applying to observations, tables or graphs of the errors known to be present, was time-consuming; the height of an air battle is no time for thumbing a "ready-reckoner." Moreover, the radiolocator read distance and bearing from the observing station; what the Air Staff at Headquarters needed was a map reference on the R.A.F. "grid." This meant more conversion operations. The whole problem of conversion and correction, after an interim period of use of an optical converter, was elegantly solved in an electrical converter, using parts familiar in automatic telephones. The calibration corrections were most ingeniously and conveniently put in with a soldering iron by a linesman, and could be changed at will by another application of a soldering iron, the graph of the correction being reproduced in a copper wire soldered over the contact-strip "field." The electrical converter, affectionately and inevitably called "the fruit machine" by R.A.F. radiolocation operators, shows position, height and number of aircraft in formation in illuminated numerals when the operator presses four keys on his desk—and if traffic is brisk it will store up a new set of figures (for another formation) until the "teller" presses another key when he is ready to see them, after telephoning the previous set to the operations room.

Dr. W. B. Lewis, F.R.S., and Dr. F. C. Williams, two prominent radar scientists, check a "scanner," which searches the skies for enemy aircraft. It was fitted to the nose of night-fighters.

Three of the operator's keys merely intimate to the "robot" calculator that he has set the distance pointer to the indication whose range is to be read by the machine (not by him or her) the bearing pointer to the directional setting, and the height pointer to the height setting (on both of which he or she exercises judgment but need not read) while the fourth is one of a bank of "number of aircraft" keys from which he or she selects the one corresponding to the estimated number of aircraft in formation. It has not ceased to surprise the original experimenters (who modestly said that it should be possible to count the aircraft in a small formation) that the members of a skilled watch will agree within ten per cent., and within ten per cent. of the truth, on the number in a tight formation of 100 or 150 aircraft. The first electrical calculator outside the experimental station was installed at Poling in June, 1940.

The Continuous Watch Begins

The development of the main Coastal Chain of Air Ministry Stations was left, in earlier stages, at the completion of three interim stations and the planning of 20 "final" stations. The interim cover for the Thames Estuary was assured by five stations for which the equipment was built, still under the supervision of the original constructional engineer, in the workshops which he controlled successively at Radio Research Station, Slough, and at Orfordness and Bawdsey; they survived in operational use well through the Battle of Britain.

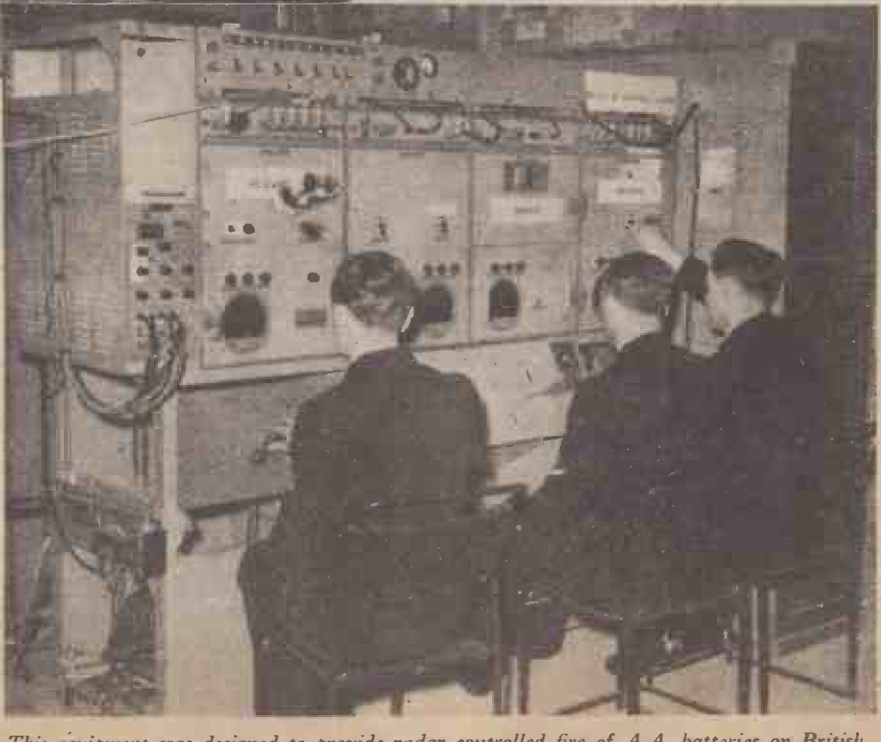
This Estuary chain, comprising Dover Dunkirk (near Canterbury), Canewdon (near Southend), Great Bromley (near Colchester), and Bawdsey, went over to 24-hour watch in September, 1938, at the time of the Munich crisis. It was supplemented by mobile stations, which will be discussed in a later chapter.

On Good Friday, 1939, the chain of stations from Ventnor, I.O.W., to the Firth of Tay, went over to 24-hour watch, never since interrupted save for a brief suspension at one station, due to enemy action.

The main chain stations had, among other provisions against enemy interference with their operation, complete underground reserve stations of smaller size associated with them. The first of these reserve stations, at Poling, Pevensey and Rye, were completed in August, 1940, just in time for the first enemy attack on R.D.F. stations, which was in that month.

Radiolocation and the Eastern Lifeline

A description of the early development of radiolocation is not complete without reference to the fact that at the same time as the East Coast Home Chain Stations were completed in England, a station was erected at Malta, and another at Aden, and subsequently at other defended ports abroad. The build-up of radiolocation by the Air Ministry at Malta, and of night-fighter interception technique there, is just as magnificent a story as that of the build-up in the United Kingdom, and the Japanese would have been very grateful if a similar process had not been undertaken by the R.A.F. in Ceylon, where the defence organisation was in a sufficient state of operational efficiency to cause severe defeats to Japanese air attacks on the eastern and western coasts of this important overseas operational base. As an illustration of the efficacy of the Malta Station, a captured Italian air officer is reported to have said



This equipment was designed to provide radar controlled fire of A.A. batteries on British ships. It can also control the main armament of a destroyer against surface targets.

that he could not understand how our R.A.F. managed to maintain a standing patrol of fighters with such slender resources as he knew we had on the island, since his attacking bombers were never able to approach without being intercepted. Of course, we should not have been able to hold Malta against air attack with the very few fighter aircraft available to us there in the early days, except by being able to have half-an-hour's warning of each attack.

The Low-flying Invader and the Radio Searchlight

Even before the first Air Ministry "Chain" (C.H.) station had been designed, there was no doubt that good though the "illumination" might be through a wide vertical arc, the lowermost "lobe of radiation" left a region just above the sea which could be neither served by the transmitted energy nor could reflecting bodies in that region send back tell-tale echoes to the receiving aerials. Therein was the Achilles' heel of the C.H. system—an aeroplane skimming the sea, a few hundred feet up, might closely approach our shores unseen by the gaze of the stations looking steadily "over its head."

Elementary principles of aerial design showed that hope of "covering" the blind area of the C.H. stations lay in the use of shorter wavelengths, aerial arrays ("stacks" of dipoles) and preferably the adoption of the narrow beam "searchlight" system which had been deliberately avoided when designing the primary "Chain."

During the early days at Orfordness, there came constantly under discussion the need for adding to the floodlight stations a group of radio searchlights and radio telescopes to hold individual aircraft under accurate location. There was also the dream of a "radio lighthouse," sending out an intense, narrow, highly concentrated beam of pulsed radio energy, with an associated receiver picking up only such energy as came in from an equally narrow sector, and, indeed, from the same sector; in fact, a sharp radio searchlight with which was synchronised a radio telescope of equally restricted field of view and consequently making very good use of echoes returning from the direction under search and turning a blind eye to interference from other directions, the whole automatically sweeping, by mechanical, electrical, or combined means a wide search area.

Some time in July, 1935, there was recorded in Air Ministry files a synthesis of some of these aspirations for a radio lighthouse. It included a clear and essentially complete adumbration of the Plan Position Indicator to be described later. By universal consent it shared the fate of some other landmarks of radiolocation. It cannot be too often repeated that among our debts to the early experimenters, one of the greatest is to their almost inhuman self-restraint. The soil which they had turned was throwing up a wealth of the most fascinating buds and shoots, everyone of them clearly strong, healthy, and a guaranteed bearer of rich and novel fruits. The temptation to explore avenues, to turn stones, to nurse the more exotic shoots, was almost irresistible. So the P.P.I., with other things, went into voluntary suspense.

The suspension was due, among other things, to the knowledge that the radio lighthouse, with or without the P.P.I., was only practically attainable when adequate power could be radiated, and adequate receiver sensitivity was available, on wavelengths much shorter than those used in the C.H. and the other early radiolocation systems.

Research and development on valves, to generate high power on these shorter wavelengths was already in progress, under Admiralty guidance, and its intensification soon provided one of the new tools required to build the radio lighthouse.

The shorter wavelength made it possible to use proportionately smaller aerials systems; these could now be mounted on a turntable of reasonable size and both the beam of radiation (the radio "searchlight") and the axis of maximum receptivity (the radio "telescope") could be swung together to point in any desired direction. Moreover, the beam could be adjusted to skim the surface of the sea in such a way that any reflecting object, just above the water, even small boats' masts as well as low-flying aircraft, would give an echo.

The radiolocation beam station for tracking the low-flying aircraft emerged directly from the work of that part of the War Office team at Bawdsey which was concerned with the location of ships as an aid to coast defence artillery.

Spotting the "Butter Boat"

In the early summer of 1939, these War Office workers had devised a very elegant solution of the problem of increased direction-finding accuracy. The directional accuracy of the C.H. system was measurable in terms of errors of a whole degree or more. The application to the radio searchlight, which they now produced for ship spotting, of the overlapping beam or "split" principle, enabled them to determine the bearing of any target to within a few minutes of arc.

It was a standard part of a visit to Bawdsey Research Station at that time for the visitor to be allowed himself to lay the ship-spotting set concealed on Bawdsey cliffs on the "Butter Boat" plying between Esbjerg and Harwich, and then to verify—visibility permitting—that the telescope attached to the aerials was, in fact, pointing between the masts of that pleasantly grey-painted 1,000-tonner. It was immediately obvious, both in theory and in practice, that this equipment was a vital supplement to the coastal chain for the location of aircraft, since it was able to track the wave-hopping aircraft with the same accuracy as it gave on ships. So great was the need to fill this gap under the Radio Ring Defence that it was decided that the first development from this War Office C.D. set should be for aircraft location, and in this application the equipment was called C.H.L. (Chain Station, Home Type, Low Flying).

A herculean effort of a team of scientists working largely as radio installation engineers had enabled a crash programme for the installation of five C.D. equipments to be carried through to operational service for ship spotting by the end of 1939. In parallel with this programme there was laid down another for C.H.L. stations which were developed and put into production in an amazingly short time. The radio industry played its part nobly working special shifts and adopting all kinds of emergency expedients. Again the installation was done by scientists who left their laboratories for the field. New recruits were brought in from the Universities; it was the experience of more than one University research worker to be sent straight to a site to be provided with some vanloads of equipment and some R.A.F. manpower, and to be told that he must erect a C.H.L. station and have it operational in the shortest possible time. Seventeen installations were working by March, 1940, and by the middle of 1940 C.H.L. stations were located at 50-mile intervals around our shores from South Wales, along the South and East coasts, to Scotland. When the Battle of Britain began in August, C.H. had been reinforced by C.H.L. in full operational condition in all the danger areas.

Throughout the Battle of Britain the C.H. and C.H.L. stations made a magnificent contribution to the defence of the United Kingdom by providing information concerning the position, heights and numbers of enemy aircraft approaching this coast, so that the defending fighters could be put up in the correct strength and in the right places to intercept and destroy large numbers of enemy aircraft, culminating in the destruction in one single day of 185.

(*To be continued.*)

The interior of the battery fire control room in conjunction with which radar helped the Dover coastal artillery to sink enemy ships on the blackest nights.

Inventions of Interest

By "Dynamo"

Salt Water to Drinking Water

AN inventor has devised a new process for converting sea water into drinking water.

The inventor has specially had in view the shipwrecked sailor on a raft. Prior methods have generally required expertly manufactured cumbersome and expensive apparatus, as in the case of the still employed in the distillation method.

The improved device is a process not needing a distillation step. It requires the use of only a few chemical reagents in small quantities which may be compactly stored in small containers ready for immediate use. Not more than two containers are usually necessary.

Only simple and improvised apparatus is needed, and no expert knowledge or accuracy is required.

Stream-lined Cycle Cape

A HEAD wind is a hindrance to a steamship, and a similar resistance is experienced by a cyclist who wears a rainproof cape.

To obviate this disadvantage there has been designed a device to enable a bicycle cape to present a streamlined form to air resistance. Its shape is controlled by a frame. This consists of a length of rod which, when extended, contacts the cape and holds it in the desired position. The front of the cape is caused to be of inverted-V form across the handle bars. The frame is a telescopic tube mounted in or adjacent to the handle.

Prefabricated Wall Structure

AT the present juncture any effective idea in connection with building construction is worthy of consideration. Among current devices on this subject is an improved wall structure which, it is asserted, can be fabricated from standardised units or parts rapidly produced on mass production lines in a factory or other central location. Thence they may be easily transported to a distance, speedily assembled and erected on the actual building site without any special degree of skill or experience on the part of the builders.

The contrivance is a wall structure consisting of vertical posts each having two sets of channels therein forming inner channels in which wall slabs are fitted to make an inner wall and outer channels in which members adapted to form an outer wall are fitted.

These outer wall-forming members are made and arranged after the manner of weatherboards. The vertical posts, wall slabs and weatherboards are all pre-formed or pre-cast from concrete, reinforced concrete or the like aggregate. The inner and outer walls are built up simply by sliding the wall-forming members into their respective channels in the uprights.

For Automatic-gyro Pilots

A NEW navigation instrument is specially concerned with automatic-gyro pilots of aircraft.

The purpose of the invention is to furnish a single instrument qualified to inform the pilot or a device for automatically setting a gyro pilot, that at the instant when the information is given the vehicle is in a truly horizontal position, and moving in a straight line without any horizontal or vertical linear acceleration, and without any angular acceleration.

As a result, at this instant of time the gyro of the automatic pilot can be set to the true vertical and to the true north-south direction.

The instrument includes a resiliently suspended weight which is adapted to occupy a predetermined position in the vehicle when the latter is horizontal and subject to no acceleration, and which is capable of displacement in any direction from the position mentioned. There are means responsive to the entry of the weight into the predetermined position for giving the required information.

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."

Unsewn Umbrella Cover

THAT portable shelter from rain, the umbrella, is the subject of an invention for which an application for a patent in this country has been accepted.

At the present time a considerable amount of hand labour is involved in the sewing of umbrella covers to the frames. Each rib is hand sewn to the cover in at least two places. The main object of the improved device is to eliminate this hand labour.

Attempts to secure covers to frames without sewing have been made by means of tips or clips formed to fit over the ends of the ribs. But this has necessitated the stretching of the covers as the tips were being placed in position. The result has been that with certain materials the cover has received a permanent stretch, and the tips, being loose, have fallen off the umbrella when in use.

According to the improved device the ribs are provided with holes—usually in pairs—at spaced points in their length; and the cover is fitted with wire or like members, a part of each of which will register with and pass through the appropriate hole. Afterwards it is bent down below the rib to prevent its withdrawal.

New Heating System

AMONG recent applications to the British Patent Office is one relating to household heating. The invention comprises a readily removable self-contained heating system entirely independent of the water supply of the house. It includes in combination a tubular water heater. This is so designed that it will fit an open fireplace and will replace the ordinary grate without being built in, and is unconnected to the water installation of the house. It can easily be removed.

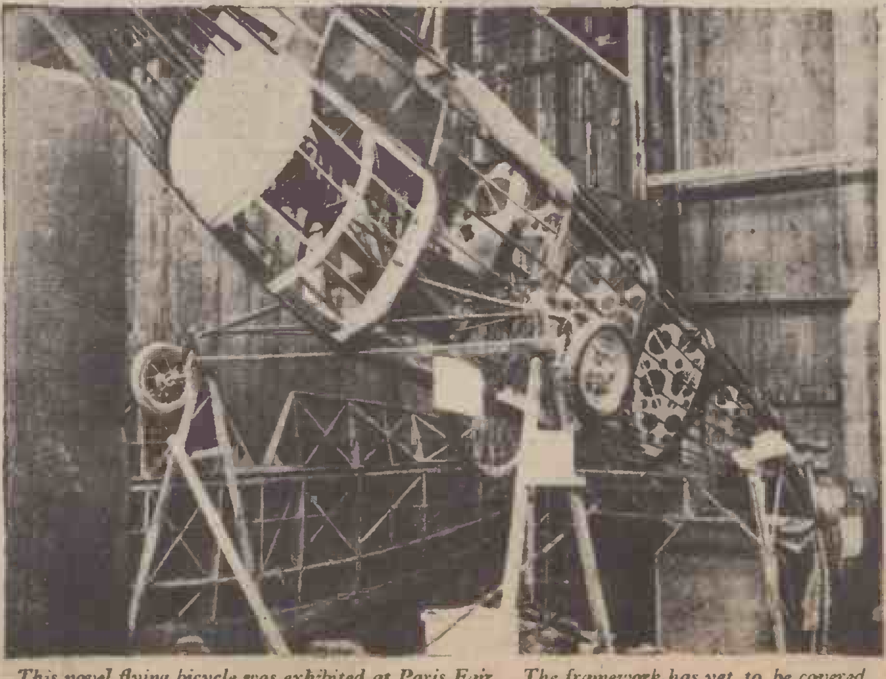
Connected thereto is a radiator in the room, and there are means for the introduction of water into the system.

Jet-propelled Wiper

AN application for a patent has recently been filed in this country for an improved windscreen wiper. This invention consists of a wiper supported on an arm which is tubular, and it is propelled by a jet of fluid passing through holes in the arm in a direction practically transverse to its length.

Generally Useful

AMONG inventions recently submitted to the British Patent Office figures a holder for a safety razor blade stropping appliance, which plays many parts. This holder, which may be made of metal or from synthetic resinous or plastic composition, has a handle designed to serve as a paper knife, an envelope opener, and a scraper. Also it carries a nail file.



This novel flying bicycle was exhibited at Paris Fair. The framework has yet to be covered, and the wings are seen against the partition on the left.

THE WORLD OF MODELS

A Model Maker with Engineering Skill: A Model Broadcast and a Model for Post-war Planning

By "MOTILUS"

IT is an outstanding fact that most model enthusiasts have other hobbies besides their interest in the craft of modelling. They are sometimes keen photographers, often take an interest in horticulture, and not infrequently are gifted artists and musicians.

The subject of our article this month is no exception to the rule—Mr. L. G. Bodiley, of Northampton, is not only a very enthusiastic and skilful model maker, but is also a capable gardener and keen amateur photographer, and both he and his wife are clever pianists. And I think you will agree with me as this article proceeds that his talent as a modelling man has not suffered from his other activities!

Fig. 1.—The End of the Run. Mr. L. G. Bodiley and his little daughter Jean being hauled by the ½in. scale Pacific type locomotive during the steam test.

From his very young days he has been interested in models and model making, electricity and mechanics generally, but it was after his one and only visit to the Model Engineer Exhibition in 1938 that he became particularly interested in the making of "live steam" locomotives. Since that time, this most fascinating of hobbies has "held the field" and even during the war he has carried on in what leisure time he could spare.

A 2½in. Gauge Pacific-type Loco

One pleasant evening in the late summer he invited me to watch a steam test of his first completed model on his garden track. The model is a 2½in. gauge Pacific-type locomotive, lettered K.R.R., No. 27.

On arrival at No. 27, Kingsley Road, I took several photographs of this model (Figs. 1 to 4) and examined the good workmanship, and then he began to raise steam, stoking up with charcoal and then steam coal. It took less than five minutes to raise steam from cold, and on the first run along the 100ft. track the locomotive hauled Mr. Bodiley and his little daughter with ease. Later it carried three grown persons without undue effort. This is the limit of the seating capacity of the present rolling stock. The track, which is raised on trestles and laid alongside the garden path and the dividing party hedge, is in a picturesque setting. The rail itself is Vignoles section in drawn brass, about ¾in. scale, so as to be

Fig. 2.—A detailed view of the 2½in. gauge model, showing the cab fittings and tender.

suitable for the present locomotive, and also heavy enough for the larger model he is now in the course of building.

Now for a few details of this half-inch scale Pacific. It is based on "Fayette" drawings, and has a locomotive-type firetube boiler (fitted with combustion chamber) using, as previously mentioned, steam coal as fuel, and the working pressure is 70 to 75lb. The two cylinders were made from Mr. Bodiley's own pattern, and are fitted with internal admission piston valves operated by "Baker" gear. Bore and stroke are ⅞in. and 1⅛in., and cab-operated drain cocks are fitted. A mechanical as well as a hydrostatic lubricator ensure the well-being of the cylinders and valves under superheated steam. Other features are pop safety valves, lifting at 75lb. pressure, and snifting valve, in addition, of course, to the usual cab fit-

Fig. 3.—Close-up of the 3½in. gauge "Royal Scot" chassis

tings, i.e., water and steam gauge, blower, whistle and reverse wheel. The tender, supported on leaf springs, holds about half a gallon of water, and this is fed to the boiler by two axle pumps (controlled by by-pass valves in cab) and a hand pump, as required. The rear truck of the locomotive is easily removable, and this allows the grate and ash-pan to be dropped for cleaning purposes.

Having witnessed this demonstration of the locomotive's possibilities, we were invited to inspect the workshop in which it was made. This was situated in an attic room at the top of the house, which Mr. Bodiley began fitting out as a workshop about seven years ago. It was well fitted up and neatly arranged. The machine tools comprise a 4in. Drummond lathe and a sensitive drill, both driven by electric power. Mr. Bodiley does all his own work, with the exception of brazing.

Fig. 4.—Mr. L. G. Bodiley working on the Royal Scot chassis at his work bench.

Fig. 5.—Model of the Jane Drew kitchen unit, designed for the British Gas Association.

A ¾in. Scale "Royal Scot"

In the workshop we had the opportunity of seeing his most ambitious effort to date—the beginnings of a ¾in. scale 3½in. gauge, 4-6-0 type L.M.S. "Royal Scot" locomotive. This model is being constructed with the aid of Henry Greenly's drawings, and various material and castings are from Bassett-Lowke, Ltd., and Bond's O' Euston Road. Features of the model will be three piston-valve cylinders (outside 1¼in. and inside 1in. bore by 1¾in. stroke) operated by Walschaert's valve gear in hardened steel, and a main frame constructed almost entirely of steel. Owing to the scarcity of castings, various parts of this, such as motion plates, buffer beams, cheek plates, etc., have been built up from odd pieces of steel, fitted and brazed together, and these, in Mr. Bodiley's opinion, make a better job than gun-metal castings. It is hoped to fit injectors to this model, but an axle-driven pump and a hand pump will be included, in case of injector failure. This model has occupied nearly three years of Mr. Bodiley's spare time, but he has been rewarded by seeing the wheels "tick over" on one cylinder, using compressed air at about 15lb. pressure. It will run equally well in either direction and will "notch-up" well, and promises to be a successful engine.

Mr. Bodiley has taken great pains to make and fit everything as perfectly as his limited equipment will allow, even though this means at times scrapping and starting again.

His little daughter Jean, aged seven, is a keen admirer of his work, especially when it is "in operation," and he has encouraged her interest in the hobby by making her models, one of which is an attractive model of the *Santa Maria*, made up from a set of printed cardboard parts.

I wonder how many model engineers heard the interesting broadcast by Mr. W. J. Bassett-Lowke, "Models in Peace and War," which was recorded for the Pacific and North American services of the B.B.C., and afterwards given as a topical talk on September 13 after the 1 o'clock news on the Home Service? This talk occupied fifteen minutes, and gave some very interesting information on the valuable part models have played in helping to win the war.

A Model Kitchen

Here is another example of a housing model—a portion of a kitchen designed by Jane Drew (Fig. 5). It shows the special arrangement of a small dining recess partitioned off, then the kitchen and washhouse—all interconnected. The model is made more realistic by the reproduction of the various kitchen utensils—kettle, plates, cups and saucers to scale. This type of model is being used increasingly for display by architects, town planners, municipalities, and firms who manufacture household equipment.

This sturdy pedal-driven jeep, built by Mr. F. Chapman for his small son, took just two weeks to make. It is constructed chiefly from odds and ends, the only parts purchased being the wheels.

Letters from Readers

"Preventing Railway Accidents"

SIR,—I should like to voice an opinion in criticism of a letter written by "Safety First," headed "Preventing Railway Accidents" in the September issue of PRACTICAL MECHANICS.

As a railway employee temporarily working for H.M. Forces, I should like to make a few observations on this subject which will show that the railway companies have in no manner neglected the possibilities of automatic train control.

For many years the railway companies have been experimenting on methods of bringing a train to a standstill should the driver neglect to observe the distant signal in the warning position.

The Great Western Railway have in extensive use a system which has proved very successful and enables a driver to have perfect confidence in the case of heavy fogs, etc. The L.M.S. Railway too have had under trial for many years a system which has proved entirely satisfactory. The G.W.R. system has the disadvantage of being subject to mechanical wear and tear whereby the L.M.S. system relies on magnetic operation. The subject is too extensive to go into fully, but both systems have been given wide publicity, and suggests that "Safety First" should acquaint himself with this interesting subject.

By way of interest, does the writer of the letter mentioned realise what would happen should any part of a fast moving vehicle strike a stationary object in the permanent way? Also, a braking system has yet to be devised which can pull up a train travelling at speed, in 50 yards.—SIGNALMAN (B.A.O.R.)

A Screwdriver Problem

SIR,—With reference to Professor Low's theory concerning the screwdriver in last month's P.M., I should like to give mine, which is as follows:

When a long screwdriver is used the force exerted at the handle tends to twist the steel blade until a point is reached where the blade attempts to spring back to shape, releasing all the force applied at the handle in one sudden surge. This is noticeable when loosening a tight screw as the blade quivers if the screw loosens at the initial turn. I have also tried short blades with long handles, but without appearing to have such good results.—V. R. WEDDERBURN (East Barnet).

Telescope Mirrors

SIR,—A copy of your September issue has been brought to my notice, in which a query is answered concerning telescope mirrors, silvering and polishing. As I have produced over a dozen of these mirrors, beside a vast amount of other optical work, for recreation in the last 10 years, perhaps I may be allowed the following remarks. Your reader (Douglas Austin, Oldham) asks for the method of finding the focal length of an existing spherical mirror. I find the answer to his question as published, not particularly helpful. The following should be of use. The simplest way of finding the focal length of any lens or mirror is to point it at the sun, and let the converging beam of light fall on a white card. Move the card along the reflected or refracted beam until the bright circle of light is smallest. The distance from the surface of the mirror or lens is then the "solar focal length" of the object being tested, and may be measured on a rule. The curve on the surface of the mirror must then be part of a sphere of radius twice the solar focal length, and as this must be known in order to test the mirror for its optical qualities, it is important to ascertain it. However, your reader asks for the focal length, and the simple method outlined above is of quite enough accuracy to enable him to proceed. As a matter of interest the focal length of any mirror should not be shorter than six diameters. Therefore, for a 6in. mirror, 36in. focal length is the shortest that can be corrected accurately for visual work. Another point that may help your reader is that a spherical mirror will not function in a telescope. It is a property of the spherical mirror that it can only produce an image free from distortion if the object is at centre of curvature (the second distance measured by the method previously mentioned). The returning image is then formed also at centre of curvature, beside the object, and as the usual subjects of telescopic study are far away, this is obviously not the correct place for the image.

The figure needed for the surface of a mirror for telescope use is termed a "paraboloid of revolution" and is recognised by the fact that, when tested at the centre of curvature, the rays from the edge of the mirror focus farther away than those from the centre. The distance between the two focal planes must be equal to the radius of the mirror, in inches, squared, divided by the radius of curvature. The formula is written thus $\frac{r^2}{R}$, and for a 6in. diameter mirror of 36in. focal length works out as follows: diameter of mirror 6in., radius squared therefore 9in., focal length of mirror 36in., radius of curvature = 72in. The distance between edge and centre rays must then be $^9/_{72}$in. or $\frac{1}{8}$in., with the edge rays focussing farthest away from the mirror.

This is the only shape known to science that has the property of producing a perfect image of an object at infinity, and the image is distant from the mirror half the radius of curvature.

In view of the above, I consider that it is most unlikely that your reader has a mirror that will repay his work in mounting it, but the actual labour of making a mirror for telescope use is not at all great, provided that the constructor has the necessary patience. I find there is a large amount of curiosity on this subject among the general public, and have myself started one or two people on amateur optics with very good results. The processes are not at all expensive, and for a mirror no special glass is needed. —G. A. HOLE (Patcham).

Bournemouth and District Society of Model Engineers

SIR,—Since November last we have managed to revive much interest in model engineering here and have had many successful meetings.

The most outstanding being visits to 2½in. gauge garden railways. Mr. A. G. Green's in May, with his "Princess Royal" (4-6-4), and Mr. G. A. Turner's in June, with his "Green Arrow" (2-6-2), where members were able to enjoy the experience of driving locomotives.

Club meetings are held weekly and most interesting lectures and talks have been given: Mr. A. J. Thorne on "Unique Locos," Mr. K. Dickson on "Locos of the Future," Mr. H. Tongs on "Welding," lathe demonstrations, track nights, etc. There is an extensive "0" gauge layout in the Club headquarters, where members have been able to test and exhibit their handiwork. Mr. Ray Coomer's S.R. Schools and Merchant Navy Class Locos being excellent examples of the hobby. Negotiations are at present in hand for a strip of land on which to lay and operate a multi-gauge track. It is also hoped to hold an exhibition shortly.

Application for membership should be addressed to the Hon. Secretary, G. E. Frewer, "Arun," Elm Avenue, Christchurch. —G. E. FREWER (Christchurch).

Model Engineering Society for Prestwick

SIR,—It is proposed to start a Model Engineering Society in the Whitefield and Prestwick districts of Lancashire. It is felt that a club of this description would meet with support and enthusiasm.

A meeting was held at the Stand Grammar Girls' School, Whitefield, at 8 p.m. on November 20th, 1945.

Interested readers are asked to get in touch with Mr. Alan T. Stevenson, 2, Newlands Drive, Prestwick, Lancs.—A. T. STEVENSON (Prestwick).

Electric Gas Lighter

SIR,—I was very interested in the article on "An Electric Gas Lighter," by Hobbyist, in the October issue of PRACTICAL MECHANICS. As I constructed a similar lighter from odds and ends of scrap some months ago, I thought perhaps the details might be of interest to your readers.

My "gun" had a hollow barrel with eight holes drilled about ¼in. from the business end. The "element" consisted of wire taken from a burnt-out soldering iron. I wrapped six turns of this wire round a darning needle and formed an element about ¼in. long. When tested with a grid-bias battery on 7½ volts the result was entirely satisfactory. Instead however, of using a battery I led the flex to the nearest house power plug and connected it to the 8-volt tapping of a mains bell transformer. The result again was entirely satisfactory, and it has been in use in that way ever since.

When time permits I intend fitting another of these gas lighters in the bathroom and to feed it from the same transformer. Whether the transformer will be powerful enough to drive both lighters at once remains to be seen. In any case it is hardly likely that both lighters will be in use at the same time.—A. WHETHERILL (London, N.).

OUR COVER SUBJECT

THE illustration on the cover of the present issue shows a corner in the Metallurgy Department of the National Physical Laboratory at Teddington. Here, the scientific investigation of the constitution, structure and properties of pure metal and alloys and refractory materials is combined with researches relating to the properties of metallic parts in engineering. The effect of all types of stress under various conditions of temperature are studied and results passed on to the British engineering industry.

The operator seen in the illustration is engaged on high-frequency heating research work, and on the left, behind the wire-netting, is the heavy duty H.F. generator which feeds the alternating current into the furnace and H.F. ovens.

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.

Low Temperature Glaze

FOR some time now I have been trying to get a low temperature glaze on to woodwork. I have been using a mixture of china clay, waterglass and whiting, but find that this does not give enough body to the glaze. I shall therefore be glad of your advice.—J. E. Peland (Skerton).

LOW-TEMPERATURE glazes, even under the best of conditions, are not usually very satisfactory, and we think that you will have considerable difficulty in getting them satisfactorily on wood surfaces. Try, first of all, substituting the whiting in your formula by white lead. Alternatively, try a mixture of 3 parts white lead, 1 part borax in place of your whiting. White lead gives good body to a glaze. Sometimes, zinc white (zinc oxide) can be used in place of it, but the zinc oxide has not quite the same body. You cannot use flints and stones in your glaze because of your requirement of low-temperature application. Consequently, you will be more or less confined to various mixture of china clay, white lead, tin oxide, borax and waterglass.

You do not, of course, inform us what you consider to be a low temperature. However, all such glazes above mentioned are more or less fluid around red heat (and sometimes under that temperature). It must, therefore, remain a matter of experiment on your part in order to hit the right proportions of the mixture to fulfil your requirements.

The majority of these formulæ have remained unpublished. Because of this fact, it might pay you to get into touch with The British Refractories Research Association, The Mellor Laboratories, Shelton, Stoke-on-Trent, which organisation might be able to recommend a glaze definitely suitable for your especial purpose.

Chrome, Brass and Copper Plating

I SHOULD be grateful for information on the following points:—

My mains supply is 240 volts D.C. Is there any means of using this through a resistance for electro-plating ?

Would a lorry dynamo, 12 v. 30 a., be of any use for plating chrome or brass ? If one dynamo is insufficient could I use two connected in parallel to increase the amperage ?

What is the formula for chrome-, brass- and copper-plating solutions ? Will chrome "take" on steel or would it be advisable to plate a thin layer of another metal and then chrome over this ? If this is done, is it necessary to polish the first layer ? What is the best polishing material, e.g., tripoli or rouge, for polishing chrome or brass ?

Am I right in assuming that a higher current is required to start plating—known as a strike—and then a gradual reduction till the desired thickness is deposited ?

Is it correct to use paraffin wax for stopping-off the areas which do not require plating ? R. Penfold (Clapton).

THE best method of obtaining a low-voltage high-current supply would be to use a mains-voltage motor driving a low-voltage dynamo. A lorry dynamo could be used for plating small articles, or you could use two in parallel for larger articles. The third brush, if fitted, should be removed from each machine and the field coils fed from the main brushes through a variable resistance for field current and voltage control.

For chromium plating you could use 250 gms. of chromic acid and 2.5 gms. of sulphuric acid per litre; for brass deposition we suggest you use prepared salts, 12 to 16oz. of brass salts and ½oz. of ammonium chloride being used per gallon. These salts are a chemical combination of copper potassium cyanide, zinc potassium cyanide, potassium sulphite, and potassium cyanide. For copper plating you could use 34oz. of pure copper sulphate, 2oz. of potash alum, and 5 fluid oz. of pure sulphuric acid per gallon.

Steel articles which require chromium plating should first be nickel plated; or you could first nickel plate the article, copper plate and polish, and then deposit a further coating of nickel before chromium plating. We do not consider it necessary to apply a high current density to commence plating.

For copper plating a thick coating of ordinary whitewash could be used for stopping-off, and for gold plating stopping-off lacquer is used.

Small Motor Generator

I WISH to construct a motor generator to convert 2 v. D.C. to 120 v. D.C. at 10 m/a.

Please state dimensions, details of laminations of armature and poles, number of turns motor and generator, details of both commutators, type of bearings, gauges of wire, etc. I want the motor generator to be as small as possible. Could you also tell me where to get a book on the subject ?—E. D. Medcalf (Saffron Walden).

FOR a motor generator set of the capacity stated we suggest a two-pole motor and dynamo with armatures of about 1½in. diameter by 1½in. long, running at 4,000 r.p.m. Two volts input is rather low, and if you manage to construct such a machine we are afraid the output voltage will vary rather considerably due to variations of brush contact volt-drop on the motor.

It is not possible to supply winding specifications without having fully dimensioned and descriptive sketches of the field iron systems you propose to use, including the dimensions of the armature slots and teeth, and the air gap clearance between the armature and field magnets (which may be measured by means of feeler gauges). We should also require to know the number of armature slots and commutator segments. For a smooth output voltage the number of slots and commutator segments of the dynamo should be as high as practicable. The book "Practical Design of Small Motors and Transformers," by E. Molloy (Geo. Newnes, Ltd.), gives some useful information on the design of such machines. Messrs. George L. Scott & Co., Ltd., of Hawarden Bridge Steelworks, Shotton, Chester, may be able to supply suitable armature stampings.

Running D.C. Motor on A.C.

I HAVE a D.C. motor of 12 B.H.P., laminated fields, series wound, 2,000 r.p.m. Should it run approximately the same off A.C. mains ? The brush position has got mixed up; with the brushes between the fields, the armature will not rotate, and with the brushes in line with the fields the armature turns very slowly and can be stopped by slight pressure with the hand. —A. Robertson (Glasgow).

UNLESS the whole of the field iron system is fully laminated, including the poles, pole pieces, and yoke, we anticipate there will be considerable heating when used on A.C. We assume the two field coils are actually connected in series with each other in such a way as to create poles of opposite magnetic polarity, and in series with the armature. It is probable the field coils have too many turns for satisfactory operation on A.C. We suggest you try connecting the field coils in parallel with each other, still keeping them of opposite polarity and in series with the armature. Even then it may be necessary to connect a diverter resistance across the field windings to weaken them still further, or to reduce the number of turns in each coil.

As regards brush position it would be useful to find the exact neutral position. To do this you could supply the two field coils alone with a suitable D.C. voltage. All the brushes should be removed with the exception of one on each of the two spindles, these being filed so they make contact with the commutator in the centre of each brush only, along a line parallel with the micas. These two brushes should be connected to a low-reading voltmeter. The brushes should be adjusted until, on interrupting the field supply, there is no kick on the voltmeter needle; the brushes then being in the neutral position. The best running position will probably be a few segments back from this position, i.e., in the opposite direction to rotation.

Dyes for Veneers

I SHALL be pleased if you could give me information concerning the dye used in marquetry for dying veneers. It must be a dye that will penetrate the thickness of veneer, usually about 1/30in., and, of course, it will have to take polish after cleaning off.

I only wish to dye small pieces of veneer in various shades of green, red, yellow and blue. Also, is it possible to mix colours in wood dyeing to get intermediate colours ? How is the dye applied to the wood, and where are the chemicals obtainable ?—G. Morley (High Wycombe).

IN order to dye thin wood veneers your best plan is to proceed as follows:

Dissolve 5 parts (by weight) of tannic acid in 100 parts of water. Immerse the wood pieces in this, and gradually raise the temperature of the solution to boiling point during about 15 minutes, stirring the wood pieces more or less continually. Allow the liquid to cool, still stirring the wood pieces, and then withdraw them and allow them to drain (but not to dry completely).

Have ready the dye bath. This should be made by dissolving 5 parts of dye and 3 parts of sodium sulphate (Glauber's salts) in 100 parts of water. Immerse the tannin-treated wooden pieces into the cold dyebath, and gradually heat the liquid to boiling point, stirring the woods all the time in order to be sure of even dyeing. Keep the dye bath at nearly boiling point for 20 minutes. Then withdraw the woods and wash them well in warm water. Finally, allow them to dry slowly—*not* by heat. The wooden pieces will now be fully dyed, and although their surfaces will look dull, they can be brightened up by subsequent polishing.

The best dyes to use are those of the "basic" or "acid" class. Suitable dyes of these classes are:

Methylene blue; methyl violet; Hoffman's violet; naphthol black; night blue; Bismarck brown; fast brown, G.; chrysodine (orange-yellow); acid green; brilliant green; malachite green; acid magenta; fast acid red; saffranine (yellow); tartrazine (yellow); acid yellow; naphthol yellow.

All these colours (average price 1s. 6d. oz.) are obtainable from Messrs. Harrington Bros., Ltd., 4, Oliver's Yard, 53a, City Road, London, E.C.1; as is also tannic acid.

The tannic acid treatment of the wood is not absolutely essential, but it improves the permanence, evenness and depth of the dyeing.

Any of these dye solutions can be mixed to give intermediate shades, but you should bear in mind the fact that these synthetic dyes will not generally stand strong sunlight without fading.

Dead-black for a Lantern

HAVING made a lantern-type projector, I wish to coat the inside of the lamp house a dead-black, and the outside a slate shade in either lacquer or enamel. Can you give me the address of a firm who could supply these ? It will be observed that something having good heat-resisting qualities will be required. The best dead-black I have used in other directions so far has been drop black (bound in oil), with turpentine added, but I am uncertain as to whether this would be suitable where heat is concerned. The whole of the lamp house is of sheet iron.—E. W. Smethurst (Oldham).

A DEAD-BLACK composed of drop black in oil and turpentine would be quite suitable for your use in the manner indicated, always provided that a very minimum of oil is used. Here, however, there is a danger of so cutting down the proportion of oil binder that the paint may tend to flake away from the interior of the lantern. Even so, it could not do much harm, and we think that you could make a very serviceable dead-black for yourself in this manner. Alternatively, you can obtain for about 1s. 6d. a small bottle of instrument-maker's dead-black from Messrs. Flatter's & Garnet, Ltd., Oxford Road (opposite the University), Manchester; or from Messrs. Johnson & Sons, Ltd., Photographic Chemists, Hendon, London, N.W.4.

The enamelling of the exterior of the lamp house is a much more difficult proposition. When these parts are manufactured commercially the exterior is always finished with a stove-enamel, which is an enamel which has been applied and then "stoved" for some hours in a specially designed furnace at a temperature of about 600 deg. F. We do not see how you can imitate this process. Your best plan would be to seek out some local enamelling firm which would do this particular job for you, for there is no commercial cold-applied enamel which we can recommend and guarantee to remain free from blistering under heat. If, however, you do ultimately find it necessary to use some non-stoved type of enamel, one based on a synthetic resin would give the best results, and for this we would advise you to apply to Bakelite, Ltd., Grosvenor House, London, S.W.1.

Copying a Sketch on Glass

I HAVE a sketch done on glass and desire to make a few copies.

Could you please give me details of a solution sensitive to light with which I could coat other sheets of glass and obtain my copies by exposure ?

I would also require a method of fixing. Any colour would do.—J. Chisholm (Glasgow).

YOU do not give many details concerning the nature of the sketch on glass which you desire to copy, in which circumstances we are somewhat hesitant in judging the right process for you to follow. It might be easiest for you to purchase ordinary photographic lantern plates (of a suitable size for your original) and to copy the original on these in accordance with the instructions given with the plates. This would, of course, necessitate some skill in photographic processing on your part. Alternatively, provided that the original sketch is "strong" enough you could copy it by means of an adaptation of the carbon process in the following manner:

Dissolve 6 parts of ordinary cooking gelatine in 100 parts of water. Then dissolve in the resulting solution 4 parts of potassium bichromate. This dissolving process must be done under artificial light, and from now onwards the gelatine solution *must not* be exposed to ordinary light, since it is now sensitive to the latter. To this bichromated solution of gelatine add sufficient pigment (soot, red oxide, blue, etc.) in just sufficient quantity to colour lightly the liquid. The liquid will set when cold.

Take a glass plate having a perfectly clean surface and flow a thin layer of the bichromated and pigmented gelatine solution on to the plate. Set it aside in a dark room to cool and to set. When perfectly set expose the plate against the original glass sketch in a printing frame to sunlight for about three minutes. Then remove the plate from the frame and soak it in water for about half an hour.

The effect of the light exposure will be to make insoluble the bichromated and pigmented gelatine which received the fullest exposure, whereas the gelatine which was protected from exposure behind the opaque lines of the sketch will remain soluble, so that on subsequent development by simple immersion of the exposed plate in a bath of clean water the still soluble parts will dissolve away, leaving the original image in white lines on a dark background. This is a "negative image," and if a "positive" image of dark lines on a white or clear background is desired another coated plate will have to be exposed under the negative plate.

No fixing or treatment other than water development is required, and the image obtained is absolutely permanent, or, at least, as permanent and resistant to fading as is the pigment used in the making of the sensitised gelatine solution. Hence, if ordinary soot is used for this, the picture will be absolutely permanent.

Making Mirrors

I WISH to mount a photograph on a piece of glass and make a surround of quicksilver, i.e. a mirror surround. Can you please tell me how to apply the quicksilver to the glass to make a mirror?—W. Downey (Liverpool).

MIRRORS are made by depositing silver. Quicksilver or mercury is not applied to glass. The process is a difficult one, and it calls for much practical experience. If, therefore, you are as yet unable to silver an ordinary mirror you will not have much success in the task which you propose to set yourself.

However, for your information, the following is an outline of the process:

Make up a solution of shellac in methylated spirit and paint two or three coats of this solution on to the glass area which is *not* required to be silvered, allowing each coat to dry before applying the next one

Now make up the following solutions:

Solution 1.—Silver nitrate, 135 grains; distilled water, 5 ozs.

Solution 2.—Ammonium nitrate, 130 grains; distilled water, 5 ozs.

Solution 3.—Caustic potash, 220 grains; distilled water, 5 ozs.

Solution 4.—Sugar, 105 grains; distilled water, 2½ ozs.; tartaric acid, 25 grains.

Boil the above ingredients gently in a flask for 10 minutes. Then cool and add rectified spirit, ½ oz.; distilled water, 5 ozs.

The above four solutions must all be made up separately and kept in separate bottles, which must be scrupulously clean. Distilled water is essential in each case.

For use: Mix equal volumes of solutions 1 and 2; then mix equal volumes of solutions 3 and 4; and finally mix these two combined solutions together and pour them over the glass area to be silvered. Silvering will take about four minutes, after which the glass is immersed in clean water to wash away the solutions, and afterwards put away in a current of air to dry.

Note carefully that the solutions must only be mixed immediately before the silvering operation, and also that the glass surface must be most scrupulously clean before silvering, otherwise the silver layer will not remain.

After the silvering has been completed the shellacked area of the glass may be wiped clean by means of a wad of cotton wool charged with methylated spirit.

Eliminating Wood-boring Beetles

COULD you please give me any advice on the following subject? I am taking over the tenancy of a house, and the old tenant tells me that parts of the woodwork in the house are infected with the wood-boring beetle, and that some parts of his furniture were affected.

How can I protect my furniture? Is there any cure for it if it gets in my furniture? The house is situated near a timber works, and I expect the beetles come from there.

I am having the house fumigated by the local health authority, and perhaps that will help. I have seen some of the skirting boards in the house, and they are full of tiny holes.—W. S. Braines (Weymouth).

IT is very possible that the woodwork of your house has been infected by wood beetles from the neighbouring timber works, and if you had sent us some of the dead beetles we could have determined this point for you. However, wood-boring beetles are extremely common, and much damage is done annually to timbers and furniture by them.

If your house (together with the furniture) is effectively fumigated by hydrocyanic gas by the local authority, then you will obtain a perfect cure for the trouble, for by this means all living stages of the beetle, whether in the wood or without (including eggs) will be destroyed.

At the same time, we would advise you to purchase from Messrs. A. Boake, Roberts & Co., Ltd., Carpenters Road, Stratford, London, about 2 or 3lbs. of copper naphthenate, and to dissolve this green, resinous material in 4 gallons of light creosote oil, which you will be able to obtain locally. The creosote will have to be heated for the effective solution of the copper naphthenate. With this solution (preferably used hot so as to effect better penetration) liberally paint all the bare woodwork of the house, including the backs and bottoms of furniture (but not the polished surfaces). The pungent smell of the creosote will be pretty bad, but this can be minimised by treating the house room by room, and by opening the windows.

Give one application of the solution now, and another in March next, for it is at the latter season of the year that the beetles emerge from the wood.

This treatment will supplement the fumigation of the house, and, more still, will more or less permanently render the woodwork immune from further beetle attack, since traces of the creosote and copper naphthenate will remain in the wood, and these are toxic to insect life, although harmless to animals and humans. Please note that wood which has to be painted over should not be creosoted. In such instances dissolve 1 part of copper naphthenate in about 70 parts of paraffin, and use this as a wood-impregnating material.

The worm holes in the timbers are best filled up with very fine sawdust made into a paste with strong glue solution.

High-temperature Melting Material

COULD you tell me the formula or composition of a substance that will resist a temperature of 1,400 deg. C. and not melt or even go plastic? Porcelain is too expensive.

Also, could you tell me of a compound which would generate heat when subjected to an electric current?

What is the construction of a selenium cell, and are there any other elements which change their resistance when subjected to light?—K. L. Carpenter (West Bromwich).

IN the absence of more details concerning the exact purpose for which you desire to use a high-temperature melting material we cannot possibly answer your inquiry very fully. You mention that porcelain is too expensive for your purpose, which suggests that you require a large area of the material. For this reason we suppose also that pure silica (which begins to melt about 1,600 deg. C.) would also be unsuitable, and that refractory metals, such as tungsten, would be altogether out of the question.

In these circumstances we can only suggest mica and asbestos, lime and magnesia as suitable materials, but, of course, the two latter would be unsuited for any structural purposes.

There is no material which of itself generates heat under the influence of an electric current. If heat is developed in any given instance, that heat is always due to its resistance to the current. For this reason, therefore, any material which is partly conductive, i.e. which partly resists the current, will become heated when a current is forced through it; the actual amount of heat developed being governed by the degree of resistance of the material, the mass of material present, the intensity of the current, and other varying factors.

Basically, the average selenium cell consists of an insulating slab of unglazed porcelain or ebonite over which is wrapped about 50-60 turns of fine-gauge bare copper wire (say, 36 gauge). The wire turns do not touch each other. The sensitive surface of the cell is made by rubbing over the wire turns molten vitreous selenium so that selenium sinks between the turns of wire, and is enabled to short-circuit each turn, thus decreasing the resistance of the area so treated.

There are no other elements or materials which normally show a resistance change under light action. Some of the extremely fine cathode coatings of photo-electric cells, such as mixture of alkali metals and their hydrides should show some resistance changes under light action in high vacuuo, but their release of electrons under such conditions is of far more importance than their mere alteration in resistance. For practical purposes, therefore, selenium is the only element which usefully changes in resistance under light action, and, furthermore, it is only the vitreous or "metallic" form of selenium which will do this.

Heating a Substance by Steam

I WISH to heat a substance by injecting steam into it under pressure.

It has the following characteristics: Specific heat, .2; weight, 100 cu. ft.; moisture content, 20 per cent.; temperature to be raised from 60 deg. to 212 deg. F.

Could you please give me the necessary formulæ for finding:

(1) The quantity of steam required per cu. ft.

(2) The most economical pressure, 20lb. to 80lb.

(3) The time required to reach 212 deg.

Would anything be gained, such as time or pressure, by increasing the moisture content and using super-heated steam?—M. Gould (Grantham).

YOUR problem will have to be solved experimentally. It cannot be theoretically calculated (at least by us) because there are too many factors capable of variation, and also because insufficient information is given by you as to the exact nature of the substance and its actual quantity.

The amount of heat in a substance, as you probably are aware, depends on (a) its mass, (b) its temperature, (c) its specific heat, but since the specific heat varies with temperature, all the above three factors in your case will be varying.

The actual pressure of the heating steam will be immaterial provided (a) that the steam has at all times entirely free access to the material under treatment, and (b) that its heat is maintained at a more or less constant temperature. The time required for the material to reach 212 deg. or any other given temperature will be dependent not on the steam pressure but on the amount of material to be heated and the rate of dissipation of heat from the system.

Nothing would be gained by increasing the moisture content of the material or substance, because by so doing you would at the same time be increasing the amount of water to be heated up in the substance, and at 212 deg. F. this water would actually absorb *extra* heat in being changed from liquid water to gaseous water (i.e., steam). Your best plan would be to decrease the water content of the substance as much as possible and to rely on an exposure of a maximum area of the substance to the heating effects of the steam.

Whether super-heated steam should or should not be used in this particular case is entirely more than we can say in the absence of detailed particulars of your projected process.

Cleaning Mercury: Barometer Making

I WISH to fill a glass tube with mercury for a barometer. How can I clean the mercury before putting it into the tube?

Would a 3/16in. internal diameter tube answer the purpose?—G. Bond (Belfast).

THE precise method of cleaning mercury is dependent to some extent upon the amount of material which there is to clean and, also, upon the actual amount and nature of its dirt-contamination. In your case, the best way would be to squeeze the mercury through a little bag of chamois leather containing one or two pinholes at the bottom. Very possibly, the mercury may be made bright and shiny by this simple method. If not, it will require acid treatment, which is best effected in the following manner: Mix together 20 parts (by volume) of strong nitric acid and 80 parts of water. Then squeeze the mercury through the chamois leather bag into this. The mercury will impinge on to the surface of the acid in the form of a fine spray and will sink to the bottom of the liquid in tiny particles which will then coalesce together. The acid is then poured off and the mercury is well washed by repeatedly filling the vessel with clean water.

This acid treatment should be repeated three or four times, and finally the mercury should be squeezed through the chamois leather bag into a perfectly dry vessel. It will now be bright and silvery, the acid having dissolved away all impurities, and it will be able to be used in confidence for barometer filling. The acid can be used over and over again.

Any diameter of tube will be suitable for making a barometer. A 3/16in. internal diameter tube will therefore be quite effective, but the mercury level will not be quite so easy to read as it is in the case of the more usual ¼in. internal diameter tube.

For effective barometer working, three essentials are necessary, viz.: perfect cleanliness of the mercury, perfect cleanliness of the interior walls of the tube, complete absence of air from the space above the mercury level in the tube.

Cement for Gramophone Record Material

WILL you inform me as to the following: With what could I cement the material of which gramophone records are made?

What is the approximate cost of such a cement, and where I could obtain some?

I do not wish to repair broken records, but to make useful articles from old records.—G. Kirk (Kettering).

YOU can make a cement for gramophone record material by mixing resin and wax. Take 5 parts of ordinary resin ("rosin"). Melt it gently in a pan and then add to it 5 parts (by weight) of beeswax (or, alternatively, 2½ parts beeswax and 2½ parts ordinary candle wax). To the mixture add about ½ part of castor oil to render it plastic and less brittle.

This proportion of castor oil may have to be varied somewhat according to how soft you require the cement to be. It may be an advantage to you to prepare two kinds of cement—one soft and the other hard. The consistency of the cement should be such that it remains firm and rigid in the cold, but softens completely when warm. If a glossy surface is desired with the cement, you might advantageously add about 1 part of shellac to it.

The cost of such cement is relatively low, beeswax being its most costly ingredient.

If necessary, you can add a little pigment, such as lampblack, brown ochre or red oxide, to the cement in order to colour it to any required shade.

Talk in the Stable

A Phantasy

By R. L. JEFFERSON

THE cycle shed in the popular North Road hostelry was full of all kinds of machines; most of them were, of course, of the road-racing type, many had sprints and tubulars with "spares" lashed to the saddlebags; the owners of the machines were in the inn having late tea and talking of to-morrow's event.

At seven o'clock out came the cyclists, and the shed soon became a scene of feverish activity, wheels were changed, tyres inspected and pumped up, and the hundred and one other things that racing men do were done to the accompaniment of much chat and banter.

Soon all the jobs were done, and one by one the men left the old cycle shed until only the elderly doctor remained. This grizzled veteran always rode in the "24"; he had never won anything, but always made an annual appearance in this event, which had become a tradition to him. The doctor gave a last look-over his old Chater-Lea and left the shed, closing the door quietly behind him.

Night settled down, auguring a fine to-morrow, with promise of speed in the air. The riders were early abed to prepare themselves for the strenuous efforts of the next morning.

Said the Chater-Lea

Presently the only sound to be heard was the night wind rustling through the trees; the moon shone through the window of the cycle shed full on the old doctor's bicycle. Presently this venerable vehicle "spoke"; it addressed its remarks to a very new lightweight maker's latest product. "May I ask," said the Chater-Lea, "why your master has allowed your maker to put such a vulgar finish on you? Frankly, your finish looks cheap and nasty, and serves to draw attention from your doubtful fittings." "Oh," said the lightweight, "my master is young and enthusiastic; he will no doubt get over it in time." For a new machine the lightweight was quite modest and was willing to listen to the old Chater-Lea, which, like all old things, was a bit garrulous. "Yes," said the Chater-Lea, "I could tell you some stories of where I've been. I've seen all the counties of these Islands more than once; my old cranked stays are not a whit less rigid than your straight, tapered ones. What you gain by your present position quite escapes me. Look at your bracket, only 10½in. from the ground. I've a good 13in. clearance, which helps me to be rigid, and my very short back triangle makes me very stiff in the drive. My hubs, which you will observe are of the disc adjusting type, have never been touched since I was new in 1911. Of course, I'm oiled and cleaned every week, and I've been re-enamelled once, that was in 1922, the year Marsh brought the road title back where it belongs on this side of the water.

"When I'm not racing, my master goes touring on me. What delightful spots I've visited! Considering that I have only one brake and a fixed wheel, I've held my master back very well on some of the worst mountains of Wales and our own Lake District. When you've done the number of miles I've done you will be entitled to call yourself a machine; until then listen and absorb as much information as you can, store it up, if it's good use it for the benefit of your master."

The 56in. "Ordinary"

The old Chater-Lea was about to resume in much the same manner as before when he was interrupted by an apologetic cough from the darkest corner of the shed. Unseen earlier by any of the cyclists there reposed a 56in. "Ordinary," now, of course, very rusty. It was partly hidden by barrels and bits of wood stacked around it. Presently it, too, began to talk. "You'll pardon me, sir, I'm sure," it said, addressing its remarks to the Chater-Lea, "I don't wish to be rude, but you must admit I've been very patient in listening to your views on cycling. Of course, as I was built in 1881, I look down upon you in more ways than one from a very great height. In my opinion your exploits are negligible compared to mine. I originally started as a path-racer, and was owned by a very great man. This gentleman—and he was a gentleman—was not only a cyclist, but a man of means, and a patron of the arts; he employed a qualified mechanic to look after his stud of machines. He had five, of which I was the newest and lightest. I actually weighed 23lb. stripped for the path, and had the then new Bowns Aeolious bearings, and ran, to use my master's words, 'like silk.'

"I was fortunate enough to win over 40 prizes for my master in his first year's ownership of me; he was very proud of me as I was of him. The mechanic was a very decent fellow, and he never used the wrong sized spanner on me or hit me with a hammer as I had seen other machines so treated. It grieved me to see this, as I was the product of a very great engineer, Thomas Humber. The next year my master bought a brand new 'Invincible' racer, and this machine only weighed 21lb., and was nickel-plated all over. My master came in third in his first event on the new steed. He attributed his lack of success to early-season unfitness, and after he had failed in two more events he grew dissatisfied with his new mount and finally sold it cheaply through the columns of *Bicycling News*. I was very glad, of course, that my master rode me to success in 36 events that season. I was sent back to Humber's in late October for a thorough overhaul and re-enamel. My master, as was his custom, attended the Stanley Show at the Agricultural Hall. Many and gleaming were the exhibits, and very plausible were the frock-coated gentlemen in charge of the stands. My master ordered a machine from Ellis and Co., and came away armed with catalogues and other souvenirs which were given away in great quantity in those days.

"I'm afraid I've got to admit that even when I came back from Humber's the new machine quite put me in the shade; it was finished in a really beautiful shade of green, and the workmanship was superb. The weight was 22lb., and roller-bearings and steel hubs fore and aft made up a very good machine. My master won many races on his new mount, and only used me for training. Presently my lease of life with my good master came to an end, and I was sold for £4 10s. to a fairly keen young clubman of the Canonbury Bicycle Club. I'm sorry to say this young man didn't treat me in anything like the manner of my old master. I was seldom oiled or adjusted, and never cleaned, even when I'd been out in the pouring rain. One day my rear wheel bearing seized up solid, and my young master 'went over the top.' I can't say I was sorry for him. I believe had he been killed I wouldn't have shed a tear, but unfortunately he wasn't, and soon recovered. He remounted after freeing the cone in my rear wheel, but he never bothered to oil me, although goodness' knows I could have done with it. I doubt whether he even owned an oil can. He had very few spanners, and only used them when something went wrong. Of course, I gradually got worse under such treatment. My head bearings were in a shocking state, and when the spoon brake was applied to my front wheel I shook all over as with the palsy. Eventually I got relief when my backbone broke clean in two on Pentonville Hill. My master this time was a hospital case; in fact he was in the Great Northern Hospital for over two months."

The Hobby-horse

Dawn was just breaking, and the old Humber was about to resume, when he was interrupted by a hobby-horse, completely covered by wood and sacks, under the front wheel of the "Ordinary." "Why don't you shut up," said the hobby-horse out of its mahogany mouth, "or I'll begin and turn you all green with envy." He never started, for the door was thrown open by a lad in tights and alpaca who grabbed the new lightweight and wheeled it into the yard. The "Ordinary" and the hobby-horse relapsed into silence and the dust of years, and prepared to wait patiently for the return of the cyclists' steeds to tell them the result of the "24."

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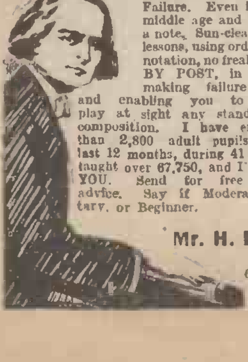

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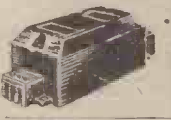

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THE Cyclist

Editor : F. J. CAMM

VOL. XIV DECEMBER, 1945 No. 286

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Comments of the Month By F. J. C.

New Road Safety Campaign

THE Rt. Hon. Alfred Barnes, M.P., the new Minister of War Transport (incidentally, why continue to include the word "War" in the title of the Ministry? The war is over), at a recent Press conference stated that he proposes, conjointly with the Ministry of Information and the Royal Society for the Prevention of Accidents, to launch a "Keep Death Off The Road" campaign. An inspection of this campaign leaves us with the impression that it is the mixture as before. It quite fails to recognise that accidents in the main are not due to the carelessness of motorists, although everyone is well aware that a small percentage of motorists are careless, and an even smaller percentage are accident prone. The campaign also fails to appreciate that accidents are due, in the main, to the natural carelessness of pedestrians, and also to our obsolete road system which has failed to keep pace with developments in road travel. Buses, for example, are allowed to use routes never designed for such gargantuan vehicles. Bus and tram stopping places are fixed at traffic lights, causing severe congestion and creating danger points. They are also permitted to have stopping places causing public vehicles proceeding in opposite directions completely to block the road. There are far too many traffic lights, which build up clots of traffic which would be safer if kept apart. Because traffic lights are insensible to the needs of the moment, and needlessly hold up large numbers of vehicles, they should be abolished at all points except multi-crossings, such as Trafalgar Square. Pedestrians, at present, cannot commit a traffic offence. It is still considered that the making of regulations and the infliction of penalties will solve the traffic problem. That being so, why are not regulations made controlling pedestrians? The plain fact is that all road users will have to make concessions, for it is manifestly unfair that one section should be held responsible for the results of carelessness of other sections. Mr. Barnes thinks that a publicity campaign punctuated by stupid slogans will solve the problem and make people road sensible. We can assure him that these schemes have been tried before. There have been many broadcasts and Press campaigns, but the accident figures continue to show an appalling increase. If we continue to tackle the effect instead of the cause, those figures will continue to rise.

Same Old Furrow!

THE Ministry of Transport cannot plead that they are without advice on the complexities of road accidents. Almost every national body concerned with motor-cars, cycles, pedestrians, public service vehicles and road making have independently issued reports dealing with this problem, and many of them have issued collective reports. In spite of the valuable suggestions which have been made, the Minister proposes to plough the same old furrow, and to presume that motorists go out at night with large searchlights attached to their cars looking for people to kill. If the Minister would investigate these reports, he would find therein valuable information, and he would also be able to assess the results of previous publicity campaigns. All of them have been abortive.

It is true that the Minister's campaign is largely directed to motorists. We are all agreed that the majority of accidents involve motorists, and the new campaign virtually points the minatory finger at them. In fairness, however, we must admit that carelessness is not the prerogative of the motorist only; cyclists and pedestrians are careless also. The real test of the campaign is to see what effect it has upon the accident problem, say, within a week of its inception. We are certain that there will not be a diminution. Yet this campaign is to cost the taxpayer £250,000, which would be better spent improving the roads. Although we are confronted, as the Minister says, with as much danger from accidents on the roads as we were from air attacks during the war, the vital difference is that the solution to the road accident problem is in our own hands. Even with air raids the accidents could have been less but for the carelessness of members of the public who ignored advice to take precautionary measures. We agree with the Minister that what is needed is a treaty of alliance between all classes of road users, based on the golden rule of doing unto others as you would have them do to you, by scrupulously observing the Highway Code, whether we are on foot, on a bicycle or at the wheel of a car. The new campaign will draw attention to the false sense of security, especially among children, resulting from the absence, in recent years, of heavy traffic, to increased motor traffic, the poor condition of many vehicles, inexperienced drivers, and road obstructions due to war conditions. We suggest that the Minister of Transport, in connection with the latter, should press for the release of labour to build new roads and remove the obstructions, and that he should impress upon the Government the need for applying the Road Fund to the purpose for which it was intended. Regarding the poor condition of many vehicles, this is entirely due to the iniquitous Purchase Tax, which compels motorists to use old vehicles instead of buying new ones; and also to the great shortage of replacement parts, due to the stupid Government policy of demobilisation.

"Self-preservation"

WE think "the false sense of security" is a myth. We do not for one moment believe that pedestrians are now presuming that because there were few vehicles on the road during the war, there are not more to-day. They are not blind, and can see for themselves. Self-preservation is the first law of Nature, and if people will continue to be careless, they will pay for their folly. To suggest that accidents are due to a desire for massed-manslaughter on the part of motorists is fantastic and untrue. We hear far too much of the carelessness of motorists and too little of the number of accidents they avoid.

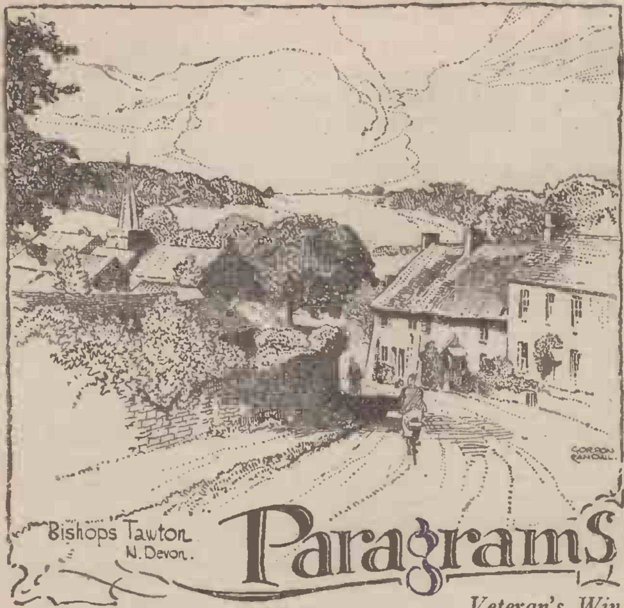
In this connection we oppose the attitude of those fawning individuals who doff their hats in reverence at our so-called cycling-legislators, who have espoused wrong policies in connection with cycling for several decades, because of their pugnacious desire to impose their wills on memberships which have no say in framing such policies. We have not any cyling legislators.

More than 100 people are killed on the roads of this country every week, and it would be idle to blind ourselves to the gravity of this problem, which will not be solved by listening to the sectarian arguments of particular bodies, especially where those arguments are based on false premises and are divorced from fact. Our cycling bodies, if they wish to conform to the new road order, which Mr. Barnes wishes to inaugurate, will have to modify their unbending attitude, which they have adopted for 50 years. In other words, they must become realists and bring their ideas up to date. It may be necessary, in order to bring this about, to lop off some of the dead wood from the trunk. It is high time that a new and enlightened outlook permeated the musty portals of Craven Hill and Doughty Street.

As far as "The Treaty of Alliance between all classes of road users" is concerned, the Minister should be aware of the fact that that Treaty already exists in the form of the Roadfarers' Club, the members of which are non-sectarian, and are composed of cyclists, motor-cyclists, pedestrians, politicians, motorists, Ministers of Transport and all those interested in the solution of road problems and who are without axes to grind.

The Roadfarers' Club issued, at the request of the Ministry of Transport, a memorandum on The Design and Layout of Roads in Built-up Areas, and if the new Minister will study that memorandum and adopt the proposals made therein, he will achieve a diminution in accidents in built-up areas at once. This National body is a non-political and non-profit-making organisation which does not favour motorists, cyclists or pedestrians. It wants the roads made safe for all to use.

The campaign of hate against motorists which has been promoted by the C.T.C. and N.C.U. during the past fifty years, and their stubborn opposition to every suggestion for improved methods of road safety if such methods opposed the so-called liberty of the cyclist, has been one of the chief stumbling blocks to progress.



Producing Bicycles

A FORMER "shadow" factory at Berkswell, near Coventry, once owned by Messrs. Rootes, has been converted for the production of bicycles.

From Northern Scotland

THE Thurso Cycling Club—the most northerly in the British Isles—has lost, by resignation, its noted hon. gen. sec., John Gair, who has resigned. He is well known to tourists and to record-breakers.

Expensive

IT is stated that cycles are now costing over £60 each in Japan—a country noted for its pre-war cheapness of such articles.

Depleted but Carrying On

DESPITE depletion in membership, the Barren Rock Wheelers—a Service Club in Aden—has decided to hold five road events during the next season. Membership is chiefly among R.A.F. personnel.

Tropical Twiddlers' Change

W. V. CAMERON has taken over the hon. secretaryship of the Tropical Twiddlers in place of L. J. Howe, who has been posted to a transit camp.

Course Record Lowered

BY clocking 1.0.49 to win the Hounslow 25-mile event, C. Cartwright, Manchester Clarion, lowered course record which stood to the credit of G. Fleming with 1.0.53.

"Painted Boats"

OPEN-AIR enthusiasts will welcome the film "Painted Boats," a semi-documentary production dealing with life on Britain's inland waterways.

Glad News

E. DRAKE, Bournemouth Arrow C.C., who was taken prisoner at Singapore, is now safe and sound.

Tyres in France

IT is anticipated that the French Dunlop Factory, which is now about 30 per cent. of its pre-war output, will be back at full pre-war capacity next year.

Manchester Wheelers' Loss

FRED LEEMING, former president of the Manchester Wheelers, has died. He was 80 and an active rider until a year or so ago. Mr. Leeming had a wide circle of friends in the North.

Southampton Champion

DESPITE his three years in the Middle East, John Potter has won both the Road and the Track championships of the Southampton Wheelers.

Southgate Promotions

BOTH G. E. Thomas and R. S. Philpot are now majors in the Indian Army.

At Long Last

A BRIDGE over the River Severn between Aust and the Beachley Peninsular, which will save a mileage of 54 on the Southampton-Bristol-Cardiff journey, is stated to be in the highest priority category. Tourists will welcome its construction.

East Liverpool's Jubilee

THE year 1946 will see the revival of the classic East Liverpool Wheelers' "50." It will also see the postponed "jubilee" celebrations of the club which was founded in 1890.

Redditch Diamond Jubilee

THE Diamond Jubilee of the Redditch Road and Path Club was appropriately celebrated recently with the only founder-member, H. Guise, in the chair. Mr. Guise is the reigning president.

Machines for Overseas

DESPITE the fact that bicycle manufacturers in this country aim at producing 1,500,000 cycles, two-thirds of these are for export. The industry, says George Wilson, president of the Manufacturers' Union, wants 20,000 more men before it can begin to cope with the present demand.

Hitchin Club Bereaved

A MEMBER of the Palestine Police, James Barry (Hitchin Nomads C.C.), has been killed in the execution of his duties.

Veteran's Win

THE final fixture of the Veterans' Time Trial Association—a 25-mile road handicap—was won by J. B. Austin, Oxford City Road Club, with a time of 1.7.12.

New Record

BY riding 50 miles motor-paced on Herne Hill track, Harry Oxley established a British record for the distance with a time of 1.25.4. The ride is, of course, subject to official N.C.U. confirmation.

The Catford Climb

THE old-established Catford Hill Climb was won this year by G. Fleming, Belle Vue C.C., with 2 minutes 33⅗ seconds. He used a gear of 56.for the Brasted Hill ascent.

Honour Deserved

BARNSLEY Road Club have made Jack Simpson a life member in recognition of his outstanding rides this year. He is current 50-mile National champion and was last year's 25-mile champion.

The Dutch Desire

IT is stated that Holland wants 3,000,000 British bicycles. Meanwhile, it is of interest to note that the recent dock strike in London held up the export of many machines, among them 15,000 of a famous make.

Overseas Demand

REGULAR shipments of British machines are being made to America. There is a demand from Brazil for British bicycles; one famous firm has sent 10,000 machines to Holland, and has in hand orders from India, Australia, Kenya, Egypt, Iraq and Portugal.

Reigate Club Reforms

A MOVE is afoot to re-form the Reigate Road Club.

National Hill Climb Champion

R. J. MAITLAND, Solihull C.C., is National Hill Climbing Champion by virtue of his performance in scaling the stiff test near Chapel-le-Frith, Derbyshire, in 3 mins. ⅖ secs. He used a gear of 62.8 for the 903 yards test.

Tyneside Decorations

FLYING OFFICER M. W. STOTT, Barnsbury C.C., has been awarded the D.F.C. for devotion to duty. Jack Carr, Gateshead C.C., has received the D.C.M.

Liverpool Traders

A DETERMINED effort is afoot among leading Liverpool traders to form a cycling club among themselves.

Scottish Successes

J. ALLISON, Musselburgh Road Club, won the R.T.T.C. British All-Rounder Competition with an average speed of 22.528 m.p.h. A. Overton, Kingston Road Club, was second with 22.325 m.p.h., and D. Scott, Crawick Wheelers, third with 22.008 m.p.h. Calleva Road Club (Derbyshire, 21.942; D. S. Burrows, 21.499, and L. C. Dunster, 21.407) with an average of 21.613 m.p.h. won the team race.

Aero Model Winners

A TEAM of five model aeroplane makers from the Midland region has won the Aero Modellers' Trophy in a competition, open to the whole country, organised by the National Association of Spotters. The five come from Fort Dunlop tyre production department, the machine shop, the offices, and the new factory at Speke.

TOPICAL NOTES

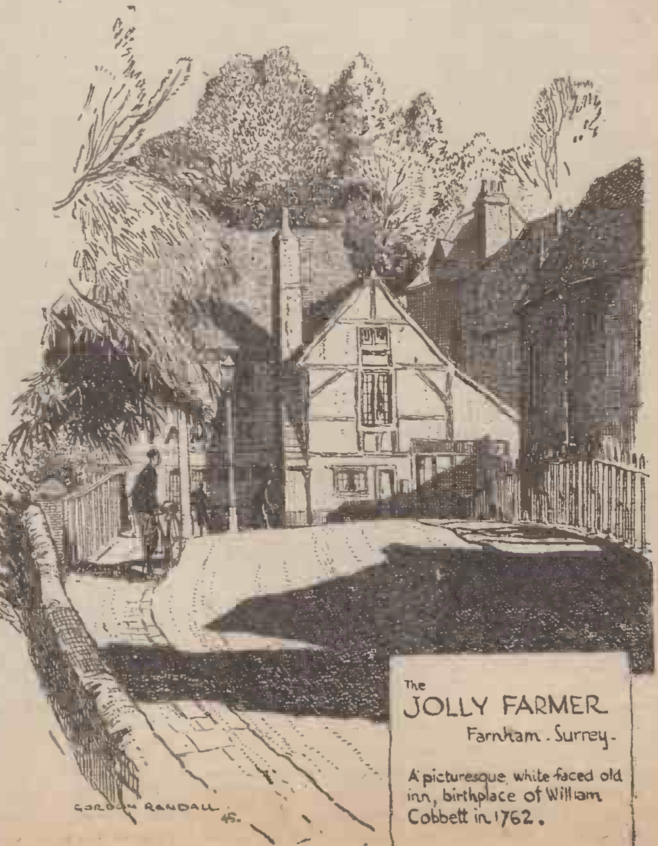
By "Wayfarer"

Catechism

THE dirty-faced little boy, complete with bicycle, seemed to spring from nowhere just as the hill I was climbing was beginning to "hurt." He said, quite gratuitously: "That bike runs a bit 'ard, do-an it?" A criticism of my bicycle being a criticism of me, I replied, laconically, "No." Young Dirty-face persisted: "What sort of chain is that? It's a big 'un, 'aint?" I replied curtly to the second part of the inquiry: "Dirt!" The catechism continued. Was I camping? No! Was I going far? Birmingham! How long would it take me to get there? Two hours! Discouraged by my (rather unusual) attitude of non-fraternisation, young Dirty-face slid out of my ken as unostentatiously as he came into it, leaving me to "get on with it" in peace and quietness—which was my strong desire.

Bargaining-point

I OBSERVE that some ingenious person has written to the press to say that he has taken his gas mask to pieces, to find that it contains, among other ingredients, more than 2½oz. of pure rubber. This, he says, represents some 70 tons a million. Thus there must be thousands of tons of high-quality rubber lying idle, in the possession of the public. The ingenious one wants somebody to do something about it. Well, if it is of any interest, I am prepared to swop my gas mask for a pair of pre-war light tyres. And I'll throw in a stirrup-pump—*and* a bucket of sand!



The JOLLY FARMER
Farnham. Surrey.
A picturesque white faced old inn, birthplace of William Cobbett in 1762.

Around the Wheelworld

By ICARUS

"Signs" of the C.T.C. Times!

ONE of the advantages of membership of a National cycling body is the touring handbook supplied to members, containing addresses of places which cater for cyclists. Presumably, before the names and addresses are inserted in the handbooks the premises are inspected and the tariffs and prices approved. The insertion of a name and address is a valuable advertisement for caterers and every effort should be made to keep the information up to date. The war has imposed unforeseen difficulties upon caterers, and many of them have discontinued catering altogether because of the problems of staff and food shortage. Such a touring handbook is published by the C.T.C., and it contains a large number of addresses. It would be thought that through their much-vaunted consular system it would be a comparatively easy matter to keep the information reasonably up to date, and that in any case they would welcome advice from members when the information is found to be inaccurate. This, however, is not the case, if we may judge from the information disclosed in a contemporary. It would appear that some addresses had been visited, but whilst they still exhibited the C.T.C. sign, they flatly refused to provide the refreshment. Apart from the inconvenience and extra journeys caused by this misleading information, a member of the C.T.C. thought that it would be useful knowledge for other members if he wrote to the Editor of the C.T.C. club journal asking for a little space in which to correct the inaccuracies. The Editor of the journal however, thought that the matter was not suitable for publication! What is the value of this handbook if it cannot be relied upon, and what efforts do the C.T.C. make to check the information before publishing a new edition? Why is it that establishments are permitted to exhibit a C.T.C. sign if they have abandoned catering? Is it because the C.T.C. consider that the exhibition of the signs continues to provide publicity for them? Shortage of labour can hardly be advanced as a reason for non-removal of the signs. Anyone could spend a minute removing the screws or the nails. Is it the reason that the C.T.C. Council is so full of its inhibitions and political issues that it forgets the *raison d'être* of its existence? It is a touring club, not a political body. We all know that it is not a democratic body, and I have given plenty of examples of its dictatorship methods. It had been hoped, after recent changes in the management, that many of the causes of complaints of C.T.C. members would be removed. One of those complaints has been that a small coterie of correspondents monopolise the club journal and that it is next to impossible to get a letter published in it. It is time that the officers of the club at Craven Hill realised that they are paid to serve the members and that they are not the proprietors of the club. Although I do not support the suggestion that Craven Hill and craven stupidity are synonymous terms, I do think that we should hear less highfalutin nonsense about "cycling legislators." There never has been a C.T.C. cycling legislator, although I know that term has been applied to secretaries of the C.T.C. A legislator is one who makes laws, but the only laws made by officers of the C.T.C. are those which concern the conduct of their club. I shall join the C.T.C. when I can have a hand in the conduct of the club's affairs, as any member should. I would not belong to any club, nor would I advise anyone else to join, where a resolution passed at an annual general meeting can be set aside by a committee. I would not concede that right to any committee. Such, however, is the constitution of this club, which really exists to promote cycling touring, that this is possible. I suggest that it gives a little more time to the touring side and eschews entirely mixing politics with it. It is for this reason that I have not joined another so-called National Body, which was founded by a political party.

I warn the C.T.C. that if they want to make a political issue of cycling they are riding for a fall.

Safety First for Children

I HAVE received the following letter from Mr. R. Stevens, B. S. Criddle, and A. H. Blennerhassett:

"We read with considerable interest the activities of the various county police, checking the cycles and riders at the schools. One county police-chief states that every child rider should have to pass the Highway Code before being allowed on the road; another states: 'We have not the men or the time to inspect children's cycles, leaving it to the teachers.'

"We of the Children 'Their Safety' First Group support whole-heartedly making it compulsory for all children who are cyclists to pass the Highway Code and to have their cycles passed as roadworthy. This checking up, passing, etc., should not be passed on to the already overworked police force or the teaching profession, as really it is not their job.

"We have the finest cycling clubs and organisations in the world, with men and women who have spent a lifetime on the roads. There is nothing these experts do not know about cycles and the rules of the roads of Great Britain, and we feel sure that if they were approached in the right spirit these people would jump at the opportunity to assist, check, teach, in fact anything within reason, without charge, for the children's good. Never was the spirit of the roads higher than it is to-day, as one cyclist helps another.

"Before full recognition is given it would greatly assist the authorities and cyclists' clubs if the Minister of Transport hinted that they all amalgamate and become one official body, such as the R.A.C., which could operate on a county basis.

Two New Competition Records

AT a meeting held on October 7th, the National Committee of the R.T.T.C. passed as Competition Records the following performances made on July 13th, 1945:

R. J. Maitland and R. W. Bowes (Solihull C.C.): 50 Miles Tandem, 1hr. 47m. 15s.
A. Overton (Kingston R.C.): 12 Hours Single Bicycle, 251⅞ miles.

R.R.A. Secretaryship

THE Committee of the R.R.A. announces that at their meeting on October 16th, the vacancy caused by the regrettable resignation of Leonard Ellis, was not filled. A liaison officer was appointed to act "between the committee and the public until the end of the year, or until a new secretary is appointed." The committee invites nominations, or suggestions for suitable likely candidates for the post of secretary. It should be noted that the position is an important one and it is highly desirable that applicants should have the use of a telephone during the day and have reasonable office facilities.

I hope that when the appointment is made it will be made outside the membership of any other National body. It is an honorary post, but I feel that the R.R.A. should not expect the secretary to provide free office and telephone facilities for professional record-breaking.

New N.C.U. Clubs

THE following clubs have recently affiliated to the Union: Carlton Royston C.C., Greenock United C.C., Queslet C.C., Wombwell Wheelers C.C., Maghull A.T.C. Wheelers, Cedars Cycling and Camping Club, and Woodville C.C.

The Southern Counties Cycling Union

THE S.C.C.U. intends to make a return to its pre-war eminence south of London as soon as possible, judging by plans made for 1946. Two of the fixtures are given below:

January 19th: Victoria Coach Station Reunion Dance.
February 16th: Kennards, Croydon—Dance.

On the road the "Syd Gray 100" will be promoted again and the Annual Meeting is to be asked to inaugurate a championship decided on average speeds over 25, 50 and 100 miles. All S.C.C.U. events will be eligible, and times recorded in any fully open "50" or "100" on southern roads will be included. The competition will be confined to members of clubs affiliated to the S.C.C.U.

The famous Good Friday meeting at Herne Hill will be promoted by the "Counties," with the usual gathering of road and track stars. It is expected that Tommy Godwin will endeavour to retain his hold on the B.S.A. Gold Column in the 5-mile point-to-point event.

Cadmium Plating

I AM informed by the Board of Trade (Industries and Manufactures Dept.) that there may shortly be made available to the bicycle industry a certain amount of materials for cadmium plating.

Northern Tricycle Association

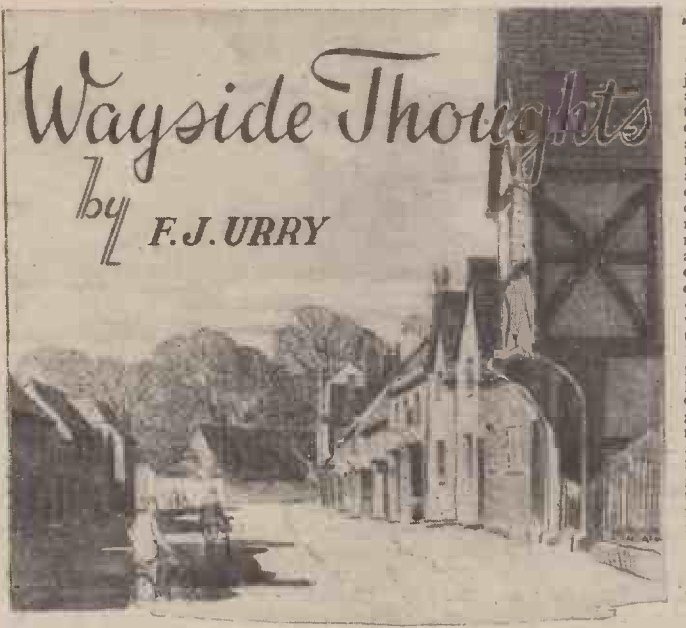
THE Northern Tricycle Association held their closing run on October 28th at Holmes Chapel, when a large number of members and guests had lunch.

Clements Wins Stalingrad Memorial

ERNIE CLEMENTS, Wrekin Racing Club, made sure of the "Stalingrad Memorial Circuit" promoted by the London Section, B.L.R.C., in Battersea Park recently.

Later on came the long awaited "Memorial Circuit" comprising the full distance of 50 kilometres—18 laps of the park. This event had brought together a hot field, with a large contingent from the Midlands. The "fireworks" were confidently expected, especially in view of the points system under which the event was run. The full field of 40 started, and at the end of the first lap a terrific battle ensued between Clements and Baker for full points, Clements gaining the verdict by inches. The second lap proved to be another exciting "all the way" struggle between the same two riders, Baker taking premier honours by the same margin. The crowd were really on their toes over these two lap sprints, for the speed was noticeably greater than ever before, and it was obvious a fierce fight was to take place for each lap. This proved to be the case, for the points were hotly contested, with Jones and Clements, Wrekin R.C., Baker, West London, and Jaggard, Ealing C.C., taking the lion's share.

Wayside Thoughts by F. J. URRY



Focus on Truth

THE price of good second-hand bicycles of good pre-war breed is increasing, and will continue to increase as the troops come home, unless or until the trade applies itself to the superior models required by discriminating riders. It has been said by some manufacturers that the war machine has been good enough to serve a purpose (which is true enough), and they see no reason why any great change is necessary. On the other hand I know most manufacturers were not very proud of their war products in bicycles, but they were chained to the mediocre supplies of the component people, and could not help themselves. Now the fact that the price of second-hand machines of good make and quality is rising must surely prove to the doubters that a considerable market exists for the very best they can produce, and the sooner that demand can be met, the better for the reputation of the industry. I know there are many difficulties facing makers, the greatest of which is shortage of labour and that fact suggests the need for accelerating demobilisation, a condition which is agitating most manufacturers; but I do press this matter of quality on the trade, for it is not exaggerating when I say thousands of riders are very weary of their present mounts, and want something better, much better, and want it quickly if their interest in the pastime is to be retained. For a good bicycle *must* be the foundation of enthusiastic cycling, and it is enthusiasm for the game and all it connotes in happiness and health that the expansion of the industry finally rests. So this matter, in my opinion, is of the first importance; better bicycles, tyres, rims, brakes, and gears. They are all beyond the blue-print stages and are only held up for lack of labour or supplies, which is the same thing. This is one of the reasons why I hoped we should have a show this year, or very early next, for a fixture of that sort would have given an impetus to better production by energising quality competition. That is not to be; but I do hope 1946 will not be a barren year for those among us who want to buy quality.

Those Good Days

THOSE autumn days! They are gone now until the winter, spring and summer usher them in again for the glory of appreciative mankind. In the fullness of the quiet beauty of those autumn weeks I had no holiday coming to me beyond the ones common to all of us, but I think I used that little leisure time to the greatest advantage commensurate with my activity. On many evenings I came home with the sunset, sometimes riding down a cloth of gold laid along the shiny road by the glory of the sun, and in the little wind was a little rustle of dry leaves as they whispered by, a kind of valediction to the summer. One evening I stayed quite late to see a combined harvester finish a field of wheat, on the edge of which a couple of my farmer friends were killing rabbits, and the dalliance was worth while for I went home with the fodder for a fine stew. That was the first evening since late spring I used a lamp, and the flicker was only necessary over the last few miles. On another evening I saw a man (after rain) land a fine trout from a stream I had never dreamed would hold such a fat inhabitant; but he told me he knew the fellow was there all right, and had eluded him since the spring. He, too, was a farmer rightly fishing his own length of brook; and I learned from him that "combined" corn did not go to the user or the miller as we see it bagged in the field, but to drying floors where it had to be emptied and spread and then rebagged before it was saleable. We live and learn, or we ought to. On another of my journeys I saw the brooks overflowing after a day of drunken rain, when the woodlands were adrip with jewels, and as an angry sunset blazed to light the horizon in its setting the land seemed aflame. That was a lovely evening, the air so clear and the vision so clear that a whisper in the silence sounded like a shout. How easy it is to do these things with the aid of a bicycle?

Sartorial Matters

SOON, too soon, we shall want gloves and a jersey, heavier stockings and bigger shoes. I hate to think of this seemingly over-dressing while the days are still comfortable, even if the evenings are chilly and a light pair of gloves are desirable: but those colder days come, and there's nothing like being in readiness to meet them. I'm afraid most of us have no coupons to lavish on the extras that make for cycling comfort in wintertime, so we must make the best of the raiment we possess. I have a pair of pre-war skin gloves which are the warmest protection I have ever owned. They were a present given to me many Christmases ago, and I was told at the time the rather coarse fur was horse skin. Well, good luck to the spirit of the horse that grew this skin for it has kept me warm for more than seven years. The palms of those gloves are now a series of patches and only enough of the original material is left to hold them together, but even so they keep the cold wind out and give comfort to my grip. Cold feet are my main trouble in chilly weather, and though I have never been able to completely cure this disability, I can and do reduce the frigidity by using oversize shoes with cork soles, and sometimes when the weather is really Arctic I supplement this foot gear with spats, dark grey ones made by my friend, Sydney Vanheems, the clerical outfitter, so that from feet to knees I sometimes wear the appearance, if not the distinction, of a bishop, but any such likeness ceases at a higher elevation. Of jerseys, I still have a couple which are just respectable and they must do their job until coupons cease from worrying and wool is of the best. As a fact it is remarkable the things we can do without if we try, and still keep ourselves warm and at least semi-respectable.

The Quiet Rain

SUNDAY morning came and with it rain, quiet, sober rain, without any spite, and the trees dripped and the hedgerows were full of moisture. It was warm enough to loiter, and I did that very thing for some twenty miles along our Midland lanes; but not before I had settled an argument with my folk who thought I was a trifle mad to go riding when there existed no other reason than exercise. They still fail to understand, after all these years, that cycling exercise is good for me; nor is it the only attractive thing to attain and observe on a dull day. I went by a series of lakes usually populated at this season of the year with ardent anglers, but now only peopled with the quiet rain breaking the reflections of the surrounding trees, and on through a park where, but a few short weeks ago, radar was installed and has left its mark of desolation, which only the passage of time will repair. Under a bank I sat in a dry spot and smoked with the grey view of the Alne Valley below me, and beyond the few cattle within sight and an occasional milk lorry on its way to or from town, the whole countryside seemed deserted. Now I do not know how you who read feel when you are out on such a little excursion as this, but I always have the vague impression that the land of my birth is more mine in such circumstances than at any other period. It is a mood of quiet contentment, something that no one can give you, you must discover it for yourself, and the road to it is by the silent passage of a bicycle at a time when other people seem to think the country is not worth while. It always is.

Eleven Millions

A KIND of Gallup Poll has been taken in order to assess the number of cyclists in Great Britain, and the rather astonishing figure of 11,000,000 is the result. I say astonishing because, while I have claimed and felt justified in the round figure of ten millions many people, including leading members of the industry, thought that number was an exaggeration. But if we really need to know a more exact figure of the cycling population—or the private motoring population—it only needs an extra line or so on the next census paper, and that document is certainly overdue. The whole document as published by the Wartime Social Survey people is very illuminating, and deserves the close study of people who are interested in the sport, pastime, utilitarianism or business of cycling, for it gives a focus of the uses of the nimble mount that in my opinion can be greatly expanded by the co-operative methods which the industry could easily apply if they possess any faith in the possibility of such expansion. For outside the purely technical press, cycling as a means of enjoying leisure time as well as filling a cheap travel need, has been badly neglected the last thirty years. Practised riders know how good it is, but the utilitarian and the non-riders are for the main part out of touch with these sections of the public. When one does hold forth on the virtues of the pastime to the uninitiated, listeners either think one is a sheer fanatic, or quote that old jibe of the unfit and ill-mounted that "cycling is hard work." It is no use telling people that is untrue, you must prove it if you are to convert them to a simple and happy way of life; and I for one believe that can be done if the industry has sufficient faith in the article it makes and sells.

The Cheap Line

I THINK one of the most remarkable things in connection with organised cycling is the fact that subscriptions have not been increased in the majority of cases. Hence we have cycling organisations and clubs functioning on much the same annual payment as was the case in 1939. Can this service still go on without increase of subscription? Everything I buy, whether it is necessitous or otherwise, has advanced anything from a third as much as pre-war up to twice the amount, and I'm beginning to wonder how the clubs are going to meet the racket of increased costs. Where salaried people are employed remunerations have advanced considerably and there is little doubt but that increased services to members will be expected, once things settle down, and that again will mean more staff and an added cost to the charges of efficiency and upkeep. It is a problem with which many executives are faced, and with the present and the likely shortage of labour for some time to come, will need probably the only possible remedy, an increase in subscription rates. And what applies to the bigger organisations is equally a problem for the local clubs. Naturally we all hope the drastic action of an increase in subscription will not be necessary, but for the life of me I fail to see how a steady rising cost of administration is going to be met. I well remember when the C.T.C. subscription was raised from 6s. to 10s. a year, people prophesied that was the beginning of the end and that the end would not be far off. Yet after that decision was made and carried into effect, the membership roll increased to the highest point it had achieved since the boom days of the middle nineties; so you see even a big advance of 4s. per annum will not stifle a needed service to the cyclist, always provided such service is efficiently run and maintained. I mention this matter not with the purpose of boosting the big club, but rather to point out to the new generation who hold responsible positions in local cycling circles, that if the increase is justified by service, there is little need to fear its consequences. Enthusiasm, rightly directed, is the main item of good will in most organisations, and if this is there then money will not be lacking, but if it wilts under the touch of time or divides its interests, then no amount of money will pave the way to success.

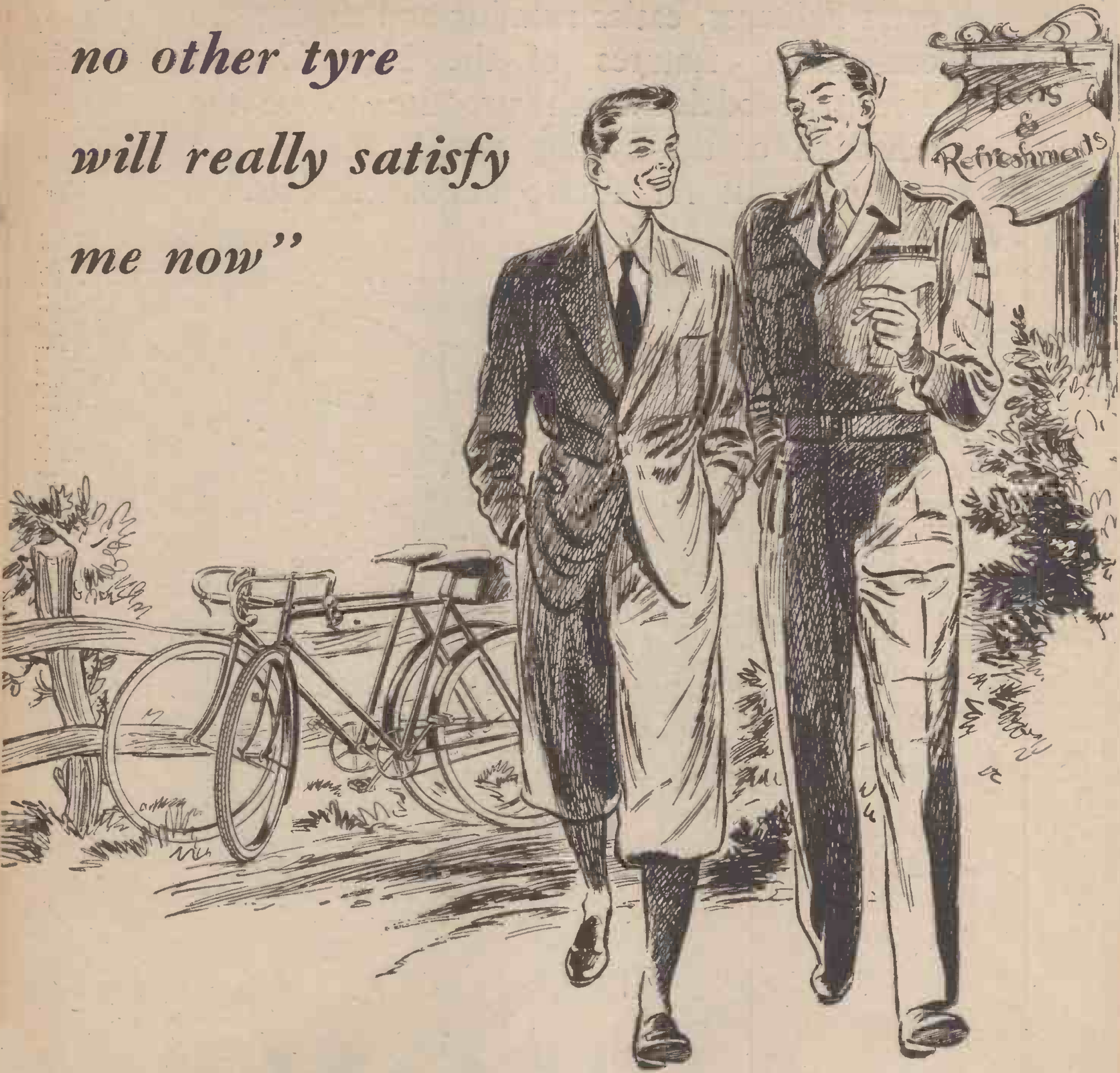
Chipping Campden—
Gloucestershire
The fine Almshouses and the Church.

"After what I saw 'out there'—

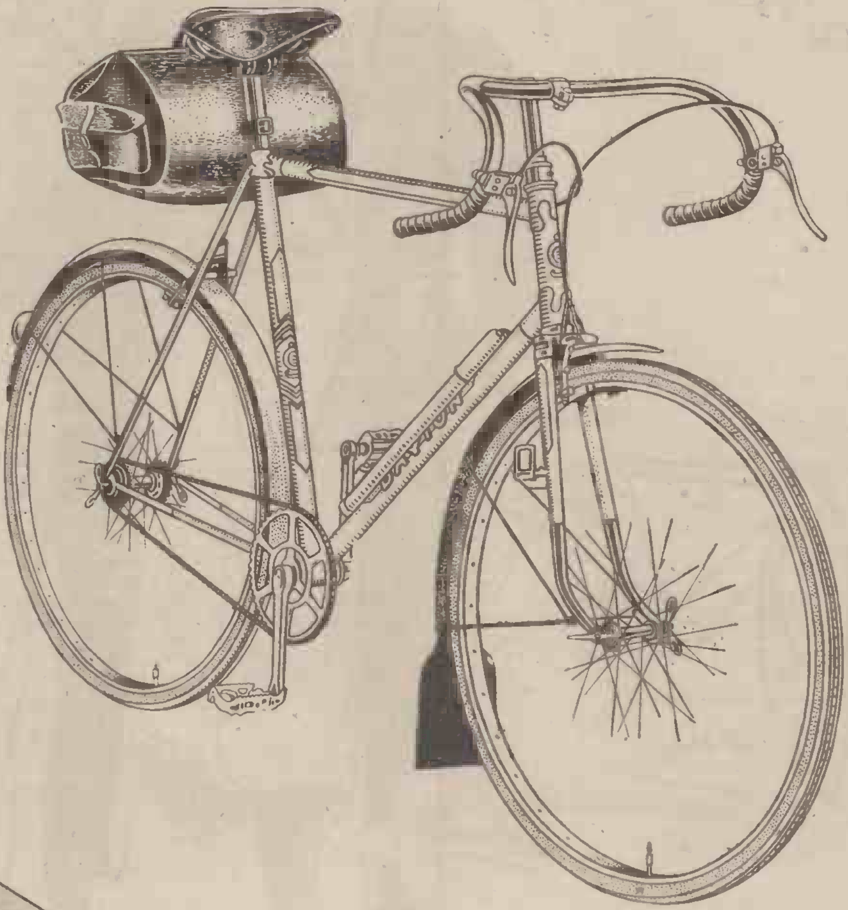
no other tyre

will really satisfy

me now"



Firestone



CYCLORAMA

By H. W. ELEY

The famous BELL INN at Stilton. Huntingdonshire

How Many Cyclists?

THERE has always been a great deal of argument and controversy about the number of cyclists in this country. Whenever the claims of cyclists have been put forward, and it has been desirable to give figures of the number of people owning and using cycles, wild guesses have been made, and vastly differing estimates given. Has the recent investigation of the Wartime Social Survey clarified this matter? Have we at long last got a reliable estimate? It is hard to say, but what is certain is that the Survey revealed some most interesting things. For instance, we find that no less than 27 per cent. of the workers of this country reach their place of labour by bicycle! The very thorough investigation also revealed that 18 per cent. of the adult population use cycles for pleasure. Investigators interviewed some 2,800 persons, and the information gleaned cannot but be helpful to the industry, and it is to be hoped that the full story will be publicised and the old figure of ten million cyclists in the country either confirmed or rectified.

Michaelmas Magic

I HAVE ever been fond of the season of Michaelmas. It brings us many good things, and not the least is the glory of the Michaelmas daisies . . . those good flowers which seem to bloom well in any garden and flourish in any soil. They are the blossom of the season, and for many years I have had a fancy to wear one in my buttonhole on Michaelmas Day. Then there is Michaelmas goose . . . and I always vow that goose is a better dish at this season than at Christmas! And out in the lanes the early morning rider may see the gossamer webs of the spiders stretched from bush to bush . . . and there is a tang in the air which only this mellow season can give.

Cycling . . . the "Handmaiden"

IT often occurs to me how wonderfully the bicycle assists one's various interests and hobbies. Lately I have done a good deal of fishing, and it is the bicycle which has carried me, and my impedimenta, to river and pool. And when I go out, as I sometimes do, on a butterfly-hunting expedition, it is the faithful cycle which takes me to that common where the Chalk-blues abound, and where I also obtain my specimens of the Fritillaries. Is one a keen photographer? Then the finest pictures are within reach if one has a bike. Yes, there is no doubt about it . . . the bike is the handmaiden of all sorts of interests and hobbies and pastimes—its utility is a thing to marvel at, and even though one may love a cycle for its own sake, there can be no denying that as an article of utility it stands supreme and unchallenged.

There are More Cycle Pumps

NOT so long ago there was an acute shortage of cycle pumps, and many a rider had a good alibi when tackled about that ever-green question of tyre inflation! But I gather that the situation is now much easier, and it is getting comparatively easy to buy a pump at the local cycle-dealer's. And what a good investment a pump is! Those few strokes with the pump may mean extra miles. Nothing robs the cyclist of mileage so much as the habitual under-inflation. "Pump 'em up hard" is a slogan which pays good dividends, and apart from the extra mileage there can be no question that riding is more comfortable when tyres are well inflated than when they are flabby . . . despite the widespread belief to the contrary!

The Rolling English Road

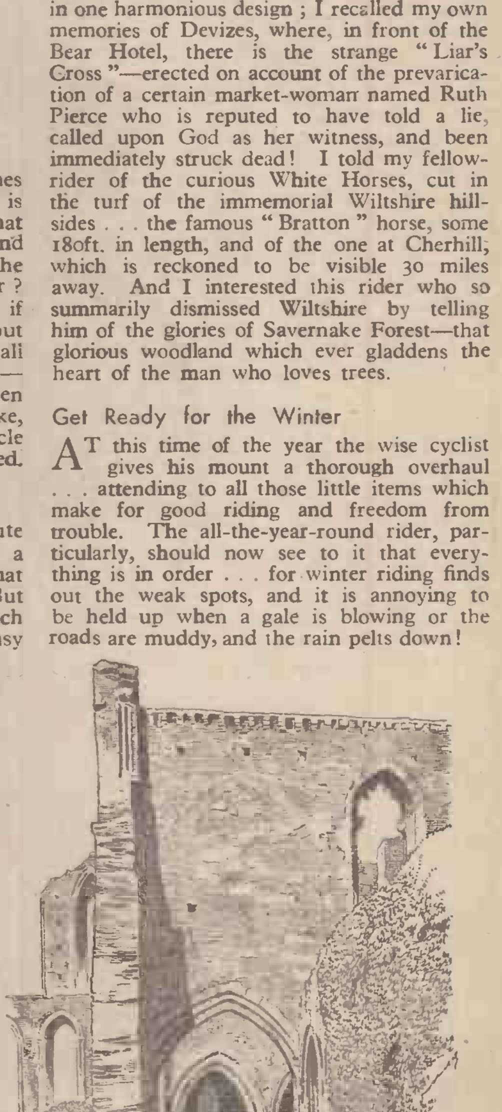
AFTER six years of war, when our roads have been called upon to carry truly enormous loads, and when repair work has necessarily had to be largely suspended, I have come to the conclusion that our roads have stood the strain amazingly well. Bearing in mind rides through various counties, on main and secondary roads, and on lanes and byways, I find myself willing to pay tribute to the makers of our roads . . . they built well, and whilst, of course, one knows that much repair work is now necessary, there can be no doubt that the good old English road has "taken it" well. When I think of the convoys of giant lorries which have rolled along our highways, when I remember the tank-transporters of the war years, when I remember that in pre-war days repair work went on all the time . . . then I feel like saluting the makers of our roads . . . and I trust that I am not alone among cyclists in this feeling!

Wiltshire Ways

IT is strange how certain of our English counties seem to be unknown territories to the average cyclist. In talks in little inns, in wayside cafés, I have discussed the scenic merits of all our shires . . . and heard the expected eulogies about Devon and Sussex and Warwickshire and Surrey. But I have rarely heard much about Wiltshire . . . and on asking a cyclist recently what he knew of that county, he remarked that he liked Wiltshire bacon, and dimly remembered gazing in awe at Stonehenge! But I told him that Wiltshire had much more to offer than a tasty breakfast and the awesome memorials of the dim past. . . . I told him of Salisbury, with its graceful cathedral built in one harmonious design; I recalled my own memories of Devizes, where, in front of the Bear Hotel, there is the strange "Liar's Cross"—erected on account of the prevarication of a certain market-woman named Ruth Pierce who is reputed to have told a lie, called upon God as her witness, and been immediately struck dead! I told my fellow-rider of the curious White Horses, cut in the turf of the immemorial Wiltshire hill-sides . . . the famous "Bratton" horse, some 180ft. in length, and of the one at Cherhill, which is reckoned to be visible 30 miles away. And I interested this rider who so summarily dismissed Wiltshire by telling him of the glories of Savernake Forest—that glorious woodland which ever gladdens the heart of the man who loves trees.

Get Ready for the Winter

AT this time of the year the wise cyclist gives his mount a thorough overhaul . . . attending to all those little items which make for good riding and freedom from trouble. The all-the-year-round rider, particularly, should now see to it that everything is in order . . . for winter riding finds out the weak spots, and it is annoying to be held up when a gale is blowing or the roads are muddy, and the rain pelts down!



The beautiful ruins of Valle Crucis Abbey near Llangollen. N. Wales.

Notes of a Highwayman

By Leonard Ellis

Britain's Touring Grounds (13)

FOR some reason South Wales has not achieved the same popularity as North Wales as a touring ground, and I suppose that the reason is not far to seek. The tremendous area of coal-mining activity to the north of Cardiff and Swansea acts as a deterrent to many cyclists, and it must be admitted that industry has left its mark very heavily on these parts. It is true, however, that much of this can be avoided, and for those who try and succeed there is ample reward. It is perhaps true to say that South Wales does not possess the scenic gems to be encountered in the north; the mountains are not so spectacular, the lakes are not so fine, but in the same breath let us admit that the country is not so overrun. There is often a great solace in the lack of popularity. The mountain scenery in South Wales can almost be summed up in the words Black Mountain and Brecon Beacons, and here there is no lack of beauty. The little town of Brecon makes a good centre and the ascent of the Beacons from here is a favourite jaunt. There are five major peaks, the highest, Pen-y-Fanz, being 2,907ft. This is only 20ft. less than Cader Idris, one of the northern giants.

Highlands of South Wales

FROM the summit of the Beacons there are extensive views extending to the Black Mountains and away to the Bristol Channel, if visibility is good. Brecon Cathedral ranks next to St. David's among the larger churches of Wales. The Black Mountains lie to the south of Hay, another charming centre, and embrace several peaks in the region of 2,500ft. It is possible that the South Wales coast line will hold its own with anything that the North can show, and for sheer grandeur there is nothing to equal the awe-inspiring crags of the Gower Peninsular. This latter is indeed the gem of gems and is in itself a perfect touring-ground, although small. It is somewhat difficult to approach as Swansea lies athwart the only road, but with care the worst parts can be avoided. The Gower provides an amazing variety of scenery, from moorland to sand dunes, from rocky coast to pastoral meadows.

The rocky coastline of the Gower.

For Pass-stormers

TO the hardy "rough-stuff-merchant" the centre of South Wales acts as a magnet, as there are dozens of miles of really adventurous travel among the mountain tracks. It was many years ago that I essayed one of these trips, but failed to realise the amount of time that could be expended in carrying the bicycle through fords and over boulders. It was tea-time when we decided to forsake the main road near Llanwrtyd Wells and struck north-westward for Abergwesyn. So far, so good, but here the road petered out, and for the next 15 miles we plodded and floundered along the banks of the River Towy going southward.

In Glyn Tarell, Brecon Beacons.

Eleven o'clock struck as tired and hungry we entered the village of Cilycwm, where we failed to obtain shelter or food. A little beyond the village we were just on the point of making our beds in a pine spinney when a policeman took us in tow, and walked with us to Llandovery. One o'clock tolled from the churches as we came into the town and even he realised the hopelessness of finding us any accommodation. He was a good sort, and after extracting a promise from us not to smoke and asking us to forget that we had ever seen him, he found us a nice little haystack, and wished us goodbye. It was a glorious trip, but would have been better with a supply of iron rations. There is plenty of scope in South Wales. Castles by the dozen; miles of lovely coastline and plenty of interesting towns for the average tourist, and the whole inland country for the fire-eater.

My Point of View: By "Wayfarer"

Oversight

A RECENT letter in *The Times* about "London Traffic," suggesting severe restrictions as regards the presence of private and other motor-vehicles in certain districts of the Metropolis, was curiously lacking in one respect. The writer made no mention of bicycles. He might very well have demanded the complete exclusion of cyclists from London.

Time Dawdles On

ONE evening, some 10 years ago, a friend and I went for a ride, in the course of our journey pausing at a little country post-office in order to buy chocolate. I was much struck by the internal appearance of that establishment, where, in addition to selling stamps and postal orders and things, on behalf of H.M. Postmaster-General, a trade of sorts was done in cattle medicine, buckets, soap, aspirin tablets, sheets of corrugated iron, packets of note-paper, bottles of castor oil, clothes lines, and many other things.

I often thought of that tiny shop, with its variegated trade, so reminiscent of the places at which I used to spend my fugitive pennies more than 60 years ago. I was never quite sure of its location, however. And, lo and behold! a short time ago, when I was off on a week-end jaunt, I re-visited it, finding it quite unchanged except, perhaps, that stocks were scantier. There was the step-down on to the tiled floor; there was the hanging paraffin lamp, ready to function on the fall of darkness; there were the post-office scales (what a story they could tell!); there were the bottled sweets, with a piece of stick for stirring 'em up; there was the cheerful soul behind the counter, prepared to sell you a dog licence, or a packet of hairpins, or a tin of sardines. The whole place was unchanged, changeless—like the shops of my childhood. "Time marches on," says the B.B.C. "Time dawdles on," say I.

The Final Hour

ON the first Sunday in October it came as something of a shock to discover that "interference with the clock" meant the lighting of one's lamps immediately after tea, that pushing back of time thus involving 1½ hours' additional consumption of the medium one uses for obeying the law. Personally, I did not, and do not, mind. Having always had a passion for cycling in the dark, I welcome the greater opportunities which will now fall on me, thanks to the revived operation of the Summer Time Act, 1925. I have already brought my "fleet" of gas-lamps into operation, and I look forward to sitting behind the solid white glare they provide, unconcerned with the blackness of the night—nay, in full appreciation of that sable quality. The blacker the night, the better.

The only snag I see in this return to pre-war normality is that the day is coming when we shall have to light-up before tea on our Saturday or Sunday (or other half-day) jaunts. To meet this position—and to avoid "wetting the carbide" prematurely—I shall (as usual) provide myself with an electric battery lamp, which (presuming good behaviour!) serves the purpose admirably. Nevertheless, it is rather a solemn thought, as regards the final hour which "daylight saving" gave us during the war (in the winter, I mean), that "we've had it."

Curious Experience

ON the last Saturday in September I had rather a curious experience in connection with tea. The house to which I went, about 20 miles from home, yielded no reply to my summons, and I transferred my custom to an adjacent bungalow advertising teas. The front door was open and I could hear somebody moving about. Almost pulling the bell out by its roots availed nothing: neither did shouting and banging on the door. At last the woman-of-the-house happened to come into the entrance-hall and saw me. She turned out to be as deaf as a post, but, reading the question on my lips, she admitted me, providing quite a nice tea, though the wet part did not run to more than two cups.

When it come to paying, she said: "Half-a-crown," and I nearly collapsed. Handing over the money, I expressed the view that the charge was extortionate, whereupon she said: "If you want any information, speak to my husband: he's in the kitchen." So straightway to the kitchen I went and said my piece to the man, who was also deaf, but only slightly. He replied: "But you've had some of our rations." When I asked what that had to do with the matter, he changed his ground and suggested that it was not easy to get teas nowadays. "Oh, yes it is," I retorted. "I'm out every Saturday and Sunday, and I experience no difficulty. Anyhow," I added, "that's beside the point." Again he changed his ground and said that they didn't want to supply teas. "Then why the blazes don't you take in your notice?" I remarked.

At this point the woman came into the kitchen to see if any casualties had occurred, and the husband bellowed into her ear the information that I considered the charge was too much. Her response was as curious as it was futile: "I don't get around much and don't know what I should charge." Having reiterated my view that 1s. 6d. was the top price nowadays, the husband again did the bellowing act: "Give the gentleman a shilling and let him go." Then to me: "Don't come here again." My assurance that a visit from me was never likely to recur, and that I would take steps to ensure that none of my friends came for tea, infuriated him. He shouted: "Get out. I'll open the door for you . . . Oh! it's open." (Anti-climax!) So we parted, not exactly the best of friends, and I repeated that this really was my first and last visit. I object to being overcharged: I also dislike being undercharged, believing that "the labourer is worthy of his hire."

Colleague Urry

A FEW months ago, when I was compelled to spend a few days in hospital, one of my visitors was none other than Frank Urry, well known to readers of this periodical. As usual, F.J.U. was looking the very picture of health, and it struck me that he was a magnificent advertisement for our pastime, in which he has revelled for almost as many years as I. He has a penchant for holidays, and his bronzed appearance may give rise to the misconception that he spends all his time out-of-doors, as he would like to do. He has to work for his living—unfortunately, as he would say!—but he achieves 14 miles a day to and from the grindstone, while he is out on a bicycle most week-ends. Frank and I live about seven miles apart—and seldom meet! Having been visited by him in January, I did not see him again until September, when we encountered one another in the country, he returning home to dinner, his bicycle laden with rabbits (one of which, with characteristic generosity, he offered to me), eggs, and things, and I working out a "short cut" to an appointment with a knife and fork at Henley-in-Arden. Yes! F.J.U.'s appearance constitutes eloquent testimony to the value of cycling as a "health resort."

"Practical Mechanics," Advice Bureau COUPON
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