BLAST-PROOF BUILDINGS—*New System*

NEWNES

PRACTICAL MECHANICS

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MARCH 1942

SUBSCRIPTION RATES
Inland - - - - - 11s. per annum.
Abroad - - - - 10s. 6d. per annum.
Canada - - - - - 10s. per annum.
Editorial and Advertisement Office: "Practical Mechanics," George Newnes, Ltd.
Tower House, Southampton Street Strand, W.C.2
'Phone: Temple Bar 4363
Telegrams: Newnes, Rand, London.
Registered at the G.P.O. for transmission by Canadian Magazine Post.

PRACTICAL MECHANICS

Owing to the paper shortage "The Cyclist" and "Home Movies" are temporarily incorporated

Editor: F. J. CAMM

VOL. IX. MARCH, 1942 No. 102

FAIR COMMENT —— BY THE EDITOR

Jet Propulsion

THE internal combustion engine, even in its best form, is notoriously inefficient. It is a heat engine, and it is quite a simple matter to calculate the number of heat units in a gallon of petrol, and to equate it to the number of heat units which actually perform useful work in the engine. An average efficiency for a well tuned and well designed internal combustion engine is probably not more than 20 per cent. The steam engine, too, is inefficient. Scientists have for many years been endeavouring to find some new form of heat engine which will make greater use of the number of heat units which ignition releases from the fuel.

The Diesel engine in many respects is superior to the petrol engine. For many years, experiments have been conducted with internal combustion turbines, with jet propulsion, and the so-called reaction engines. This latter is a misnomer, because all forms of power work by virtue of reactive force. You cannot have action without a corresponding and equal reaction for that is one of the laws of mechanics.

Hero first produced a jet propelled engine in which steam was taken from four pipes diametrically opposed, causing a shaft to revolve. Toy boats have also been produced which work on the principle of jet propulsion.

It is interesting, therefore, to record that jet propulsion has been successfully demonstrated in connection with cars and more recently with aircraft.

The Italians in August 1940, at the Taliedo Aerodrome, flew the Caproni-Campini C.C.1 jet-propelled aeroplane, and it was flown by Colonel Mario de Bernardi. The Schneider Trophy Pilot flew the new aeroplane for 10 minutes or so. Experiments have continued since that time, and Signor Secondo Campini about a year ago designed and constructed a jet-propelled aircraft on somewhat larger lines, and incorporating the results of his experiments with C.C.1. The new machine is known as C.C.2, and I hope to be able to include some illustrations of it in the next issue.

It is a two-seater aircraft with pilot and observer seated in tandem, and it is of low wing design with outward retracting undercarriage, and enclosed cockpit, and single fin and rudder. It has no airscrew, and weighs about 11,000 lbs.

Naturally, the details of it are somewhat scanty, but in December of last year it was flown from Taliedo Aerodrome to Tanate Aerodrome, Guidonia, by Colonel de Bernardi. It took him just over 2¼ hours to cover the 168 miles of this journey, but this included a short stop at Pisa. Bernardi carried a mail bag, and Capt. Pedace as a passenger. He reported that the average flying speed was 130 miles an hour approximately, although he had not endeavoured to push the machine all out.

Inspection of the photographs to hand show that the machine is extremely simple in design. In the nose of the machine is a circular duct through which air enters. The air is expanded and is then passed into a compressor of the usual aeromotor design, or it may consist of a turbine of the internal combustion variety. The air is then ejected through a duct at the rear, having a control outlet to the rear of the tail. The compressor is driven by the exhaust gases of the motor, and these exhaust gases pass through the same duct and thus augment the propulsive effort.

There can be little doubt that within the next ten years we shall have jet-propelled aircraft and vehicles, and that internal combustion turbines will begin to replace the present somewhat complicated internal combustion engine.

At present we have to have a complicated crankshaft, valve gear and transmission, in order to drive a car, and in the case of an aeroplane we must use an airscrew which at best is only about 70 per cent. efficient. The engine as a heat engine is only 20 per cent. efficient, so the overall efficiency is only 70 per cent. of 20 per cent., or approximately 14 per cent. It is obviously a sounder principle to use expanding gases direct rather than through this complicated mechanism of crankshaft and valves.

The Engineer's Vest Pocket Book

The Engineer's Vest Pocket Book, containing 600 pages of valuable tables, formulae, and memoranda on mechanical engineering and workshop practice is now ready at 7s. 6d., or by post 8s. It is attractively bound in dark blue leather cloth with round corners, gold lettering and gilt edges. A catalogue of our technical books for engineers, electricians, motor mechanics, and radio engineers is available free to anyone addressing a letter to the Publisher, George Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2.

The Scrap Metal Salvage

In this country the Minister of Works has undertaken, at the request of the Minister of Supply, the job of sweeping the country from end to end of steel and iron scrap. The need for scrap recovery is as urgent as the need for the recovery of every piece of waste paper. It is hoped to obtain 40,000 tons of scrap metal each week of the National drive. In addition to the normal supplies of scrap which arrive through scrap metal merchants, who will carry on their business as hitherto, the Ministry of Works are starting an intensive drive under three heads—a National survey of all idle iron and steel in lots of over three tons in any one place. This survey is being accelerated, and it will be made compulsory to disclose all such metal; clearance of local dumps to which lots of less than three tons should be sent at once, and acceleration of the collection of iron railings. Under the first of these three headings will be included disused pit-head gear, bridges, rail tracks and factory machinery, as well as the larger accumulations of loose scrap.

Under the second heading, the small quantity in yards of all sorts from small builders and factors, with no regular scheme of passing scrap back to the foundries, as well as the scrap turned out by private householders and others will be collected; local dumps will be cleared, but not necessarily immediately, for they are to be cleared county by county. What the country needs is a steady regular flow to the foundries, and that can only be secured if each town and village starts to fill up its dump now. The molehills of scrap should be turned into mountains, for the war machine must be fed. Three counties have already been tackled simultaneously: Essex, Wiltshire and Cumberland. Every householder is asked to spring-clean the house of all useless metal, from food tins to useless broken bicycles. Every garage should turn out its old plant, wheels, rusty nuts and bolts. Every farmer should clear his barns of old machinery.

This drive for scrap metal should not be allowed to obscure the equally important drive for the recovery of every scrap of waste paper. We must continue the paper chase whilst we are echoing and re-echoing the cry, "Any Old Iron," which from being the title of a once popular music-hall song, has become an urgent National appeal.

WASTE PAPER WANTED NOW!

TURN IT OUT AT ONCE
Your Country Needs It!

Houses Built on Balloons

A New and Revolutionary System of Building Construction

METHODS of building dwellings have varied through the centuries from caves to mud-huts, from tree-top homes to those built of branches of trees and thatched with leaves. Before the Christian era man had learned to quarry stones, and probably the first references to a building so constructed are those relating to the building of Nebucadnezzar's and Solomon's Temples. The Pyramids and other early Egyptian buildings as well as some of those still existing in China indicate that the Ancients were aware of the advantages of brick construction and that they were not entirely ignorant of the principles of moulding buildings, nor of the advantages of reinforced concrete.

No one knows who first invented the system of erecting buildings by laying one small brick on another small brick. Such invention, like that of the wheel is lost in the mists of antiquity. The size of a standard brick is 9 in. by 4½ in. by 3 in., and in spite of the many newer and improved systems of construction which have been introduced during the past fifty years by far the majority of buildings are still constructed of bricks.

Moulded Buildings

It is a slow method, and it is costly. Moulded buildings have been erected in most countries, and they show undoubted advantage over the older systems. They are cheaper, stronger, and last much longer than brick buildings. But then there are many examples of brick buildings which have lasted nearly a thousand years, and are still habitable. The argument against newer methods is that brick buildings last at least a lifetime, and except for National buildings, such as museums and Government departments, which are constructed to be handed down to posterity, it is unnecessary to supersede the old method of laying brick upon brick which has withstood the test of time.

The war may cause the building trade to change its conservative views. When the last war ended, the building trades had five years' leeway to make up. There were insufficient houses to go round, and laws were made to protect those compelled to live in rooms and flats, against the ramps and the rackets by means of which unscrupulous landlords were able to cash in on the housing shortage.

Then the jerry builders got to work. Houses having a pleasing architectural layout were sold at fantastic prices, but began to disintegrate after five years. The building trade had scarcely caught up with the housing shortage when this war started, and now all building has ceased until the war is over. Thus, there will be an even more acute shortage of houses when peace returns. The building trades will be kept busy for a fair time after the war in rebuilding bombed out areas, and it may be some time before the raw material begins to flow.

The Ministry of Works and Buildings whose job it is at the present time to consider the replanning of Britain after the war must investigate the claims of newer systems of building construction, and they must superimpose upon their deliberation the knowledge they have gained as a result of aerial bombing. Buildings must be constructed to withstand blast so that in future aerial attacks, if any, there will be less damage to property.

Factory-Built Houses

The Coventry City Council has already given its sanction for experiments in factory-built houses which are transported in sections to the site and then erected, in a tithe of the time taken by present methods. These houses have been designed by the City Architect, and they are designed round a steel frame and include three bedrooms, lounge sitting room, kitchen and flat roof. The steel frame of each wall will enclose light metal strutting on which will be fixed the inner and outer wall covering of artificial wall boards of similar material; the main idea is to evolve a plan for speeding up house building to meet the great post-war demand. Such houses can be assembled in two or three weeks. Being mass-produced, they are bound to be cheap, and being composed largely of steel, they will help to keep the munitions trades busy when orders for munitions cease.

Many other improved methods of house building are on the way, and possibly the next fifty years will see the complete supersession of our antiquated system of brick buildings, which does not lend itself to mass production. One thing which is certain to go is the plaster ceiling. It is astonishing that in spite of its drawbacks, not the least of which is its liability to crack (there is not one sound plaster ceiling in the country !) it has continued for centuries. This, perhaps, best illustrates how old-fashioned is our building trade.

Blast-proof Buildings

In America improved systems have been in use for many years, and the Americans have not been slow to perceive the disadvantages of present systems of construction. Long before they were involved in the war, they were designing blast-proof buildings made of concrete, and one of the most ingenious systems is that illustrated on the facing page. It would be impossible to conceive any system more simple or more rapid. Briefly, the foundation of the building consists of a balloon which replaces the usual wood and steel framework of the normal dwelling. The experiment has proved entirely successful, and is now undergoing further developments. In the experimental buildings a concrete foundation circular in plan is laid on the ground and around its periphery hooks are cemented in to provide an anchorage for the balloon.

The next stage is to anchor the balloon to the hooks and inflate to the required size by means of a mechanical air pump. Obviously, the building can be made large or small according to the degree of inflation. They are, of course, hemispherical in shape at present, but there is no reason why the fabric air bag should not be made of more orthodox shape. The fabric is then sprayed with a thin coat of concrete which is then covered with an insulating material and then a wire reinforcing layer. The structure is now rigid and ready to receive a further 2 in. deposit of concrete. When the concrete is set, the balloon is deflated, and the building is completed.

Openings for windows, doors, etc., can then be cut, whilst outbuildings can similarly be sprayed on to the main building. Once the basic structure is made, floors can be added in a similar way. Tests have shown that such buildings are entirely blast-proof, and offer great advantage from the point of view of central heating as well as economy of heating costs.

Spraying the Concrete

The method of spraying concrete over a light foundation is certainly ingenious, and it could be applied in many other directions without using an inflatable foundation. For example, a light wooden structure to suitable architectural design could be erected at very small cost and the concrete sprayed on to that. When the concrete is set, the wood could be taken away. Where it is necessary to include steel joists these could be included before the spraying process is commenced. It lends itself to artistic treatment, especially of the shingle-dash variety. The present method is unsatisfactory in that after a heavy rainstorm, the pebbles are washed away. The concrete itself can be coloured to any desired hue, thus effecting considerable saving in outside painting every couple of years or so. Such buildings would be damp-proof; there would not be need for damp courses, and providing that the foundations are sound, there would be no risk whatever of subsidences which take place with the normal system of construction. Samples of sprayed concrete under examination have revealed that the mass is homogeneous and tougher than the ordinary concrete.

In any case, so many buildings now have the brickwork obscured by shingle-dash that it would seem that the building trade, could, with advantage, make use of the spraying process to obtain a more durable result.

DUST AND FUME MASK

RESPIRATORS for preventing dust and noxious fumes from being inhaled are especially designed for persons engaged in industrial processes in factories, and other places, where dust and fumes are encountered.

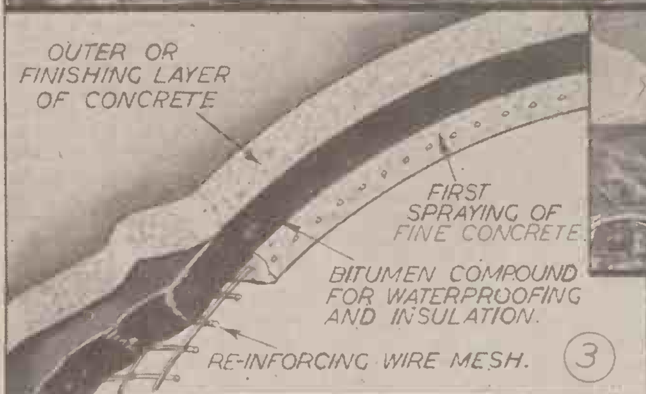
In such circumstances it is necessary to furnish a type of respirator which, while protecting the wearer from injurious inhaling, will not obstruct the vision of the worker. It is likewise beneficial for it to be cheaply made and easily fitted.

The inventor of an improved respirator asserts that the most successful respirator of this kind consists of a wire frame to which an elastic head-band or other fastener is attached. The wire frame holds a pad of cotton wool or other suitable material between the frame and the mouth and nostrils of the wearer. The inventor further declares that the chief objection to such a respirator is that it is unpleasant to wear for any length of time. This is due to the fact that the wire frame presses the pad against the wearer's lips. The result is that the pad becomes moist and uncomfortable.

In the case of the newly-devised respirator there is provided an inner frame with a cross-member engaging with a cross-member on the outer frame. The cross-bar of the inner frame behind the pad may be bent to form a looped or other protrusion. This springs into a slot in the cross-bar of the main frame holding the cotton wool tightly in position.

The cross-bar of the main frame may be formed of two wire members spaced apart at the point of clamping to receive the protrusion on the cross-bar of the inner frame together with the central part of the pad. If desired, more than one clamping device may be provided.

NEW METHOD OF BUILDING CONSTRUCTION



1. Finishing off the concrete foundation by placing hooks in position on to which the "balloon" is secured.

2. A petrol-driven compressor being decoupled after the "balloon" has been laced down and inflated.

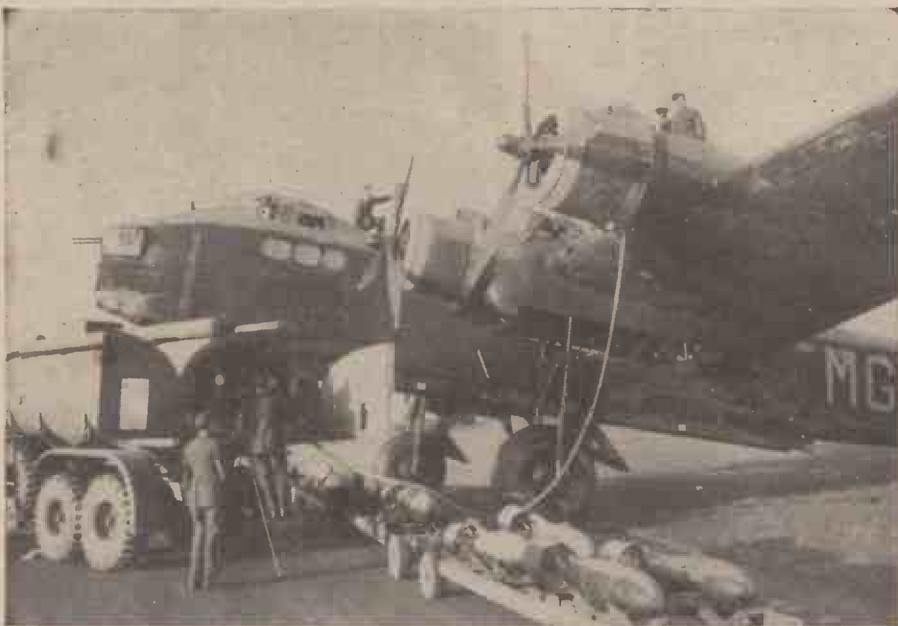
3. The complete "build-up" of the "wall" of the finished building.

4. The first spraying is being applied on to the rubberised fabric of the "balloon" and it will be seen that framework is in position for an intended window.

5. An example of two completed "formers" coupled by a circular building, the result being a three or four-roomed blast-proof bungalow of quite pleasing modern design.

Monarchs of the Air

The World's Most Powerful Fighting and Bombing Planes



Preparing a Stirling bomber for a raid on Germany

THE full page illustration on the opposite page shows five of the most powerful aircraft now operating with the R.A.F. The first of these—the Beaufighter—is a high-performance all-metal, mid-wing monoplane fitted with two 1,400 h.p. Bristol Hercules III air-cooled engines of the types installed in the Short-Stirling bomber. It carries a pilot and an observer, has a nominal speed of 330 m.p.h., and a range of 1,500 miles. It has reached a speed of over 400 m.p.h. during a power dive. The Beaufighter is mainly designed for long-range operations and night fighting.

Its armament consists of a battery of six Browning machine guns (three in each wing), which fire armour-piercing .303 bullets at the rate of 7,200 a minute, and four 20 mm. Hispano-Suiza cannon which can fire high-explosive shells at the rate of 2,000 a minute. The cannon are incorporated in the nose of the machine. The electric button for operating these guns is on the pilot's control wheel. The Beaufighter has a wing span of 57 ft. 10 in., is 41 ft. 4 in. in length, and 13 ft. 4 in. in height.

Exceptional Equipment

The equipment of the machine is exceptional. It includes navigation, formation-keeping and identification lamps, landing flares, auto-recognition equipment, signal pistol, oxygen apparatus, cine-camera mounting, stowers for computors, and map cases, fire extinguishers, first-aid outfit and axe. Four 550 gallon fuel tanks are mounted in the wings, and provision is made for carrying a 4-gallon water tank for desert use. The pilots' and observers' seats are entered by means of two special hatches, which also serve as emergency exits by parachute. Each door opens by means of a quick release so that part of the door protrudes outwards into the air stream beneath the body. A "dead air" region is thus created through which the crew can drop without risk of injury, even in a dive up to 400 m.p.h. There is a cabin heating system, controlled from the pilot's seat, by which hot air is admitted to the cockpit from the engines. Both the undercarriage and the tail-wheel are retractable. The Beaufighter is also fitted with airscrew de-icing, and Lorenz beam approach equipment.

The Hurricane Bomber

The Hurricane fighter-bomber is considered the most formidable single-engined machine in the world. It has a new series Rolls-Royce Merlin engine with two-speed supercharger. Its armament consists of four 20 mm. cannon (or twelve machine guns), and two 250 lb. bombs carried under each wing. The bombs are fitted with a time fuse so that the machine can dive-bomb from a very low height and be well away before the bombs explode. The bombs have very little effect on the speed of the Hurricane which is nearly 400 m.p.h. The four cannons are capable of firing shells of nearly 1 in., which can be either explosive, armour-piercing or tracer, at the rate of 1,200 rounds a minute, and the twelve Brownings have a combined fire power of 14.400 rounds per minute. Amunition for only a few seconds' continuous fire can be carried.

The Short-Stirling

This huge four-engined machine, which is the world's heaviest bomber, has figured prominently in raids on enemy territory for over a year, but it is only of recent date that the secret of its unique features have been released to the press. The Stirling is 87 ft. 3 in. in length, has a wing span of 99 ft. 1 in., and is 22 ft. 9 in. in height. It has a range of 2,000 miles, and a maximum speed of 300 m.p.h. When fully loaded, it weighs 30 tons, and carries a bomb load of 8 tons. Despite its dimensions, the designer, Mr. A. Gouge, says that it is very easy to manoeuvre.

The armament of the Stirling consists of three gun turrets, situated in the nose, mid-upper and rear positions of the fuselage. Browning guns are mounted in the turrets.

A complete armoured bulkhead and sliding door separate the flight compartment from the wireless operator and engineer. The first pilot has additional armour to his back and his head, and the fighting controller has armoured protection for his chest when directing the air gunners' action. The hydraulically actuated gun turrets are also armoured. The Stirling is fitted with three 42 ft. long bomb racks, which carry six 2,000 lb. bombs. No fuel is carried in the fuselage in order to minimise the risk of fire. It is all carried in the wings in self-sealing tanks.

This machine, the first of the big four-engined bombers to go into action, is being manufactured at Ministry of Aircraft Production factories, tested on an airfield on the spot, and flown direct to operational stations. Chief test pilot for Short Brothers, Mr. J. L. Parker, the first man to fly the aircraft, says that experience had shown that German fighter pilots avoided the Stirling unless they were at least three to one.

The Avro-Manchester

This huge twin-engined bomber has been in service with the R.A.F. since the beginning of November 1940. It is considered the fastest twin-engined plane in the world, and is powered by two Rolls-Royce Vulture engines. The machine is heavily armed, having a four-gun turret in the tail, a two-gun turret on top of the fuselage, and also in the nose. The Manchester is of all-metal stressed skin construction, and carries a crew of seven. The 24-cylinder X-type aero-motors are in effect two R.R. Peregrines fitted one on top of the other. The machine has a wing span of 90 ft. 1 in., is 70 ft. in length, and 19 ft. 6 in. in height. It carries a very heavy bomb load. Other figures such as weight and performance have not yet been released.

Handley-Page Halifax

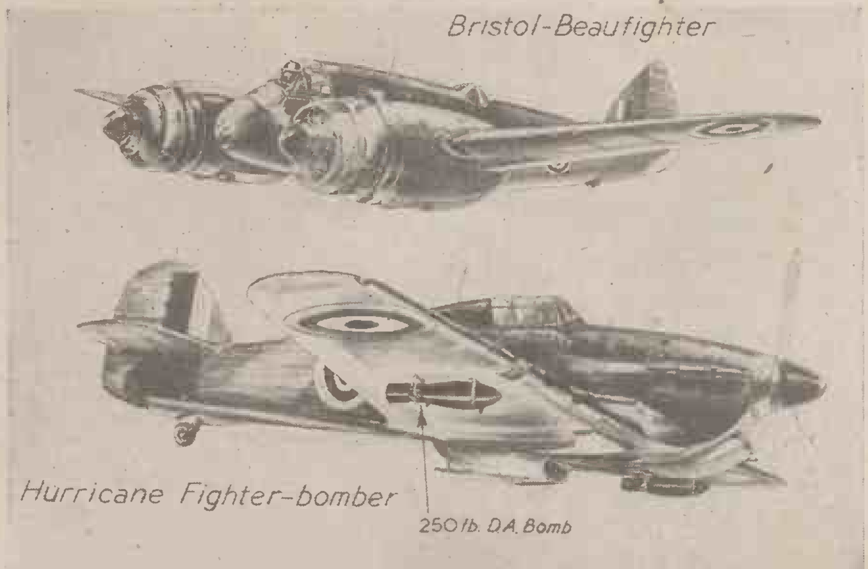
The Halifax is another four-engined bomber having a wing span of 99 ft., length of 70 ft. and height of 22 ft. It has three-bladed airscrews, and is powered by four Rolls-Royce Merlin 12-cylinder liquid-cooled engines. The position of the bomb aimer is under the forward turret, and heavy defensive armament is carried. The flaps are slotted for improved take-off and de-icing equipment is fitted to the tail unit. Airscrew de-icing is also provided and one of the features is a cabin-heating system.

Here is how one pilot described his sensations on his first Halifax flight: "I can tell you I was startled when I first looked inside the control cabin. There were more than fifty instruments—it seemed as though there were four of everything. I noticed ten petrol gauges, then the airscrew feathering knobs which adjust the blades, bringing them into line with the direction of the aircraft so that there is the minimum drag, and four extra motors to control these adjustments. Before crews take over the new bombers, they join what are called 'conversion flights.' These are courses of training in which they are 'converted' to flying Halifaxes—in more senses than one.

"After the changeover from two-engined bombers, a crew usually does quite a few hours' practice flying in the Halifax before going on operations. In that time they find that, once mastered, it is an easy aircraft to fly."

This pilot was also enthusiastic about the fire-power and armour-plating of the machine. As for its bomb load—very much greater than that of any of the older two-motor bombers—he said, "They are as unpopular with the Germans as they are popular with the crews."

PLANES IN SERVICE WITH THE R.A.F.



FIGHTER-BOMBERS

The Bristol-Beaufighter.—Nominal speed of 330 m.p.h. Range 1,500 miles. Armament consists of six machine guns and four cannon. Fitted with two 1,400 h.p. Bristol Hercules III air-cooled engines.

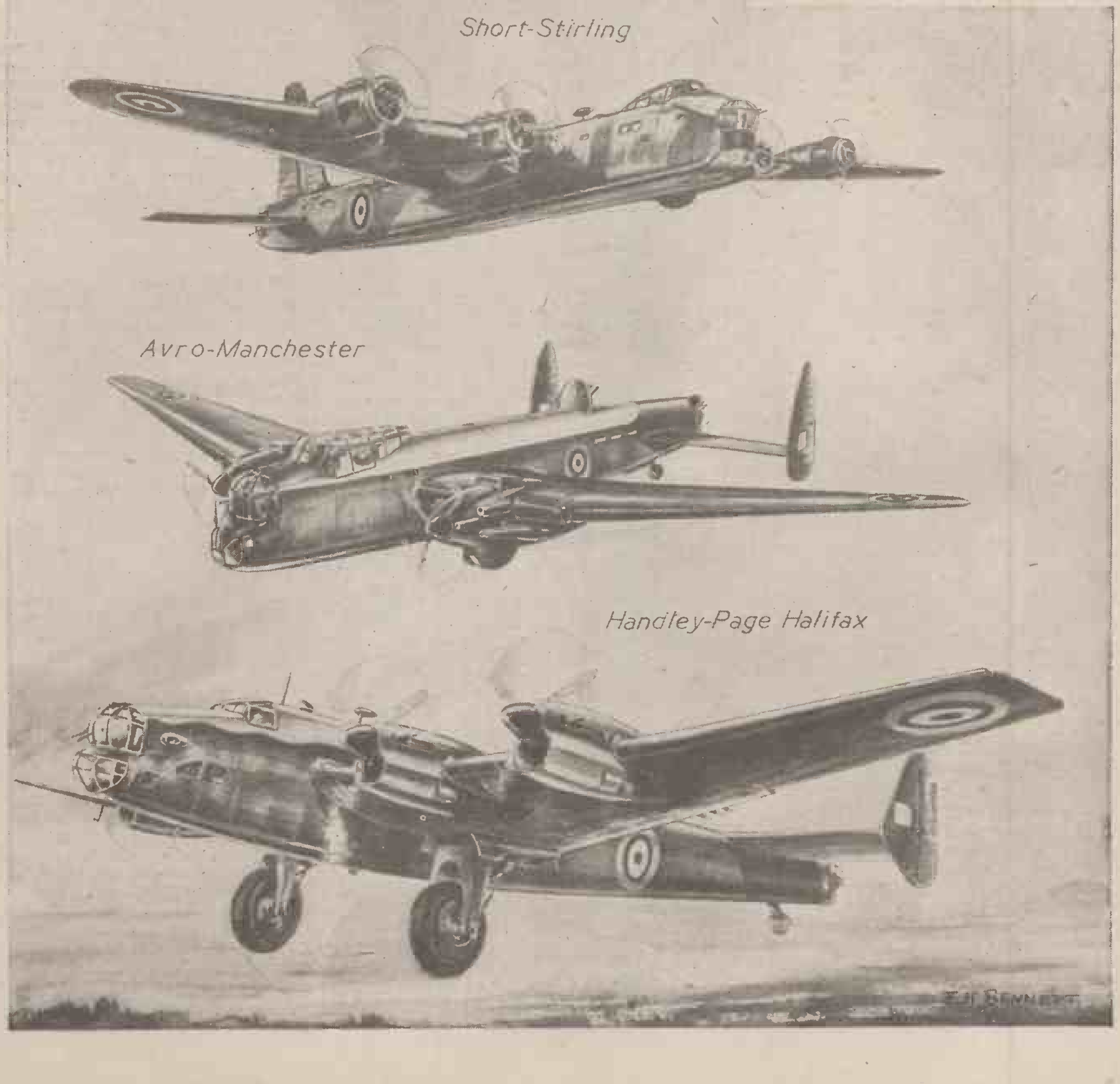
The Hawker Hurricane.—Speed of nearly 400 m.p.h. Fitted with a new series Rolls-Royce Merlin engine. Armament consists of four cannon (or 12 machine guns). Carries two 250 lb. D.A. bombs.

BOMBERS

The Short-Stirling.—Maximum speed of 300 m.p.h. Fitted with four 1,400 h.p. Bristol Hercules III air-cooled engines. Range 2,000 miles. Bomb load of 8 tons.

The Avro-Manchester.—Fitted with two Rolls-Royce Vulture engines. Armament consists of eight machine guns.

The Handley-Page Halifax.—Fitted with four Rolls-Royce Merlin 12-cylinder liquid cooled engines.



THE MONTH IN THE WORLD OF

Science and Invention

A demonstration of the usefulness of a "Tank Transporter" was recently given in the South Eastern Command. The Transport—an American "White" Tank Lorry—weighs over 30 tons when fully loaded. It has a 130 h.p. engine and is larger than any other road vehicle in Great Britain. In the illustration, the bonnet of the "White" Lorry is seen nosing the air as a "Valentine" climbs up the runners

Rubber from Wheat

A PROCESS has been discovered in the United States by which synthetic rubber can be made from agricultural products. Experts who evolved the process estimate that 120,000,000 bushels of corn or wheat would produce 600,000 tons of rubber—normal annual consumption of the United States.

The Bomtecta

THE firm of Philco Radio have produced an automatic device for the detection of fire bombs, which they have called the "Bomtecta." It gives immediate warning of an incident in any building wired with the special Detector-Conductor. The warning is caused by the entry of the bomb itself—not by the heat or light subsequently generated; thus, the "Bomtecta" gives the earliest possible alarm. It can be installed by the average handyman, and is so constructed that any defect in the installation is automatically indicated. It is suitable for private houses, shops, factories, office buildings, hotels—in fact, almost every building in areas likely to be subjected to fire raids.

"Controlled Beam" Experiments

KNOWN as "controlled beam" lighting, and conforming in all respects to the A.R.P. regulations, a new system of station name sign illumination during the blackout is being experimented with by L.N.E.R. electrical engineers.

At several provincial and London suburban stations small black name-boards bearing the station name in 2½ inch or 3 inch white letters, have been fixed in convenient positions on station walls; above and in front of each name-board, at the end of a bracket secured at right angles to the wall, is a slotted metal box containing an electric lamp, the former being so designed that the width of the light beam emitted does not exceed 3½ inches, the length of the beam being no greater than the length of the lettering which in no case exceeds 22 inches.

The light beam, therefore, only illuminates the letters forming the station name, hence the name "controlled beam" lighting.

The other notable feature of the new system is that the brightness of the illuminated lettering is within the limits allowed for A.R.P. shelter signs.

White Lines

TESTS with a new plastic white material over eight stretches of ten miles each on trunk and secondary roads have recently been carried out by the Ministry of War Transport. The material is applied hot to the road surface and sets hard immediately. It is intended, if the experiments prove successful, that permanent white lines be laid all over the country as guides in the black-out.

New Type of Tank

AMERICA is now producing a new type of tank weighing 57 tons. It has the speed of a medium tank, high-velocity 3 in. gun, power-operated turret and armour castings instead of rivets. Heavy armour plates protect the suspension tracks.

New Electric Locomotive

A NEW electric locomotive, which can haul trains at 75 m.p.h. and go a week without a overhaul, is to come into service on the Southern Railway. A steam locomotive has to be cleaned out daily. The locomotive, designed for the operation of both freight and passenger services over the electrified lines of the Southern Railway, has completed its technical test runs on the main Brighton line, and has proved most satisfactory. It can haul freight trains up to 1,000 tons in weight, and from a standing start can accelerate up to 24 m.p.h. in one hundred seconds. Drawing an express passenger train of 14 coaches, it is capable of a speed of 75 m.p.h. The locomotive consists of a box type cab carried on two six-wheel bogie trucks. Each of the six axles is driven by an electric motor through single reduction spur gearing. The box cab contains an electrically fired boiler for supplying steam for heating passenger trains as well as electrically driven compressors and exhausters for operating the brakes—it also contains the electrical apparatus for controlling the traction motors. At each end there is a motorman's driving cab containing his controller and the brake operating levers, together with a speedometer and all the necessary instruments associated with the electrical, braking and steam heating equipment. Current is collected from the conductor rail by shoes of which four are mounted on each side of the locomotive, and there is a pantograph mounted on the roof for collecting current from overhead wires, which it is intended to install in certain sidings. The controller has 26 positions or notches for controlling the voltage applied to the traction motors. Each position is a "running" position which can be used for any length of time, thus giving very smooth acceleration and a large number of "running" speeds. A novel feature embodied in the design of the electrical equipment enables the locomotive to continue exerting a drawbar pull when passing over the unavoidable "gaps" in the conductor rail which occur at junctions and crossings, when none of the collector shoes may be in contact with the conductor rail.

Winged Torpedo

IN a recent issue of "Flight," Mr. Borlase Matthews described a patented scheme for automatic aerial torpedoes, shells, or bombs. The device would be launched by catapult and flown to its target, where its wings would automatically detach themselves. The missile can be used with the accuracy of a gun and be aimed at a target well beyond the reach of the biggest gun.

Multiple Oil-film Bearing

THE multiple oil-film bearing which is a commercial production, has been developed to offset shaft deflection. The bearing is made up of three distinct parts. A hardened, ground and lapped journal hub runs against a flexible polygonal sleeve, with spherical abutments resting in the keeper sleeve. The polygonal sleeve makes contact with the shaft at various points, and does not embrace the journal as in a simple bearing. The inner surface of the keeper sleeve is made spherical, to give self-alignment with the bearing sleeve spherical abutments. This unusual bearing can be made of the usual materials, but a high tin base alloy is often employed. Tests have been carried out to determine the characteristic of such a bearing, and the conclusion reached in the paper is that the multiple oil-film principle is a marked step towards the ideal bearing giving minimum friction and high load-carrying capacity.

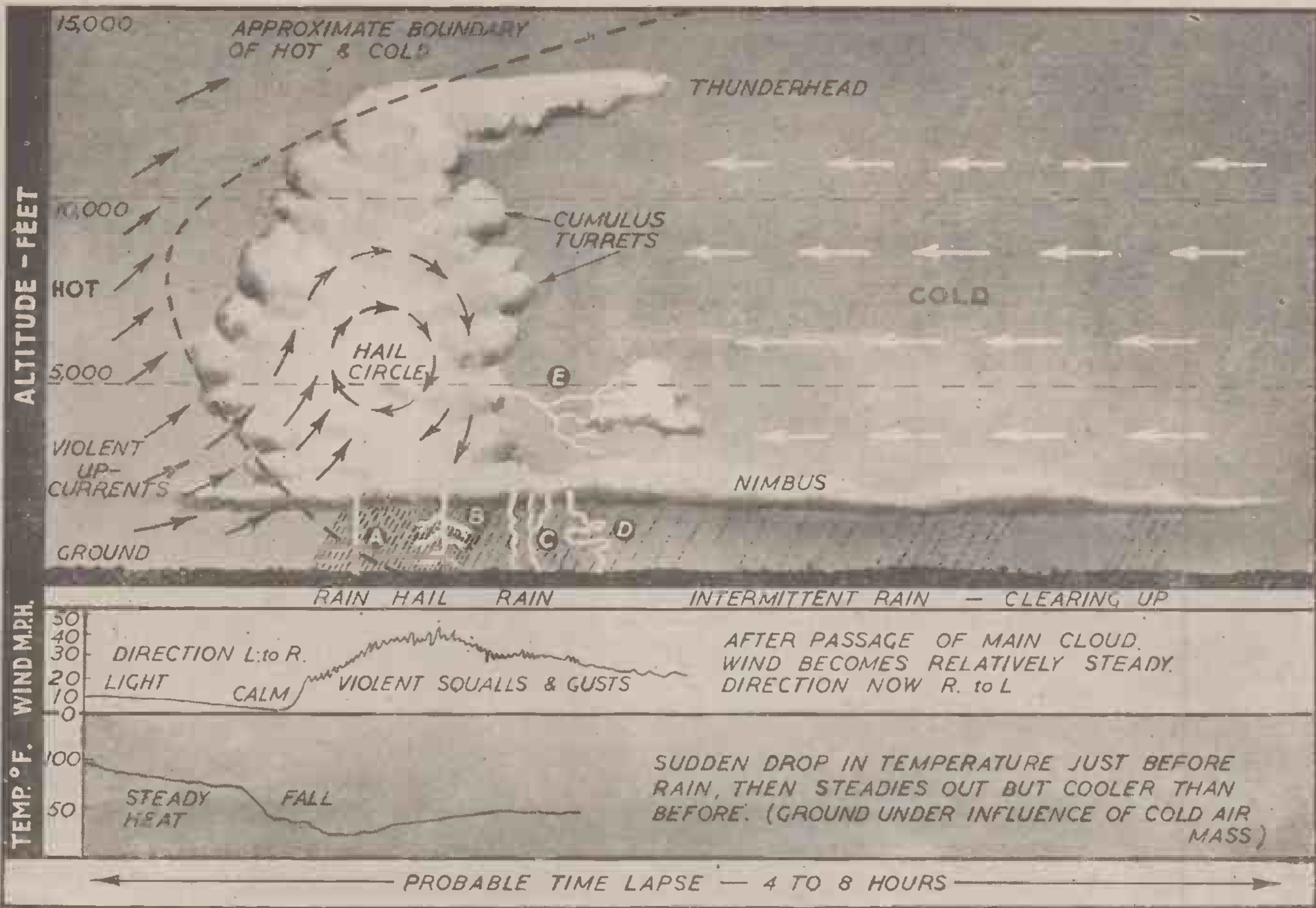


Fig. 1. A generalised thunderstorm

Thunder and Lightning

The Phenomena of a Thunderstorm and its Effects

By R. H. WARRING

EVERYONE has noticed those billowy white clouds that form in fine weather, particularly over the coast and ranges of hills. These are called cumulous clouds, and actually indicate the peak of an up-current of air, i.e., air that has been heated and risen to a great height carrying with it moisture that has evaporated from the earth's surface. At a certain altitude, depending upon a number of criteria, (actually coinciding with the altitude at which the cooling process formed by the air rising reduces the saturated moisture to its dew point and tiny droplets of water form), the cloud forms.

In general appearance it resembles a loaf with a flat base, billowing upwards to its peak in a series of turrets. A rough estimation of the altitude can be made as follows. The height of the cloud base, in metres, is given by multiplying the difference between the air temperature and the dew point by 100, if the temperature is measured in degrees Centigrade, or by 500/9 if in degrees Fahrenheit.

Thus: Altitude of cloud base (in metres)

$$= (\text{air temp. deg. C} - \text{dew pt. deg. C}) \times 100$$

$$= (\text{air temp. deg. F} - \text{dew pt. deg. F}) \times \frac{500}{9}$$

As an example: The air temperature is 80 deg. F. and the dew point is 50 deg. F.

Then height of cloud base $= \frac{(80-50) \times 500}{9}$

$= 1{,}666$ metres.

Sometimes these cumuli assume gigantic proportions, and the extent of the up-currents involved can be seen in the tremendous peak. They then often form cumulo-nimbus clouds, and with these we usually associate electrical disturbances, i.e., thunderstorms. These clouds have a characteristic shape.

Meaning of "Front"

To consider a thunderstorm in more detail we must first of all get some idea of the meaning of a "front," which is the meeting place of cold and hot air masses moving in opposite directions (see Fig. 1). This does not mean that the terms "hot" and "cold" are relative only. It is not meant to apply, for instance, any great extremes in temperature. As will be seen from the diagram, the cold air forces itself under the hot air which, being lighter, is more readily displaced. If the latter is particularly unstable it is more easily pushed out of the way, and the front advances faster.

Such a front develops as it proceeds. It may be hindered or temporarily delayed by meeting a range of hills, say, in which case it will do its best to flow round the obstacle and thus become uneven. Fig. 2 shows the formation in more detail. On the extreme left of the illustration hot air is being forced upwards, and as it cools descends once more. A big cloud is built up in the forward part of the cold region from the condensation of the water vapour in the up-currents, and this is of characteristic form. It consists of a large number of turrets capped with a flat top, resembling in shape an anvil or hammerhead, often as high as 25,000 feet. The droplets of water as they condense are still carried upwards by the powerful "updraught" and are eventually cooled below their freezing point, and form ice crystals. It is the reflection of the sun on these that give the cloud its pure white colour.

As this building up continues, heavy, black clouds form at the base and consist of condensed water vapour that has not been carried up high enough to freeze, and these straggle out, having no definite form. They are further torn up by the violent air currents, and their own continual dissolution in the form of heavy rain.

Inside the cloud itself many of the ice particles are driven round and round in a "cycle," whilst others fall again to a lower level. Here they melt and build up the nimbus, or else are whirled back upwards again. If they fall into the region of the strong down-current, they are precipitated through the cloud in the form of hail, together with rain from the nimbus. This hail may also melt in turn before reaching the earth's surface.

"Hail Cycle"

The size of the raindrops gives some indication of the strength of the up-currents that originally supported them. The hailstones, if cut across, will be found to consist of successive layers like an onion. This is the result of building up in the "hail cycle" where, melting and freezing again, a number of "skins" are added. Finally, it has got into the down-current and has been precipitated.

Now we can form some idea as to the origin of lightning. The air rushing up into the front of the cloud carries with it warm water vapour, and any charge that this may possess is magnified. Further, the droplets in the lower cloud are continually being bombarded by the uprising air, and the whole "hail cycle" inside the cloud is building up a terrific charge. Finally, the charge has reached a sufficient value to escape across the air gap to earth, or even to another cloud with a lower charge. It is assisted in this by the fact that the air itself has been ionised, but this will be dealt with in more detail later.

Consider the passage of such a storm, in which the cloud is moving from right to left (Fig. 2). On the extreme left we have a high temperature and light winds, the hot air region. As the boundary layer approaches, the wind falls off in strength, for it is now blowing *upwards*, and we get the calm before the storm. Just before the rain, the temperature also falls rapidly, and the sky is looking very black.

Fig. 3. Lightning conductor tends to move cloud charge leak away to earth

At first in this lull a few large, scattered drops of rain will fall. Then, quite suddenly, the wind will increase in velocity and become quite gusty, its prevailing direction now being opposite to that which it was before. This is because the cold air mass is moving, in this case, from right to left, and before it reached the spot under consideration the warm air direction was from left to right. Thus, we find thunderstorms "creeping up" against the wind, as the amateur weather prophet is apt to express it.

With this reversal of wind direction, squalls and a violent downpour of rain are to be expected. If the particular cloud is large enough and the ground temperature low enough, hail will also fall; otherwise this will have melted before reaching the earth's surface. The wind is extremely violent along the whole passage of the cloud, but after this has passed, it settled down to a fairly average strength, with intermittent rain from the nimbus clouds straggling along in the rear. The temperature also becomes more or less constant, although lower than before, and the atmosphere generally is in a much more stable condition.

If the extent of the heavy nimbus clouds is small then, being in the region of the cold air mass which picks up moisture from the ground, the lower layers are heated and once more we get little puffy clouds forming and the weather

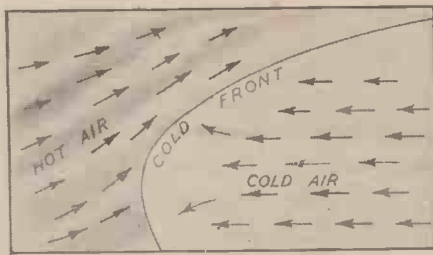


Fig. 2. Cold air mass meeting hot air waves and forcing its way underneath

is "fine." The whole operation probably takes from four to eight hours.

Electrical Phenomena

Now for the "electrical" phenomena which accompany such a storm. The cloud itself is a veritable electric generator, building up terrific potentials which must, eventually, be released. However, lightning does a lot of things that electricity does not do and *vice versa*. There is a subtle difference between the two, but, as yet, nobody has explained the discrepancies fully. For example, there is every reason to believe that if lightning were electricity purely and simply, then every flash should react on the air and the rain to form *nitric acid*, which would fall with the rain! The colour and intensity of the light from the charge, too, are not the same as those that we would expect from an electric arc under similar conditions. Still, it is definitely some form of electrical energy, and we will leave it at that.

Firstly, we see the flash which is the charge escaping to earth or another cloud. If this is particularly concentrated, then objects which it strikes are split or torn apart. It is more in the nature of a "cold," mechanical blow than the searing heat from pure electricity. In comparatively few cases only are objects set on fire, and then they are of a highly combustible nature.

Since light is almost instantaneous, it travels at the rate of 186,000 miles per second, and sound has a relatively low velocity, we can estimate the distance of the lightning flash by measuring, or counting, the time between the flash, as seen, and the thunder, as heard. Sound takes approximately five seconds to travel one mile, and so if we measure the time lapse in seconds and divide by five this will give the number of miles away of the lightning.

Lightning itself has many forms. The *red* discharge (A in Fig. 1) represents the whole cloud charge escaping and thus is the most dangerous of the lot. It consists of one terrific flash accompanied by a heavy report like a big gun. The air has been ionised by the rain, and the charged water particles, and so it takes the line of least resistance, straight downwards.

When the charge is not so heavy we may get "*tree*" lightning as at (B). The main flash is again directed straight downwards, but it branches out along its length. The main flash may die out before reaching the earth, and only one or two of the branches get that far. The thunder this time is more rattling and prolonged.

Then there is the duplex flash (C). The main flash (heavy line) is preceded by an ionising flash or flashes which travel comparatively slowly down. After this has lessened the resistance of the air, the main flash follows. The thunder is rattling at first, and then grows in intensity.

Towards the tail end of the thunder cloud we get "loop" lightning, as at (D), which seems to wander all over the sky, often crossing itself. The thunder is heard as a long, prolonged grumble of very irregular form.

Those are the main flashes that are directed towards the earth. There may also occur cloud to cloud flashes as at (E). These are quite harmless unless the cloud receiving the charge is now so overloaded that it discharges straight away in form (A). Since (E) is above the clouds, the colour of the flash may appear different to the others to an observer on the ground. Lightning seen direct is usually of a white or pale blue colour. If viewed through cloud, or heavy rain for that matter, it will appear reddish.

Lightning Conductor

A lightning conductor (see Fig. 3) acts as a "leak" to the cloud in the first place. It is a well-known fact in electrostatics that a charge will leak away from a body if a pointed object which is earthed is brought close to it. Thus, part of the cloud charge is continually leaking away through the conductor and reducing the ultimate potential that can be built up. Of course, it is too much to be expected that the *whole* of the cloud charge will be dissipated in this manner, but it is lessened.

If the charge that has built up should strike the building, then there is every chance of it being confined to the conductor, unless particularly heavy. That is another reason for placing it on top of the building so that a direct path to earth is offered to any flash approaching the building. Even this, however, is not proof against a red discharge.

That, briefly, is the phenomena of a thunderstorm and its effects. It occurs mainly in the warmer months, i.e., summer, although it is not unknown to have a winter thunderstorm. A lot has been talked about harnessing the clouds and utilising the enormous potentials that are built up, but no practical solution to this has yet been brought into being. When, and if, this is possible, perhaps some completely unexpected results will be obtained. In the meantime we still have lightning to contend with, and it still does a considerable amount of damage every year. Perhaps one day we shall have mastered it completely.

BOOKS WORTH READING

A Book of Trains. By W. J. Bassett-Lowke and F. E. Courtney. 32 pages. Published by Penguin Books, Ltd. Price 6d. net.

THIS entertaining little book is one of the new series of Penguin books and is written especially for young readers. The authors have endeavoured to give the history of the railway, and its development, in brief but attractive form. Many of the illustrations are in colour, and the progress of the railway locomotive from Stephenson's "Rocket" to the streamlined Coronation Scot is explained in the illustrations and the text. Station buildings, signals, how mails are picked up, railway bridges, train ferries and some famous trains at home and abroad, are also described and illustrated. This is just the right book for a boy interested in railways and locomotives.

D/F Handbook for Wireless Operators. By W. E. Crook, A.M.I.E.E. Published by Sir Isaac Pitman & Sons, Ltd. 64 pages. Price 3s. 6d. net.

THIS handbook, which is devoted exclusively to the subject of D/F work, will be found particularly useful to wireless operators who are already working on D/F, or who wish to volunteer for this branch when their training is completed. Specific D/F apparatus is not referred to in the book, the aim of the author being to give the student such knowledge of the principles of all the apparatus concerned and its operation as will enable him to view any D/F station from the specialist's point of view. The book is divided into six chapters, and is illustrated with numerous line diagrams.

Steam Power

The World's Vast Source of Mechanical Energy

IT would be difficult to compute the total power-output in the world, derived from steam. For all their use of petroleum as a producer of mechanical energy, the industries of Great Britain and America, two of the greatest users of coal in the world, would slowly rumble to a standstill without steam and the "black diamonds" by which to raise it. The same would apply, of course, to other industrialised countries like Germany and France, but Britain, above all, has cause to be thankful for her huge sources of coal. Let it be understood from the start that steam is a mere carrier of energy, the latter coming from heat which, in turn, comes from fuel. But the fact that it is a carrier for energy makes steam no less a fascinating subject for study, and an understanding of the subject is indeed a key to mechanical engineering in a great many aspects.

The statement that steam is a carrier for energy is better understood if one stops to consider its origin. To raise the temperature of water we must put heat into it; that is to say, we must put in energy, and by so doing we raise the energy potential of the water. If we continue to put heat into the water there comes a time when the latter boils and passes into steam. At this juncture a curious thing happens: when the water reaches the boiling point, the heat we are putting in no longer raises the temperature. But we know that energy cannot just disappear, so we ask: where has that heat gone? The answer is that it is used up in the actual process of converting the water molecules into gaseous ones, or in other words, steam. As soon as we have put in sufficient heat-energy for the purpose, the heat then goes to raising the temperature of the steam. The amount of heat absorbed in the process of converting the water into steam, without raising the temperature of either, is referred to as the *latent* heat of steam. It is a fixed value, being 538 calories per gramme at atmospheric pressure, but decreasing with increasing pressure. Different liquids have their own latent heat of evaporation.

Superheated Steam

If this is grasped, it will be possible to understand the meaning of superheated steam. Let us suppose we heat up water in a closed vessel with strong walls; we can raise the temperature of the steam (and any water not converted to steam) well above the boiling point of water. While its temperature is increasing so will it tend to expand, just as any gas, and so the pressure inside the vessel will also increase. There is a relation between the temperature of the steam and the pressure, the two values being interchangeable. Thus, if a steam pressure is stated we can, from a table, determine its temperature, and *vice versa*. The following figures are taken from a Steam Table, and show this connection clearly:

Gauge Pressure of Steam, lb./sq. in.	*Temp. Degrees Fahr.*
1.31	216
25.31	267
205.3	390
505.3	471
1085.3	556
2185.3	650
3185.3	705

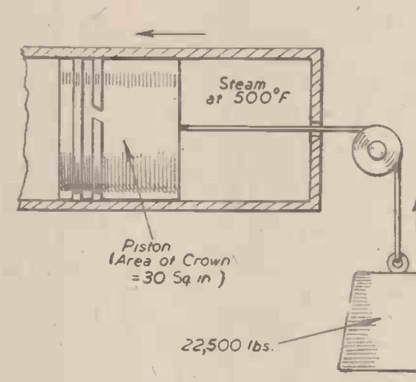


Fig. 1. Diagram illustrating how steam pressure is utilised as mechanical energy

It will be observed that by heating steam to a temperature of 700 degrees F., a pressure of more than 3,000 lbs./sq. in. (gauge) can be attained. It is considered good practice to have a high steam pressure, and boilers range from 100 lb./sq. in. to about 1,500 lb./sq. in.

The reason for this is that the higher the pressure the "drier" is the steam; that is to say, the less likely is it to condense and form wet steam or even water droplets. Dry steam is easier to transmit along pipelines to where it is required, whether it is required for operating engines or for heating. It behaves just like a gas, as already mentioned, and is invisible. The "steam" we see issuing from a kettle is not really steam, but water droplets which have condensed owing to the cooling action of the air, and a closer examination of the spout will reveal that the steam which issues from the immediate vent is invisible, becoming visible a short distance from the vent.

"Sensible" Heat

Having converted the water into steam, and continuing to put heat into it, its temperature (or pressure) is raised. That heat is stored up by the steam, and if one glances at the Table, it will be seen that we can store the equivalent of several hundreds of degrees, expressed as temperature. The actual *amount* of heat would be the temperature multiplied by the weight of the steam. This can be drawn upon just like a banking account, the steam yielding up its stored energy as either pressure or heat. The amount of the latter which has been accumulated in a steam is referred to as the *sensible heat*.

At this point we come to a little subtlety, which can be quite easily grasped when explained. It has been said that the energy which we have put into the steam in the form of heat can be withdrawn either as heat or mechanical energy. The actual process of heating has, as we have seen, produced pressure. If the vessel referred to above happens to be a cylinder with a piston, as shown in Fig. 1, this pressure can be utilised direct as mechanical energy. and for the purpose of the illustration it has been assumed that the steam has been raised to 500 deg. F., giving a pressure of about 750 lb./sq. in. over the crown of a piston of 30 sq. in. area. The force resulting is 22,500 lb, which means that if a weight of this value was moved one foot for one minute about two-thirds of a horse-power would be involved. On the other hand, if we want to utilise the pressure we have built up as heat, we can pass it by conduction into another fluid, so raising the temperature of the latter. If there is one pound of steam in the cylinder of Fig. 1, there will be sufficient heat to raise about three pounds of water from cold to boiling point. The simple treatment of the basic points of steam may serve to show how this substance can be used to store, or convey, energy or heat.

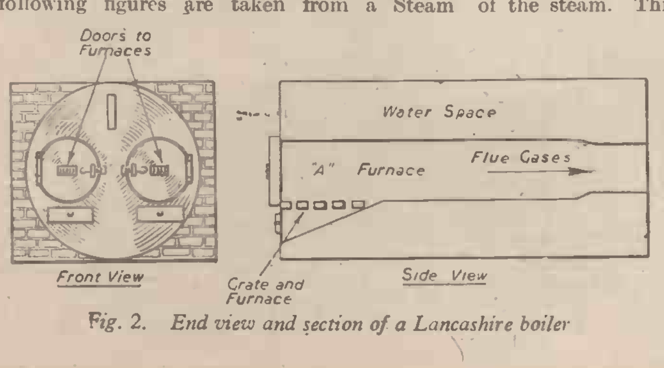


Fig. 2. End view and section of a Lancashire boiler

Steam Boilers

We will now deal with the more practical side, namely, how steam is raised and utilised in industry. The obvious way of raising steam is to put water in a vessel, build a fire underneath, and lead off the vapour by means of pipes. But to make the process an economic and efficient one, all sorts of refinements have to be employed. Figs. 2 and 3 illustrate two typical boilers, while in Fig. 4 is shown a principle of what is called submerged flame combustion. This last-named idea is quoted by way of illustrating an ideal for which all designers of boilers strive: the minimum loss of heat from the furnace due to radiation and conduction. Clearly, if we can burn a flame under water, and it has been done for many years now, for certain purposes, *all* the heat of combustion must pass into the water. It cannot go anywhere else, and so we get maximum efficiency, at least in theory. In practice there are one or two technical difficulties which, however, have not prevented a company from marketing a successful boiler utilising this principle of a submerged flame. The commonest type of boiler is that referred to as the Lancashire, shown in Fig. 2, which belongs to a class employing internal firing,

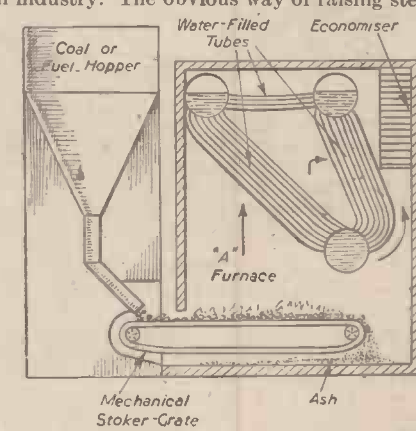


Fig. 3. Diagram showing the general arrangement of a modern triple-drum water-tube boiler

where the furnace is surrounded by the vessel containing the water. There is another main class called water-tube—externally fired boiler—as in Fig. 3. Here the water to be converted into steam is passed through tubes, around which the hot gases from the furnace circulate. It should be added that this last-named class is becoming more widely used, and is a later development in boilers than the Lancashire pattern.

Let us consider the sequence of converting the heat obtained from coal into steam. First of all the coal is burned in the furnace shown at A, in Fig. 2. The amount of air admitted to the bed of the furnace is carefully controlled, because an excess would mean that air, not required for the combustion, would steal heat from the combustion gases, being cool. In effect, coal would be used to heat up unwanted air, which passes up the stack into the atmosphere and so is lost. If insufficient air is admitted, the coal fails to burn completely, carbon monoxide being formed, which also passes up the stack into the atmosphere. There is just a right amount of air for efficient combustion, such efficiency being marked by a maximum evolution of heat from the coal

Flue Gases

On works of any size it is the practice to analyse the flue gases from the boiler, and if carbon monoxide is found, it is concluded that insufficient air is being admitted, while if oxygen is present in the gas then too much air to the furnace is indicated. The air inlet to the furnace can be controlled by means of dampers, and the outlet of flue gases into the base of the stack or chimney can also be adjusted in this way.

Coal in lumps is not the only source of boiler fuel, for pulverised coal is sometimes fed into the furnace by means of large jets, burning like a gigantic flame. In the same way oil is employed, and occasionally, oil and coal dust are mixed. But however the fuel is used, the necessity for careful air control remains. Coke is sometimes fed into the furnace, and may be mixed with breeze, but generally speaking, the grade and quality of the material by which the steam is raised must be standardised for consistent efficiency.

One of the duties of a steam engineer is to keep a log of all relevant data, such as calorific value of the coal he uses, its ash content, the composition of the furnace-outlet gases—taken periodically—the temperature of the furnace bed, and of the gases at the base of the chimney. He must also know how much water he is evaporating per hour, and at what pressure, and what is the chemical composition of the water, both as fed into the boiler, referred to as "feed water," and after heating in the tubes. The latter points are required to decide the rate of accumulation of scale, a very important matter where efficiency is concerned.

Working Efficiency

With all of the above data he is then able to construct a thermal balance for his boilers, and so arrive at their working efficiency. In its simplest form, and ignoring the calculations by which the figures are determined, the following are what one would expect to find in a heat balance:

Calorific value of coal: 11,000 B.Th.U./lb.
Coal consumption, lb./hr.: 750.
Steam raised, lb./hr.: 5,000.
Pressure of steam, lb./sq. in.: 200.
Efficiency, overall: 80 per cent.

There are ways and means of utilising as much heat as possible from the combustion of coal, but the most important one is to trap that which would normally pass up the chimney into the air. This is done by means of economisers, where the heat of the gases entering the chimney is circulated around tubes through which the cold feed water is passed. If the latter is at an elevated temperature when it flows into the boiler, it means that less heat is required from the furnace gases to bring it up to boiling point. which results in a saving of fuel.

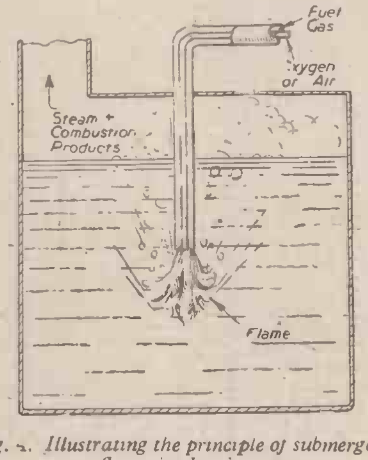


Fig. 4. Illustrating the principle of submerged flame combustion.

No mention has been made up to now of forced draught, which is often employed on a boiler, giving as it does better control over the air input. Then, again, in modern works, the steam is frequently superheated, which is another way of saying that its temperature is raised well above the point at which water is converted to steam. The higher the degree of superheat, the drier is the steam, as mentioned earlier in this article, so making it easier to convey in pipelines for lengthy distances, without the danger of water being condensed out. Apart from this superheated steam is a better source of mechanical power in engines, giving as it does a higher pressure.

Lagging of Pipe Lines

As we are now approaching the actual use of the steam in practice, reference should be made to the lagging of pipelines by which steam is conveyed to engines, turbines or to the plant in which it is required. The material used to lag pipes is a very poor heat conductor, and by wrapping them in it heat is discouraged from passing from the steam into the air. By this means the pipes can be led quite long distances, and if there is a possibility of slight heat loss, giving rise to condensation, water or steam traps are arranged in the pipeline. Space has forbidden a description of such appurtenances as valves, boiler tubes, recording apparatus for pressures, temperatures and flue gas composition, and many other items which go to make up the modern high-efficiency boiler.

A Portable Dental Chair

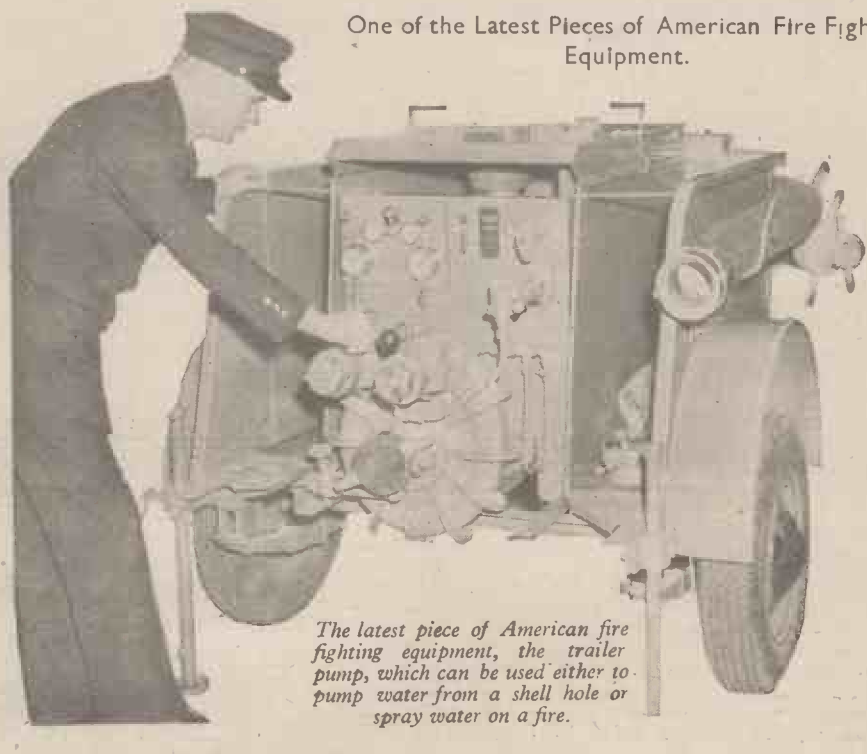
It is Adjustable and Designed for use in the Field.

THE adjustable dental chair is convenient both for the operator and the patient, though, in the case of the latter, it has not always pleasant associations. A portable chair of this description is the subject of an application to the British Patent Office. The seat—movable in a double sense—is particularly intended for use in the field. It is of simple and inexpensive construction, and yet it is adequately strong. It is also capable of all the adjustments necessary during the performance of dental operations.

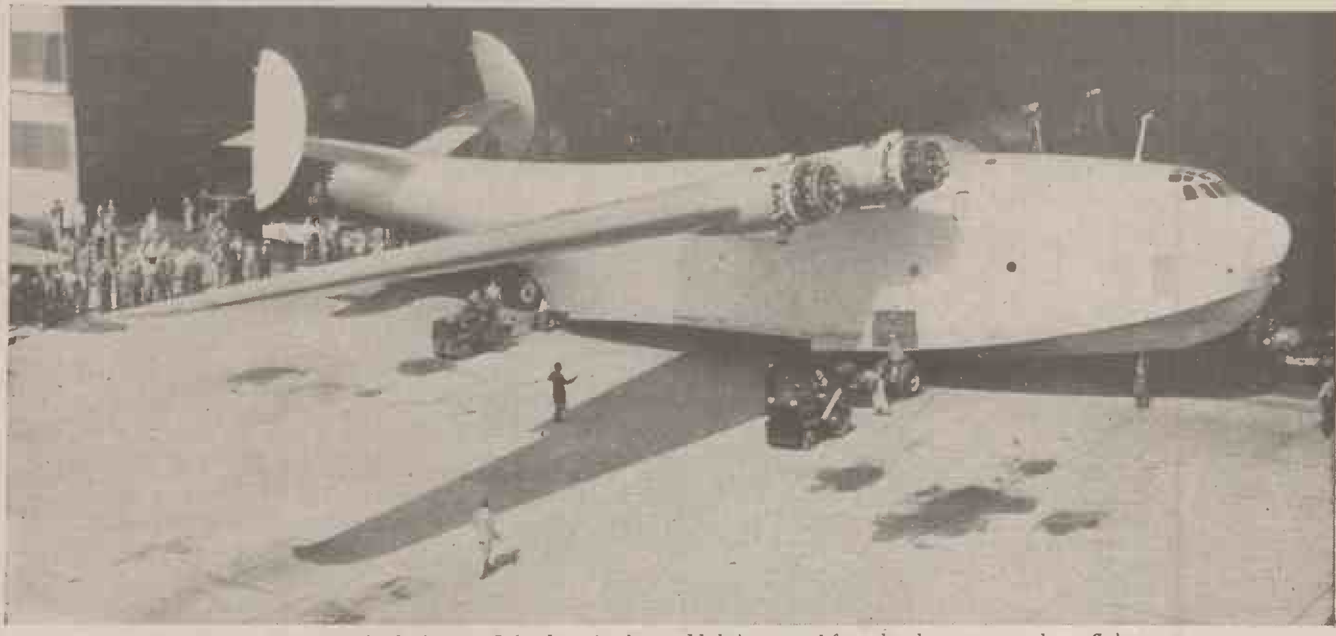
A very limited number of parts are included in the chair, and the majority of these parts are made of metal tubes in such a way that the chair is characterised by maximum strength coupled with minimum weight. It has a foldable front and is qualified to accommodate itself to a variety of positions.

Although principally designed for use as a dental chair, it would be equally suitable for a hairdresser.

One of the Latest Pieces of American Fire Fighting Equipment.



The latest piece of American fire fighting equipment, the trailer pump, which can be used either to pump water from a shell hole or spray water on a fire.



The Martin XPB 2M-1, the largest flying boat in the world, being towed from her hangar to undergo flying tests

The World of Aviation

Portable Aerodromes: An "Airmail Train"; Rocket Launching Device: American 12-gun Fighter: A 40-ton Bomber: New Aeroplane Wing.

Portable Aerodromes

THE American Air Corps are now using portable aerodromes. They are made of steel sheets 10 ft. long and perforated with large holes, known as "Marston strip." Hooked together they form a firm landing surface for all kinds of aircraft. During recent manoeuvres one mobile aerodrome was laid in 11 days by an engineer battalion. They can be made to look like orchards or cornfields from the air.

New French Flying Boats

The German official news agency reports from Paris that five "giant flying-boats" are being built in France. The new aircraft, which can accomplish a non-stop flight across the Atlantic in 20 hours, carrying 50 passengers, has a speed of about 180 m.p.h.

An "Airmail Train"

A new mailplane, which will be responsible for a 26-ton pay load, is shortly to undergo tests in America. Carrying six tons of mail, it will tow five special gliders, each carrying four tons of freight. The gliders will be released at separate destinations and piloted to earth. The Russians used this method with airmails before the war.

Air Monsters

A passenger air liner to carry 300 people each trip on a 10-hour New York-Southampton run is being built by Glen Martins. This firm are also building a three-decker monster luxury cruiser for American use.

Rocket Launching Device

It is reported that the Luftwaffe is using a new rocket launching device for fighters, as part of the defence against R.A.F. sweeps across the Channel. German newspapers say that the device can throw a fighter to a height of several thousand feet at a speed of nearly 400 m.p.h. By means of this quick take-off, defending planes might be able to gain an advantage in height before our bombers and fighters arrive.

New American 12-gun Fighter

A new American Curtiss fighter, successor to the Tomahawk and Kittyhawk, is now coming off the production lines in quantity. Armed with twelve machine guns it is credited with a speed of nearly 400 m.p.h. The machine is expected to be called the Goshawk. Officially known as the Curtiss P-40 F, the machine is a single-seater powered by a 1,300 h.p. Rolls-Royce Packard Merlin engine. It has a ceiling of nearly 11 miles, making it suitable for combating stratosphere bombers, and incorporates several revolutionary ideas.

A 40-ton Bomber

American aircraft designers are now concentrating on the production of long-range heavy bombers, including some nearly twice the size of the Flying Fortress. In addition to the Boeing heavy bombers and the Consolidated Liberator bombers a new type, the Boeing 29, is going into production early this year. This aircraft, believed to be in the 40-ton class, is to be powered with 2,300-2,500 horse-power engines.

New Aeroplane Wing

Mr. W. F. Howard, a civil engineer, claims to have designed an aeroplane wing of a revolutionary design which gives more efficient lift than the normal wing now used throughout the world. On the model he has designed, the wing, instead of being set at a positive angle, is set at a negative angle of one in seven. The wing itself is heavily cambered towards the leading edge, and is concave on the underside to such an extent as to appear to have been scooped out. The tail plane, also set at a negative angle, is of a similar type. Mr. Howard claims that his design not only gives better lift, but that the model will fly a quarter as far again as the standard model, and that at a maximum speed of 20 m.p.h. his aeroplane is 10 to 15 per cent. faster. The theory of his design, it is stated, is that a "whirl of air" is created under the main plane and tail plane, and that the aeroplane can use the upward surge of the vortices to give both lift and forward thrust. The model has not yet been tested in a wind tunnel, so it cannot be decided whether a wing of this shape and design is likely to produce complications which would prevent it from becoming a practical proposition.

New Aerial Camera

Metrogen is the name given to a new type of lens which has been produced for use in aerial cameras. Its focal length is 6 in. and aperture F/6.3. Whereas the lens used previously had only a 17 degree angle, the new lens has an angle of no less than 90 degrees.

Secret German Aero Engine

According to the official German News Agency, the German Press recently announced that a new secret aeroplane engine is already in production in Germany. It is, they say, one of the largest engines ever mass-produced, and is provided with two banks of cylinders in line. A two-engined dive-bomber of the latest type will be equipped with these engines. The fuel consumption is said to be lower than hitherto deemed possible. Light in weight, this engine is described as being capable o great performance and suitable for any plane.

A 455 m.p.h Fighter

Mr. D. R. Davis, the American inventor of the "Davis Wing," used on Liberator bombers, is stated to have designed a new fighter aeroplane, with a top speed of 455 m.p.h., and a range that could take it easily from Britain to Berlin and back. The fighter, models of which have just completed two years of wind-tunnel tests, will, if the design proves successful, have a flying time of 10 hours and a range of about 2,500 miles, and will be equipped with

A portable aerodrome now being used by the American Air Corps

four shell-firing cannon and four machine guns. Present plans are that this machine will be constructed of steel and plastic-bonded plywood, and will be fitted with an engine of at least 1,500 h.p.

Record for Dive Bomber

From New York comes the news that a test pilot of a Martin "Baltimore" medium bomber recently made a full throttle dive at a speed of nearly 560 m.p.h., which is claimed to be a record speed for a dive bomber.

The Focke-Wulf 190

A new German fighter plane which has made its appearance on the Western front is the Focke-Wulf 190. Its chief feature is the engine which uses less fuel than other types. It is air-cooled, giving the plane a stump-nosed appearance. It is very fast at low altitudes, but its armament is not very great.

Steam-driven Aircraft

Steam-driven aircraft of exceptionally high power are being experimented with in Germany. They are designed for high altitude flying. The Nazis have also produced new and bigger gliders, some with light motors to assist landing.

Jig-Saw Puzzles for Air Crews

A Royal Air Force officer has produced a new use for jig-saw puzzles. The aim is to amuse and instruct air crews, especially those who have been trained overseas and may be unfamiliar with British topography and place names. The method is to paste a map of the type used by pilots on a sheet of three-ply wood and cut it into small shapes of about equal size to form a jig-saw puzzle. In their spare time in the crew room, air crews can piece together the puzzle and, in time, will be able to take a part with a town marked on it and position it at once. Similarly, they will learn to position rivers, wooded areas, coast lines and hilly country.

Nazi's New Bomber

A new type of German bomber, the Dornier 217E, recently made its first appearance over Britain. Several of them have stayed behind at the invitation of Britain's air defences. One was a victim of the balloon barrage.

In general appearance the Do. 217E rather resembles its forebears, the Do. 17Z and Do. 215, but it has a considerably greater load capacity, longer range, and better performance. This is largely due to the installation of two exceptionally "beefy" engines of the new B.M.W. 801 type. They are 14-cylinder radials each giving about 1,500 h.p. for normal flying at height, boosted to about 1,600 h.p. for take-off. Also it is so designed as to be easily adapted for fairly steep dive bombing. Like Britain's famous Beaufort bomber, it can also be used for torpedo work. A feature of the motors is that they are fitted with fans for cooling and have an unorthodox exhaust system. The Do. 217E examined had a new type of wooden airscrew, with three blades.

The wing span of this new bomber is approximately 72 feet, which is roughly 3 feet more than that of the early Hampden, although it is nearly twice as powerful as that medium bomber.

There are some new arrangements of armour plate, including a piece to protect the dinghy, and a slab on the top of the fuselage just behind the cockpit. The new Nazi bomber is obviously intended to do a number of jobs besides bombing. Its speed would make it suitable for long range reconnaissance. Perhaps with this in mind the designers have made provision for various combinations of bomb loads, and defensive and offensive armament, including heavy calibre machine guns.

Storm Perils of the Air

January and February are the months when those who are fighting the enemy in the air have to fight the worst weather as well. Coastal Command aircraft fly in practically all weathers. Through hailstorms, snow and winds of gale force, they have to find their way. At times the pilot has to grip the control column firmly to counter the storm's buffeting blows on wings and tail.

Even rainstorms can be alarming as well as uncomfortable. Beaufort crews returned from Norway one day with their flying clothing soaked, in spite of their enclosed cockpit. The force of the wind blew rain through the window frames and other chinks until they were like leaking water pipes. But the Beauforts flew well, although the crews felt as if the fuselage was straining and protesting against the undue stresses. The Canadian captain of a Blenheim flew in a cloud-burst which was so violent that the downward air current began to force the aircraft towards the sea. Another aircraft, a Beaufort, was thrown about so much by a squall that the crew became sick, the first time in several hundred hours' operational flying.

A "wall" of cumulus cloud 50 miles long and thousands of feet high met three Beauforts on their way to Norway. "It looked so solid," said one of the pilots, "that we seemed to be going into a massive grey cliff." Thermal currents within the cloud were violent, and the Beauforts had to come out again very soon. One pilot found an electrical storm, and bright blue flashes of static electricity began to appear on all metal parts outside the aircraft, and the wireless set gave a special fireworks display of its own.

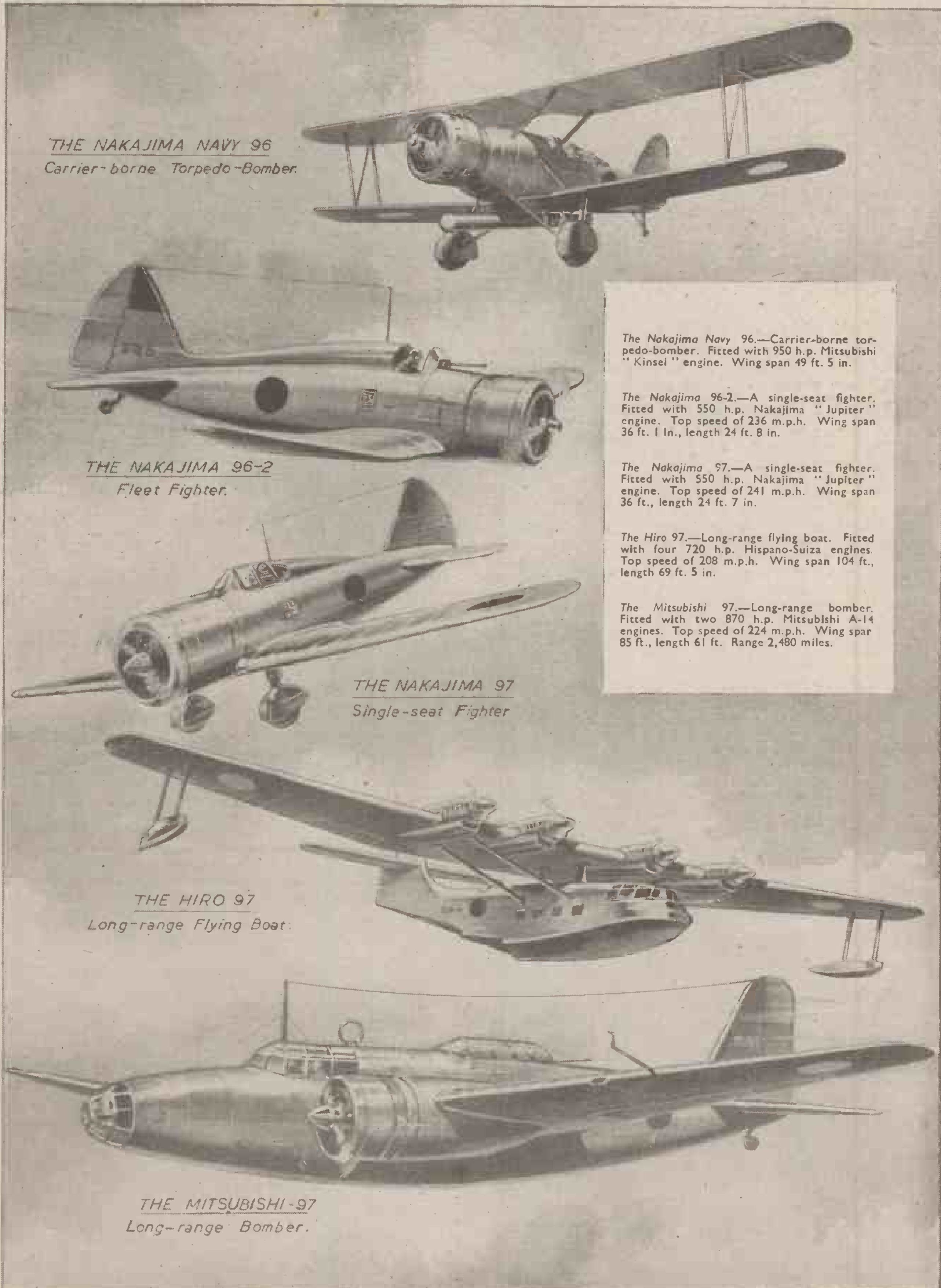
Five Years of Met. Climbs

A single seater fighter touched down gently in front of the hangars of a Coastal Command aerodrome and the pilot freed himself from his straps. "Here's to the next five years," he said. The pilot had just at the conclusion of his flight, become the world's record holder for hours of continuous flying in any kind of weather. With two other pilots this 32-year-old Flight-Lieutenant has completed five years of met. climbs—3,450 of them at an hour a time. The flight commander himself has done 848 climbs in three years. The nearest approach to this is 586 climbs, made by another British pilot.

This particular met. flight does three trips a day, climbing to 25,000 feet each time—no matter how bad the weather. Before sorties can be planned over Germany, or fighter sweeps made across the Channel, up-to-date reports must be received from the weather men on prevailing conditions. The three pilots who form this met. flight do not talk much about their own performance. Rather they talk about their "wizard" aircraft—Gloster Gladiators.

The first picture to be released of America's latest fighter plane, the Curtiss P-40 F.

TYPES OF JAPANESE AIRCRAFT



The Nakajima Navy 96.—Carrier-borne torpedo-bomber. Fitted with 950 h.p. Mitsubishi "Kinsei" engine. Wing span 49 ft. 5 in.

The Nakajima 96-2.—A single-seat fighter. Fitted with 550 h.p. Nakajima "Jupiter" engine. Top speed of 236 m.p.h. Wing span 36 ft. 1 in., length 24 ft. 8 in.

The Nakajima 97.—A single-seat fighter. Fitted with 550 h.p. Nakajima "Jupiter" engine. Top speed of 241 m.p.h. Wing span 36 ft., length 24 ft. 7 in.

The Hiro 97.—Long-range flying boat. Fitted with four 720 h.p. Hispano-Suiza engines. Top speed of 208 m.p.h. Wing span 104 ft., length 69 ft. 5 in.

The Mitsubishi 97.—Long-range bomber. Fitted with two 870 h.p. Mitsubishi A-14 engines. Top speed of 224 m.p.h. Wing spar 85 ft., length 61 ft. Range 2,480 miles.

Our Busy Inventors

By 'Dynamo"

Anti-Blast Cells

YET another air-raid shelter offers protection from the blast of the bomb. This particular shelter is designed largely for use by factory workers. The aim of the inventor has been to make a structure of such a nature that it is easily accessible. As a consequence, the worker can remain at his or her post until danger is imminent.

The shelter consists of a number of interconnected cells lined with concrete. These cells are adjacent and each is separated by a partition wall in which an opening is formed. This aperture permits the occupants to move from one cell to another.

Constructed below the surface of the floor, the upper part of the shelter has a movable or hinged cover, preferably of steel. This cover is provided both on its inner and outer surfaces with levers, handles or handholes, to facilitate opening and closing. If a somewhat heavy covering should be required, the cover may be divided into two or more parts. In some cases it may be desirable to furnish a grid on which the cover will rest.

In the course of an air-raid, a heavy fall of debris might make it impossible to raise the cover, entrapping the occupants of the cell.

To avoid this danger, it is proposed, as already mentioned, to connect a number of individual cells. And there would be as many exits as cells.

For the purpose of ventilation, in each cell a vent or flue extends downwardly from the level of the floor to within a short distance of the base of the cell.

Cot and Play-Pen

IN these troublesome times, when the mind is occupied with the machinery of war, it is refreshing to switch on to an invention relating to the age of innocence. This is an improved child's cot which folds easily into a small space, is conveniently transportable and answers a double purpose. An application for the patenting of the invention has been made to the British Patent Office.

Fresh air and bright sunshine (if any) are, by this device, allowed free access to the rising generation. When it does rise, its bed may be transformed into a tiny nursery. And in the garden this play-pen allows the child in perfect safety to partake of the fresh air and to bask in the sun.

The device consists of a rectangular box-like structure, according to the usual pattern of a cot. The walls are covered by wire gauze which permits adequate light and air to stream on to the infant. One side wall is in two sections hinged horizontally. When the upper section is lowered, and the top or lid is raised or removed, ample space is provided for the entry of the child.

Alternatively, the drop side may be kept erected, and the lid removed. The structure then performs the role of a play-pen.

An Ingenious Wool Holder

THE latest device for holding wool has an expanding bracelet for attaching to the wrist of the knitter. There is a wire support in the shape of a "V" member. This is detachably fixed at its apex to a swivel. When detached from the swivel, the arms of the support can be compressed together to allow the insertion of the "V" member, apex first, through the wool, which is retained by an arrangement on the ends of the arms.

This wool holder, while assisting the knitter, will prevent knitting of the brows occasioned by the ball rolling on the carpet.

Safe Ladders

AN inventor has devised a ladder which remains firm and upright when standing upon uneven ground. A self-acting adjustable mechanism ensures this stability.

> 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."

Co-operative toothed or rack bars with feet are used. They are relatively inclined, and are mounted in slides or guideways carried by supporting means applied to or adapted to be fixed to the legs of the ladder.

A portable automatic electric traffic signal operated by a 6-volt storage battery. The inventor, G. W. Walker, of Detroit, U.S.A. is here seen with the new unit

The mechanism functions in the following manner:—So long as a leg bears on a provided foot, both toothed or rack bars are interengaged and locked. But when both legs are lifted clear of the ground, the bars re-set themselves automatically.

Happy Landings

COMING to earth is the final risk of a nocturnal aerial flight. Bearing this in mind, an inventor has devoted his attention to ensuring happy landings by night. He remarks that it is the usual practice to illuminate the landing area by means of a lamp which emits a circular beam forward and downward from the aircraft. He states that the lamp is located in the wing near the pilot, who looks down the beam which, using a geometrical expression, he says always subtends the same angle to the line of sight of the pilot, whether the aircraft is 5 feet or 50 feet above the ground. Therefore, it is not possible for the pilot to judge how far he is above the surface of the earth until he can pick up the details of that surface. This, affirms the inventor, is a serious disadvantage, and is liable to result in an accident or damage or both, when landing on smooth surfaces such as sand or concrete.

Aerial Shadowgraph

THE object of the inventor is to furnish a system of illumination enabling the pilot to judge his distance from the ground, while the landing area is sufficiently lit up to allow him to effect a safe landing. His plan is to provide a landing lamp in such a position towards the rear of the aeroplane that it projects a beam which casts forward on the ground a shadow of a wheel, float, or other projection on the aircraft.

Trailer Ambulance

AT the present juncture in our country's history an improved trailer ambulance, for which the British Patent Office has accepted the complete specification, is worthy of attention.

At one end of this vehicle is a platform accommodating one or more stretchers. At the other end are a pair of seats facing one another. These are suitable for sitting cases, i.e., persons who require medical treatment but are nevertheless able to sit.

In addition to its normal function, this trailer ambulance could be used for the conveyance of troops.

Marking Roads

AN inventor has conceived the idea of an improved machine for marking roads, while bearing in mind the following objects. One aim has been to effect an even distribution of the paint over the surface of the road. Another object has been to produce a machine for use in painting broken or dotted lines, whereby the lines can be terminated with sharply defined ends of curved and other appropriate shapes.

According to this invention, a brush is provided adapted to be oscillated about a vertical axis by means caused by the movement of the machine over the road surface. The paint is applied to the road immediately in front of the brush. If desired, it can be fed to the road through the brush itself.

Any suitable brush can be used, but it has been found advantageous to employ a brush formed of two concentric parts. The inner part is circular and is oscillated about a vertical axis, while the outer part moves over the surface being treated, without rotating. Means are furnished to rotate the outer part of the brush when it is desired to conclude a line in order to mark a clearly defined end.

There is an arrangement for lifting the brush out of contact with the surface of the road, and it is possible to stop the oscillation of the brush when it is lifted.

The supply of paint may be effected by means of one or more pipes leading from a container and opening just above the road surface and immediately in front of the brush. To secure an even distribution of paint, two or more pipes are recommended.

PHOTOGRAPHY

Toning Bromide and Gaslight Prints

The Process Simply Explained.

By *JOHN J. CURTIS, A.R.P.S.*

TONING is an important part of the amateur's work. It is not confined to enlargements, but is equally suitable for small contact prints, and also for most gaslight papers, although there are one or two brands of the latter which do not respond to the treatment so well as others, and it is advisable to keep to one or other of the well-known makes and grades which the makers assure will give good sepia or other tones.

Before discussing the process, it is necessary to give a few hints concerning the initial preparation of a print which it is intended to tone, as I am convinced that this is where a good number of beginners have missed the opportunity of getting satisfactory results.

What type of print should be toned? The answer to this is, any print having the pictorial qualities as mentioned in previous chapters, i.e.. good gradation and range of tone values without hard contrasts will certainly give a pleasing result. Some subjects are best left in black and white, but any woodland scene or general landscape will respond satisfactorily to sepia, a seascape will require green, a moonlight effect or a snow scene blue. A fire-side study and some portraits will look quite good when toned red; the selection must be left to the judgment of the photographer.

Preliminary Treatment

Is any special treatment required when making the print? There are some very important points to bear in mind when making a print which is to be subsequently toned, and so as not to lead to confusion, I will consider each toning in its turn, and will take sepia first because this is the most popular, and can be used much more than either of the others; the remarks will apply to both bromide and gaslight papers.

Sepia toning is the result of a chemical change in the emulsion of the print, the silver salt, bromide or chloride, according to the paper, being changed to a silver sulphide, which is why the process is sometimes termed the sulphiding process; this salt of silver is harder to destroy than the bromide salt, therefore, when a print has been sepia toned, it is more permanent than in its original state.

The fact that a chemical reaction takes place demands that there must be a sufficiency of the one salt in the image on which the other chemicals can react, otherwise the action is not going to be perfect; the way to ensure a "full-bodied" image is to be quite certain that the print is correctly exposed and fully developed. By correctly exposed, I mean that you have carefully made your test strip exposures, and have found the right time to give to the sheet of paper to secure a perfect rendering of the tones and halftones which are present in the negative. When this exposed paper is placed in the developing solution it has to remain there until no further action is recorded by the developer, and that is the meaning of "developing to finality."

What is the result? You have allowed your Amidol to do its job for two minutes, and have got an image with depth; it is not just a surface image, there is "body" for the other chemicals to attack.

Washing the Prints

The second important point to remember concerns the washing. The print has been thoroughly fixed in the acid or plain hypo bath and is transferred to the washing water; it is most essential that all trace of hypo be removed, so do not stint the washing. If you cannot use running water, then be sure to give many changes until you are satisfied that all the hypo has been removed. If hypo is present when one of the other chemicals you are going to use reaches the print, a reaction takes place which is not wanted; it is a reduction action which eats into the silver of the image.

The toning chemicals can be purchased all ready for use in little pactums at 6d. each, full directions being enclosed as to how to prepare the solutions. Each pactum makes five ounces of solution. There are still many who would prefer to make their own solutions —there is always a thrill in tinkering with chemicals when you are not pressed for time and have got the space—and so it is useful to have formulae.

At work in a dark room

Sepia Toning

Sepia toning is a two-bath process. bleaching and toning, and here is the bleacher formula:

In 10 ounces of water dissolve ¼ oz. potassium bromide and ¼ oz. potassium ferricyanide.

When this is prepared, keep it in an amber bottle and in a dark cupboard; it is a concentrated solution, and will be good for quite a number of prints.

Toning formula: In 7½ ozs. of water dissolve 1 oz. pure soda sulph*ide* (note "phide," not "phite"); this solution is also concentrated and can be stored.

Take one ounce of the concentrated bleacher solution and add four ounces of water to it; place your wet print in the dish and pour this solution over it, and in a very short time you will see the image disappear until there is only a faint yellowish outline left; remove the print to another dish and wash until the water is free from the yellow tinge.

Take one ounce of the toning solution and add five ounces of water to it, pour off the washing water from the print and pour on the toning bath and immediately you will see the image come back but in a beautiful sepia brown colour, leave it for a couple of minutes and transfer it to wash for half an hour, and then hang it up to dry.

The diluted solutions will not keep very long, and if you have not sufficient work for them in the one evening, it is better to throw them down an outside drain; notice I said "outside," because the sulphide gives off a very pungent odour, which is definitely unpleasant in the house.

The potassium ferricyanide in the formula for the bleacher is the one which combines with hypo and forms the reducer mentioned earlier in this article.

Blue Toning

For blue toning, use light prints, as there is an intensifying action during the process, and as a rule it will be found advisable to soak prints in a very weak solution of Hydrochloric acid (about four drops of acid to one ounce of water), then rinse them in water before placing in the toning solution. Leave the prints in the toning till they turn a deep blue, and remember that some of the colour is removed in the washing; keep the prints turning in the washing water, do not let them overlap and stick. Continue the washing for five or six minutes till the yellow stain has disappeared, then hang them up to dry.

The formula for the blue toner is as follows:—

(1) Dissolve 15 grains potassium ferricyanide in 30 drops pure acid sulphuric and 20 ounces water.

(2) 15 grains iron ammon. citrate, and 30 drops pure acid sulphuric in 20 ounces water.

When about to use, take equal parts of each of these solutions and mix them.

Green Toner Formula

(1) Potassium ferricyanide: ½ ounce.
Ammonia (liquid): 7 drops.
Water to make up to 5 ounces.
(2) Ferric ammon, citrate: ½ ounce.
Acid hydrochloric (pure): ¾ ounce.
Water to make up to 15 ounces.
(3) Soda sulphide (pure): 60 grains.
Water up to 15 ounces.
Acid hydrochloric (pure): ¾ ounce.

Having well washed the prints, place them in the No. 1 bath until completely bleached, then wash till free from stain, and place them in the No. 2 solution for five minutes; then rinse for two or three minutes in water and transfer to No. 3 solution for five minutes. A few minutes in running water will complete the process. While still wet, there is a slight blue tinge in the image, but this usually fades out on drying. It is important to note that the washing after bleaching should be thorough.

Red Toner

The formula is sometimes termed the Uranium formula:
(1) Uranium nitrate: 45 grains.
Water: 10 ounces
(2) Potassium ferricyanide: 45 grains.
Water: 10 ounces.

Take equal parts of each and add to each ounce of the mixed solution 20 drops of acid acetic glacial. Leave the prints until the desired tone is reached, but remember a slight intensification occurs in this process. After toning, pass the prints to a dish of water for washing and change the water several times; do not use running water.

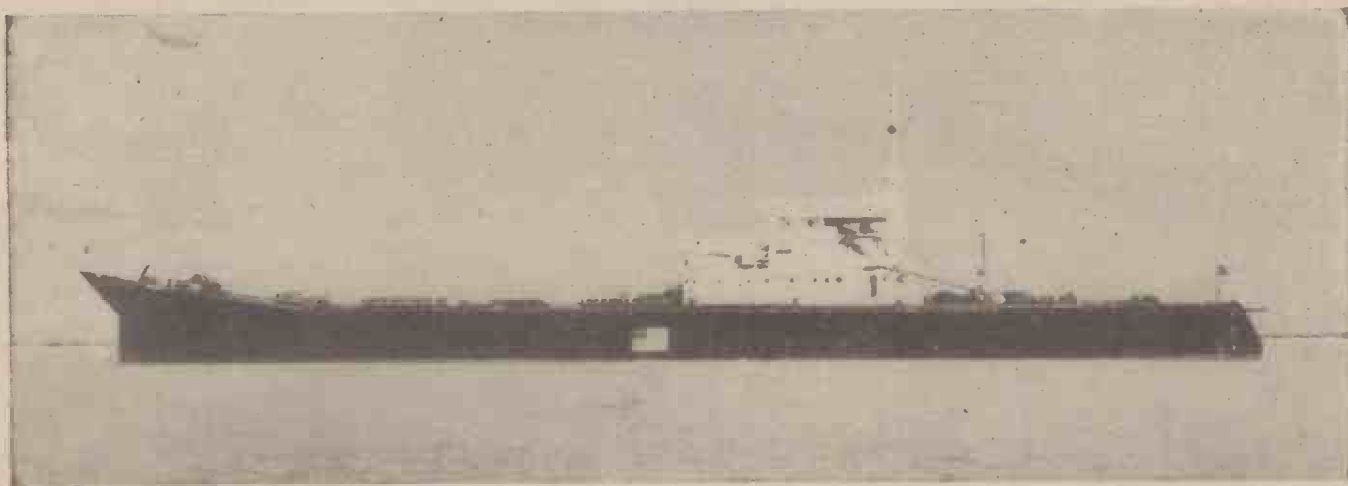
The tones are not always permanent, and in order to make them so it is advisable to fix the prints for five minutes, after toning, in acid-fixing made as follows: soda hypo ½ ounce, potassium metabisulph. 70 grains, water 20 ounces.

Be sure that the prints are free from hypo before toning.

Note.—At the time of writing, quite a number of chemicals are unobtainable, and readers should for the present try the Pactum Toners, which have a very good reputation, and are on sale at most dealers.

An Arc-Welded Cargo Ship

A Short Description of an Experimental Blockade-Breaking Ship



The "Sea Otter II," a novel ship of arc-welded construction *Courtesy of the Lincoln Electric Co., Ltd*

THE construction of the "Sea Otter II," a novel experimental cargo carrier developed by the U.S. Navy Department as an answer to the submarine threat, was made possible by use of electric arc welding, used exclusively in the fabrication of the hull and other steel parts. The welding equipment, and shielded-arc electrodes, were supplied by the Lincoln Electric Company Limited. It is hoped that large numbers of these ships, built in quantity production with arc welding, will break entirely Hitler's attempt to blockade this country.

This unusual vessel has undergone exhaustive tests by the American Navy Department, and represents an attempt to reduce shipbuilding to real quantity production by great simplification of the hull design, and by application of arc welding to speed up production. The tests were so successful that the Navy Department has formed a corporation to build this type of vessel exclusively.

Although the details of the ship, and the plans for utilisation of a fleet of them, if further tests prove successful, are, of course, secret, here are some interesting facts about the "Sea Otter II."

Welded Hatches

Originally, it was intended that the ships should have no permanent hatches whatsoever in the hull, to provide for admission and removal of the cargo. It was proposed that a new type of simple hatch cover was to be securely arc welded in place and cut off without danger to the cargo. Then it could be re-welded into place.

The ship test proved so successful that it was decided to use the ships on round trips, and the "Sea Otter II" and all future ships of this design will have permanent hatches but, it is understood, not of the conventional type.

The ship's 16 petrol engines also will be left permanently in the vessel, rather than taking them out and dismantling the ship, as had been first suggested. These changes all were made because of the extraordinary good results obtained in test runs.

Constructional Details

The first "Sea Otter II," which has a length of 250 feet, beam of 40 feet and depth of 21 feet, is of all-welded construction, employing strip steel from universal rolling mills. This requires no bending or rolling except at the bilges. The simplicity of the design, plus the fact that arc welding was used for speed and strength, permitted launching of the vessel in six weeks at a cost of £50,000. It is expected that this production time may be reduced still further if more ships are built. Produced in quantity, the cost should not be more than £30,000 each fully fitted out.

The main hull plates are of ⅜ in. steel, and the flat keel is constructed of ½ in. plates. The bottom side and deck plates are stiffened with longitudinal stiffeners. There are no transverse ribs or frames except intercostals, which are used to stiffen the longitudinals every ten feet. Nine transverse water-tight bulkheads were welded inside the hull.

The draft of the ship is 11 feet fully loaded, and it is thought that this, plus the fact that the "Sea Otter" sets relatively low on the water, and is far less visible than other types of cargo carriers, will make the ship a poor target for a submarine. It is well known that a torpedo must be set at a depth which insures its run being free of wave effect, or for ocean going setting considerably more than 11 feet.

The vessel in loaded condition is so low in the water that in heavy weather at sea her decks will be awash most of the time. Arc welded construction was utilised to enable the craft to withstand this strain, plus the shock of possible near-hits, better than other types of construction, because it has been proved that welded plates only buckle, rather than split at the seams.

Propelling Plant

The ship is propelled by 16 petrol engines of 110 horse-power apiece. These are arranged radially and coupled hydraulically, four to a propeller, the four propeller shafts descending vertically into the water in much the same manner as outboard motors, except that the transmissions are inside of cylindrical wells. The propellers are located just aft of amidships, and the motors and propellers may be lifted into the vessel for repairs while under way, and spare propellers and engines will be carried. The ship is equipped with degaussing mechanism for magnetic mine protection.

The ship has a cruising radius of 7,000 to 9,000 nautical miles, and a sustained speed of 12 knots. For short cruises, however, the vessel has sub-divided tanks to carry 95 tons of fuel, and will have a cruising range of 3,700 miles at 12 knots. She has a hold capacity of 122,800 cubic feet.

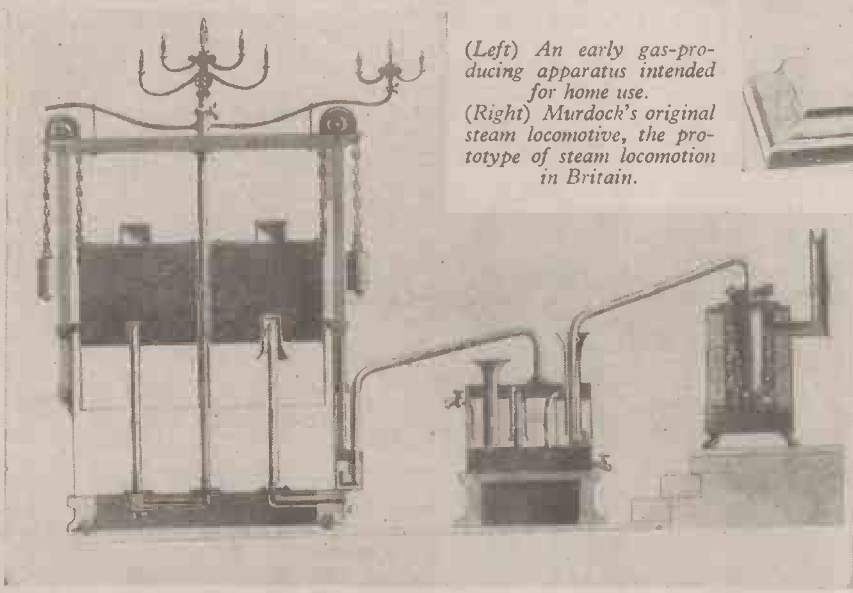
MASTERS OF MECHANICS

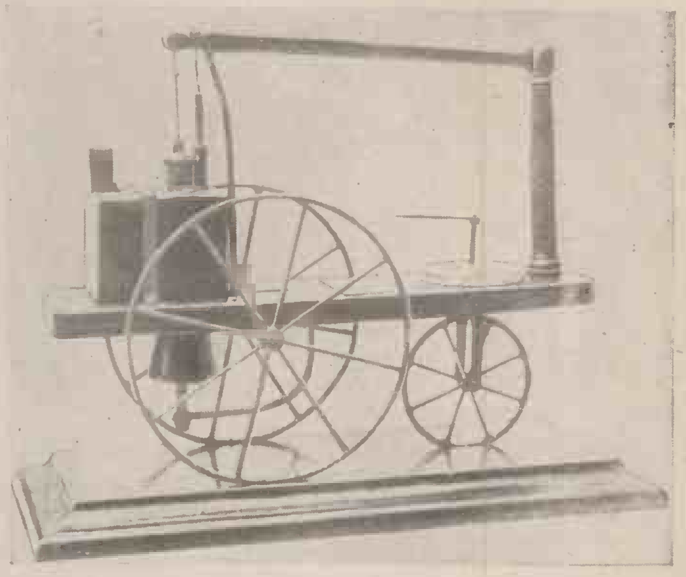
No. 73. William Murdock: Locomotive Pioneer and Inventor of Gas Lighting.

THE story of William Murdock, gas-lighting pioneer, constructor of the first working locomotive to be made in this country, and inventor of many important mechanical devices, is, to a large extent, a narration of the influence of a powerful and unscrupulous personality upon an individual of genius whose character was fashioned in a finer and a humbler mould.

James Watt, the self-styled inventor of the steam engine, stands before us as the domineering, unscrupulous personality. William Murdock, his trusted and loyal assistant, whose inherent inventive capacity and mechanical genius was of a far higher order than that of Watt, occupies the role of the very much "influenced" individual.

It is difficult to say what would have happened to Murdock if he had never met Watt.





(Left) An early gas-producing apparatus intended for home use.
(Right) Murdock's original steam locomotive, the prototype of steam locomotion in Britain.

Maybe, of course, he might never have arisen from the obscurity of his native village, but, on the other hand, there are many probabilities that he might have achieved fame in some other way, and that his inventive faculties might have been given a freer rein than they were under Watt's iron rule and jealous supervision.

William Murdock was born in an old farmhouse near Old Cumnock, in Ayrshire, in the year 1754. His father was a millwright at Bellow Mill, near by, and the youthful William, naturally enough, was put to his father's trade.

Arrived in his teens, however, the boy decided that the work of a millwright, with its unending routine and narrowness of outlook in those days, was a very uncongenial task. A few years later, therefore, he threw it up, and, shaking his native soil from off his shoes, he trudged slowly southwards, making his way to the then rapidly rising town of Birmingham, in which vicinity he had heard that there were many opportunities for young men who possessed mechanical abilities, and who knew how to use their hands as well as their heads.

Boulton and Watt

At that time, James Watt and his shrewd business partner, Matthew Boulton, were flourishing at their Soho foundry, in Birmingham. Murdock called at the Watt-Boulton Works and asked for employment. Watt was absent at the time, but the applicant was interviewd by Boulton. Noticing a very peculiar hat which Murdock, in his nervousness, continually twirled and twisted around in his hands, Matthew Boulton inquired of what material it was made. "Of timber, Sir," replied the young applicant. I turned it myself, Sir, in a bit of a lathe of my own making.

That was sufficient for the far-seeing Boulton. A youth who could make his own hat, even a wooden one, was a far different individual from the usual run of applicants, and he might be of use to the firm. Ultimately, Murdock found himself taken on at the Watt-Boulton foundry at a wage of fifteen shillings per week.

Murdock proved his mechanical abilities in a very short space of time. At first, he was employed merely as an ordinary "hand," but gradually his status in the factory was increased in responsibility. The young man showed signs of his innate mechanical genius in many ways. He seemed to have a knack of bringing the most difficult of repair and adjustment jobs to a successful conclusion. If anything new, unprecedented, or out-of-the-ordinary had to be dealt with on the workshop benches, or in the foundry, it was usually Murdock who was put on the job, or if he was not actually given the task, his advice upon the matter was frequently sought.

After two years at the Watt-Boulton factory, Murdock's wages rose to twenty shillings per week. By this time Watt and, still more, his partner Matthew Boulton, had well recognised Murdock's value not merely as a mechanic, but also as a respectful adviser on all engineering and mechanical matters. "William"—Watt invariably referred to Murdock as "William"—"William," remarked Watt, "is by far our most valuable hand. He is to be trusted."

Murdock began more and more to be sent out on repair jobs. His employers knew that if anybody could patch up an old and refractory engine Murdock was the man to do it. In time, nearly every Watt steam engine user who was experiencing trouble with his engine wrote in to the Soho works at Birmingham: "Do please send Murdock. He is the most competent engineer we know of."

Watt and Boulton had many pumping engines in Cornwall. In view of this, Murdock was eventually sent to the Duchy to take charge of them and to superintend repairs and replacements. Settling at Redruth, in Cornwall, Murdock took up his duties of mine-engine agent and engineer with great enthusiasm. So long as he remained in the neighbourhood, the Cornish engines were made to run without much trouble or involuntary stoppages.

Sun and Planet Gear

It was whilst Murdock was stationed at Redruth that he gave free rein to his inventive faculties. It is, indeed, to Murdock that we owe the invention of the "Sun and Planet" gear in which one gear wheel revolves around another in planetary or circular fashion. Watt would have liked to have claimed this invention (as he actually did many others) as his own. He did, in fact, occupy himself with preparing patent specifications for the sun-and-planet motion, and such an important mechanical principle was eventually taken over entirely by the Watt organisation.

In 1784, whilst at Redruth, Murdock constructed what was actually the first locomotive to have been made in this country, thereby anticipating the Cornishman, Trevithick, who obtained greater practical success in locomotive making. True it is that Murdock's "road carriage," as it was called, was only a model less than a foot in height. but it constituted a model which worked successfully, and it demonstrated the fact that a working locomotive impelled by steam power was a practical possibility.

Murdock's historic "road carriage" had a rectangular copper boiler heated by a spirit lamp. The locomotive ran on three wheels, the front one of which was utilised for steering purposes. The piston rod was coupled to a rocking beam, a connecting-rod from the latter descending to a cranked axle on the rear wheels. The cylinder had an effective diameter of three-quarters of an inch, the piston having a stroke of one-and-a-half inches.

Road Carriage Trial

The story of the trial which Murdock made with his locomotive is interesting, and a record of it made years afterwards states:—

> "At the time Mr. Murdock was making his experiments with his locomotive engine, he greatly alarmed the clergyman of the Parish of Redruth. One night, after returning from his duties at the mine, he wished to put to the test the power of his engine, and as railroads were then unknown, he had recourse to the walk leading to the church, situated about a mile from the town. This was rather narrow, but kept rolled like a garden walk and bounded on each side by high hedges. The night was dark and he alone sallied out with his engine, lighted the fire or lamp under the boiler, and off started the locomotive with the inventor in full chase after it. Shortly after, he heard distant despair like shouting; it was too dark to perceive objects, but he soon found that the cries for assistance proceeded from the worthy pastor, who, going into the town on business, was met in the lonely lane by the fiery-monster, who, he subsequently declared, he took to be the Evil One, *in propria persona*."

Doubts may be cast upon the essential veracity of the above account, and it has been—perhaps more reasonably—suggested that Murdock merely ran his locomotive model about in the room of his house. Whatever the truth of the matter may be, there is no doubting the fact that Murdock's invention at once aroused Watt's intense jealousy.

Watt, of course, had a business interest in all steam engines, and he disliked Murdock's dabbling in such inventions. Moreover, Watt imagined himself to be the sole inventor of the working steam engine. For anyone else, especially, indeed, for one of his own former workmen, to become an inventor, and to achieve fame and reputation, was a most) distasteful notion to Watt. But Murdock was far too valuable to the Watt-Boulton organisation to be discharged summarily. Consequently, gentler tactics were adopted by Watt to make Murdock give up his locomotive-inventing activities.

More and more work was sent to Murdock from the Birmingham foundry. The trustful Murdock was counselled to give up his "hair-brained schemes." Once, indeed, he did set out to London with his locomotive model with a view to patenting it, but he was met at Exeter by Boulton, who actually persuaded him to abandon the project and to turn back. Thus was an epoch-making invention side-tracked for a considerable number of years.

In 1799, Murdock invented the steam valve which is now technically known as the D-valve. This was used in the construction of Watt's "double-acting" engine, and it brought in much grist to Watt's ever-open business mill.

Advent of Gas Lighting

The beginnings of practical gas-lighting will ever be associated with William Murdock, for it was he who first demonstrated the practicability of utilising coal gas for lighting purposes. Long before Murdock's time it had been known that coal and other materials evolve an inflammable gas when they are strongly heated, and a few experiments in gas-lighting had been tried.

Murdock, however, in 1792, lighted up his Redruth house with coal gas jets. The coal was heated in an iron retort, and the gas was conveyed through pipes to the various rooms of the house. Murdock also constructed portable gas-holders, and there is now, in the vicinity of Redruth, a tradition that for many years he was to be seen walking along the lonely roads of that district at night with a lantern in his hand and a bladder full of coal gas held bagpipe-fashion under his arm, the bladder supplying the illuminating gas to the lantern.

From William Murdock's pioneer gas lighting experiments the enormous present-day gas-producing industry has directly descended. Here is a pair of modern gasholders, each containing thousands of cubic feet of coal gas.

In 1794, Murdock, being satisfied with the practical value of his gas-lighting system, visited his firm in Birmingham and urged Watt to take out a patent for it. Why Murdock failed to apply for the patent himself, and in his own name, will never be known. Watt, of course, on this occasion, refused to take any notice of Murdock's request, accounting himself far too busy to be occupied with it.

This time, however, Murdock protested against being put down so peremptorily. When, in 1798, he left Cornwall to take up residence in Birmingham, he lighted the works of Boulton and Watt with coal gas. Other factories, particularly in Manchester and in Leeds, were similarly illuminated. But this, however, is as far as Murdock ever went with his invention. The Watt-Boulton dominance was too powerful for his gentle and modest character to withstand. Consequently, the evolution of practical gas-lighting was left to other and freer hands.

Incidentally, gas-lighting did not come into existence without a struggle. People suspected it, resented it, and, to many, gas-lighting was the actual work of the Devil. The notion was prevalent that the gas was conveyed in a flaming state through the pipes, and when, ultimately, the Houses of Parliament were equipped with gas-lighting, the architect of the buildings gave strict instructions for the pipes to be placed several inches away from the walls for fear of the latter being burned!

The prejudice against gas-lighting is well illustrated by the following contemporary lines:—

> Must Britons be condemned for ever to wallow
> In filthy soot, noxious smoke, train oil and tallow,
> And their poisonous fumes for ever to swallow;
> For with sparky soots, snuffs and vapours, men have constant strife;
> Those who are not burned to death are smothered during life.

Gradually, however, mill premises in the Industrial North, and the London theatres and streets were lighted by coal gas. Gas companies arose and, little by little, the wave of intense prejudice against the employment of coal gas died away. Murdock lived to see gas-lighting universally used, but no credit was ever given to him for its practical origin.

In his later years, Murdock obtained a working interest in the Watt-Boulton company, but it was only a very subsidiary one. Still, he was made comfortable for life, and to the end he remained loyal to his old employers.

Application of Compressed Air

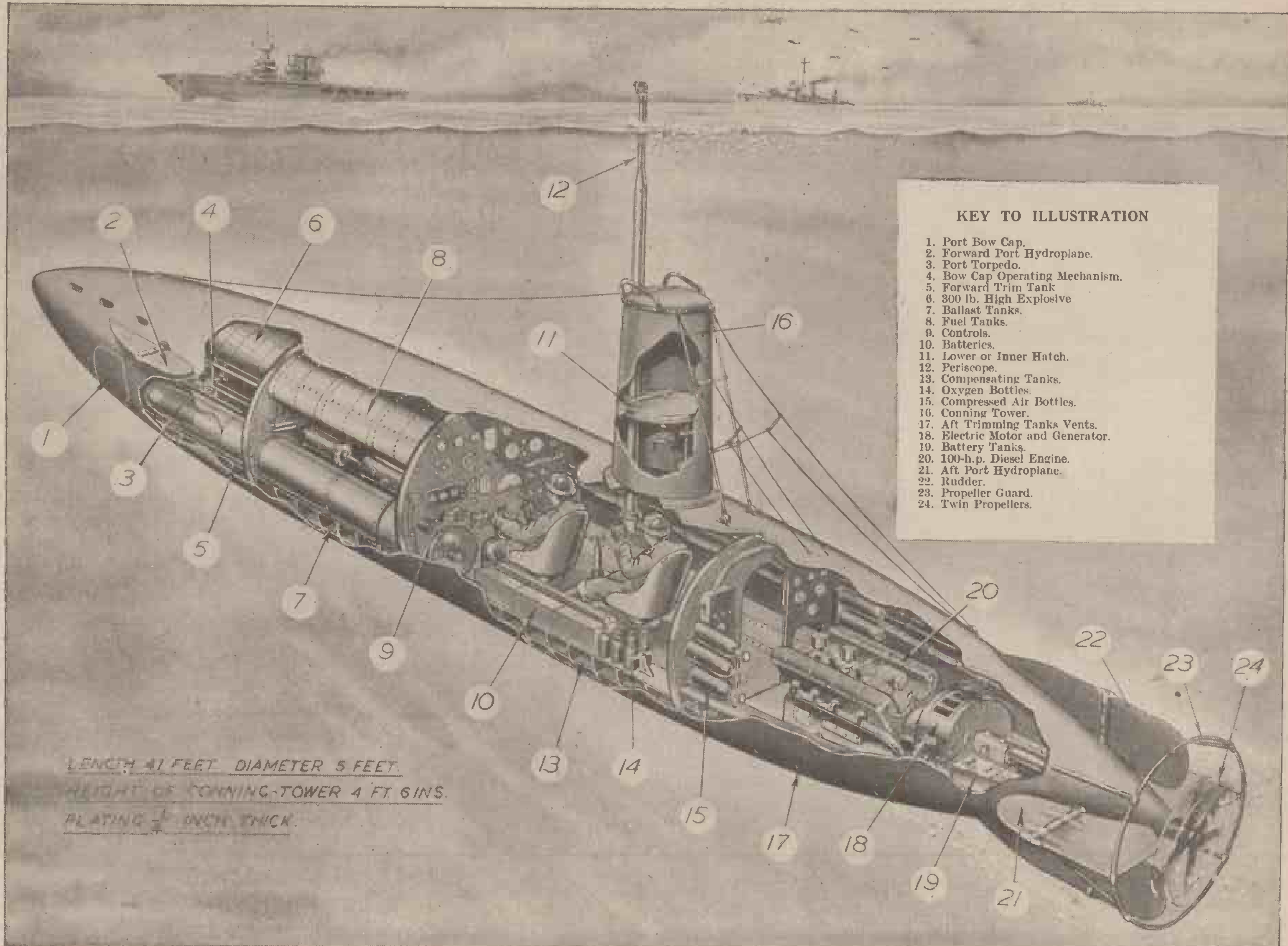
Among the many mechanical inventions and schemes which originated in Murdock's fertile mind was a system of conveying letters and packages through pipes exhausted by an air pump. This proved to be the forerunner of the old Post Office "Atmospheric Railway." Murdock invented cast-iron cement, he introduced compressed air as a motive power for machines and he carried out this latter idea to a successful conclusion. For ever inventing, designing, modifying and improving, William Murdock, taking all in all, led a happy and a placid life, the natural gentleness and urbanity of his temperament providing an effective foil against the meanness and the irritability of his master, James Watt.

A Strange Idea

The most curious scheme which ever ran in the mind of Murdock was an idea which he conceived for utilising the waste energy of the feet of animals and pedestrians as they walked along the roads and pavements of towns. Murdock assumed that a great waste of power occurs in all walking, and he dreamt of constructing roads upon the principle of a giant treadmill under which the waste energy abstracted from the feet of the walkers was to be, in some unexplained manner, stored up and subsequently utilised. It was, of course, only a dream, and perhaps Murdock himself recognised it as such.

Murdock ended his days on 15th November, 1839, at Handsworth, near Birmingham, having then reached the mature age of 84. During his lifetime his contributions to mechanical science were little thought of. We are able to regard the work of this pioneer with the truth-giving perspective of a century, and despite whatever else of interest we may perceive, it is becoming increasingly easy to recognise the fact that, although in those now distant days James Watt may have been very much the master, it was his humble employee, William Murdock, who constituted the genius.

PICTORIAL VIEW OF A JAPANESE TWO-MAN SUBMARINE, SHOWING INTERIOR MECHANISM



Sub-stratosphere Power

With Notes on the Possibilities of Steam Power for Altitude Flying

IT is a well-known fact that the density of air varies with altitude, and thus affects the performance of an aeroplane in several ways. If the atmosphere consisted of uniform air, as we know it at sea level, then its height would only be about 42,000 feet, whereas it has been established that not only does the air "thin out" at heights, but also its constituency is altered, and in some form or other extends upwards for about one hundred miles.

At sea level the composition of air is as follows:—

Nitrogen	78.03
Oxygen	20.99
Argon	.94
Carbon dioxide	.03
Hydrogen	.01

Neon, helium and niton, the remainder, together with infinitesimal proportions of the other inert gases. In addition, water vapour may be present to an appreciable degree.

With increasing altitude the lighter gases separate out from the heavier ones due to their density differences. Up to moderate altitudes the atmosphere is churned up and mixed by winds so that the sea level constituency is more or less maintained.

Composition of Air

Moisture ceases to exist above 33,000 feet, and for the purpose of this article can be ignored. An indication of the composition of air at various heights is given below:—

Altitude.	Nitrogen.	Oxygen.	Hydrogen.
330,000 feet ..	0%	0%	100%
215,000 feet ..	55.6%	4.25%	39.2%
150,000 feet ..	85%	14%	.05%
100,000 feet ..	84.4%	15%	.01%
50,000 feet ..	79%	20%	.01%
Sea level ..	78%	21%	.01%

More important to the aircraft engineer is the *pressure* decrease with height, affecting as it does the performance of both aeroplane and engine. Up to 40,000 feet the composition of the atmosphere has not varied much but its *density* has been reduced to approximately one-quarter of that at sea level (see table below).

Now remembering that density = mass/volume; mass = density × volume. Thus, the *mass* of air drawn into the engine at 40,000 feet is only one-quarter of that drawn in at sea level, so that there will be insufficient oxygen and, unless compensated for, the resulting petrol-air mixture will be badly misproportioned, and thus the power output is low. In fact, at this height, it is nil for a normal, unsupercharged engine.

Altitude.	Air density. Standard air density.	Output of normal engine
55,000 feet ..	.1057	—
50,000 feet ..	.1450	—
45,000 feet ..	.1930	—
40,000 feet ..	.2460	0%
35,000 feet ..	.3070	13.5%
30,000 feet ..	.3740	20%
25,000 feet ..	.4480	30%
20,000 feet ..	.5327	42%
15,000 feet ..	.6291	54%
10,000 feet ..	.7384	67.5%
5,000 feet ..	.8616	83%
Sea level ..	1.0000	100%

Supercharging

To overcome this loss of power, a supercharger is fitted which compresses the air before it enters the cylinders, thus increasing its density and maintaining the correct mixture. There is a limit to supercharging, however, for we cannot go on indefinitely compressing the air in order to maintain power. Already supercharger speeds exceeding 30,000 r.p.m. or 500 *revs. per second* have been used which imposes a considerable strain on the unit. Again, the supercharger itself must be engine driven and thus absorbs a certain amount of power.

It seems, then, that even with all the ingenuity of the modern engineers at our command that the internal combustion engine is becoming very inefficient at high altitudes and with the development of sub-stratosphere flying, this question is becoming of paramount importance.

The weight/h.p. ratio of a modern high-powered petrol engine is about 1.3 to 1.8 lbs./h.p., with a minimum of approximately 1 lb./h.p. The Bristol Pegasus approaches this lower value and has twice held the altitude record, first in a Vickers Vespa, and then in the Bristol 138A. In its latest form, the Pegasus XXII, it develops 1,010 h.p. for a total weight of 1,030 lbs. Corresponding values for aircraft diesel engines are slightly higher, the best being about 1.8 to 2.2. lbs./h.p.

With a supercharged engine we can say that the power remains constant up to the supercharging height, and then falls off proportional to the decreasing air density and pressure. The higher this supercharging height, the more work the supercharger will have to do. and thus the more "tricky" its design.

We find that the majority of engines are supercharged to give full power at quite moderate altitudes. The following are some typical examples:—

Napier "Dagger" ..	8,750 feet
Bristol "Mercury"	14,000 feet
"Merlin II" ..	18,500 feet

These, of course, can, and have been, modified for higher altitude work, in many cases the supercharging being carried out by "stages," but for an ordinary supercharged engine we will say that at 40,000 feet the power is only one-fifth of the maximum developed. This makes the weight/power ratio about 8 lbs./h.p.

Steam Engine Possibilities

Now let us consider briefly the case for the steam engine as a power unit for altitude work. The idea of using a steam engine is, of course, not new. Langley used them on many of his models towards the end of the nineteenth century, but found them too heavy then.

It should be possible to produce an effective steam engine *using the normal materials at present used for these types* with a weight/power ratio of about 10 lbs./h.p., operating at ground level. With the proper use of light alloys, this could be reduced to about 6 lbs./h.p., but so far such development appears to have been neglected because few people have been interested in the possibility of its application to aircraft work due to the generally presumed superiority of the internal combustion engine.

Now the decreasing density of air at altitudes *increases* the efficiency of a steam engine due to several factors. The following shows the temperature at which water boils at various heights:—

Height.	Water boils at deg. F.
55,000 feet	113
50,000 feet	120
45,000 feet	128.5
40,000 feet	137
35,000 feet	146
30,000 feet	157
25,000 feet	160
20,000 feet	174
15,000 feet	185
10,000 feet	193
5,000 feet	203
Sea level	212

Thus, the higher the altitude at which the steam engine is operating, the lower the temperature at which steam is formed and, due to the decrease in *atmospheric* pressure, the power output should increase with altitude.

Admittedly there are many disadvantages of the type but the author is of the opinion that many of these have been greatly exaggerated due to prejudice. The first, and obvious, objection is that a steam engine does not appear adaptable.

If you think of the steam engine as a massive boiler, tons of coal, heavy cylinders and pistons and masses of pipes and tubes, then it is agreed. It is not possible to take any existing steam engine and modify it for the job; a special type must be designed, or an existing *internal combustion engine modified and adapted*.

Basic Principles

Dealing with the basic principles only; we want a source of steam, i.e. the boiler and heater; the cylinders, pistons and reciprocating gear, etc., driving a crankshaft connected directly or indirectly to the propeller. The main problem will be in the heating system which will have to be a burner of some sort and will need oxygen. This may entail compressing the air again or carrying a small separate oxygen supply, but this effect is by no means as critical as in the internal combustion, remembering also that the boiling point is lowered with altitude.

The water will be used over and over again, i.e. turned into steam, fed through the engine, the "used" steam collected, condensed and returned to the boiler to repeat the cycle. A condenser of sufficient size to accomplish this would take the place of the normal radiator, and only a slight increase in size of this component is anticipated, about 25 per cent. as a maximum.

The whole engine should be smoother running since the "expansion pressure" in the cylinders is evenly supplied as opposed to the explosive charge of the internal combustion engine. This would result in a reduction in the wear of the moving parts with a longer useful life between overhauls.

The piping system carrying the steam would, of necessity, be of sturdy construction to withstand large pressures, and it is here that the metallurgist would be called in to produce a metal strong enough and yet reasonably light with a sufficient safety factor.

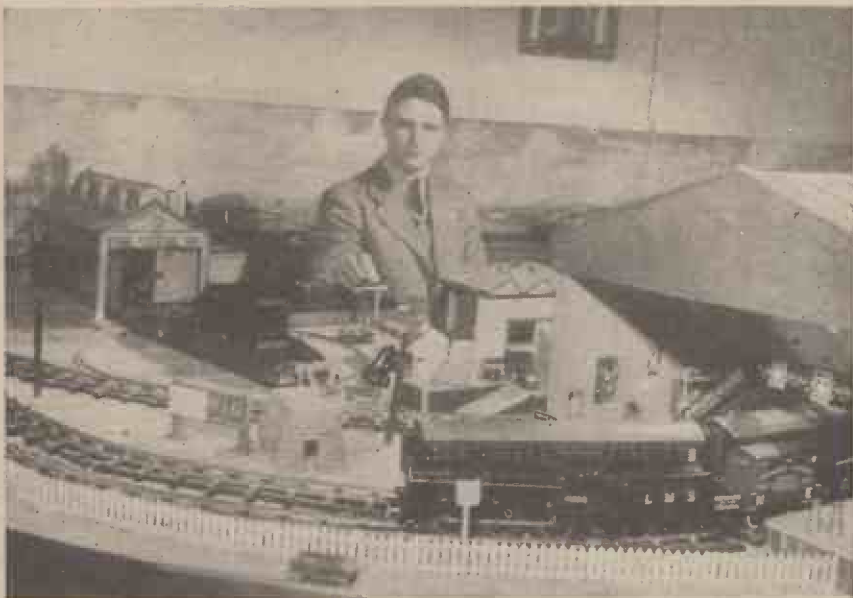
Power at low altitudes would probably be low compared with the normal internal combustion engine, with a relatively slow rate of climb, but progressive development should minimise this divergence. At altitudes of 30,000 feet or more, however, there should be a definite advantage to the well designed steam engine, increasing as greater altitudes are reached.

The author is of the opinion that a series of experiments carried out by modifying one of the existing internal combustion engines would prove of great interest, although these modifications would, of course, be extensive.

THE WORLD OF MODELS

By "MOTILUS"

A Realistic "O" Gauge Railway, and Miniature Ship Models



H. G. Hall operating his model railway. In the foreground is a railroad air-shelter, and also a Bren-gun carrier.

A Well-Planned "O" Gauge Railway

NORTHAMPTON is known throughout the world as the home of high-class commercially made scale models, and many of the town's inhabitants are model railway owners and keenly interested in model building. Among them I have discovered a young model enthusiast, who has himself, though still at school, carried out all the electrical work on his comprehensive gauge "O" railway.

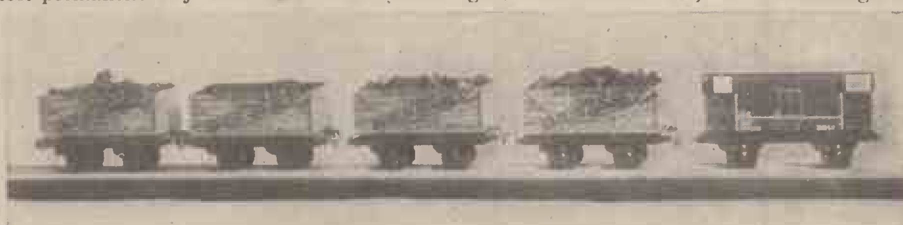
His name is George Hall, and his interest in model railways dates back to the tender age of five with his first gauge "O" railway—a Hornby with tinplate track—which he used to build up every holiday in a different shape!

The experience he gained from this "preliminary canter" was a great help when he decided to build a more permanent structure. His father, Mr. H. A. Hall, was all in favour of this, and one term while he was away at school, made the table and trestles for a much more elaborate layout, and directly his eleven-year-old son returned for the holidays he set to work to lay the track. This was five years ago, and at that time the Hall family were living at Wollaston, Northants. Since that time, every holiday, George has been adding something to the railway, and about a year ago his family moved to Northampton (and curiously enough, only a few doors away from the residence of Mr. W. J. Bassett-Lowke). Of course, the railway moved with them, this time to find a home in the garage, which has been converted into a splendid railway room and workshop for George who is now sixteen years old, and who has a decided aptitude for all things mechanical and electrical.

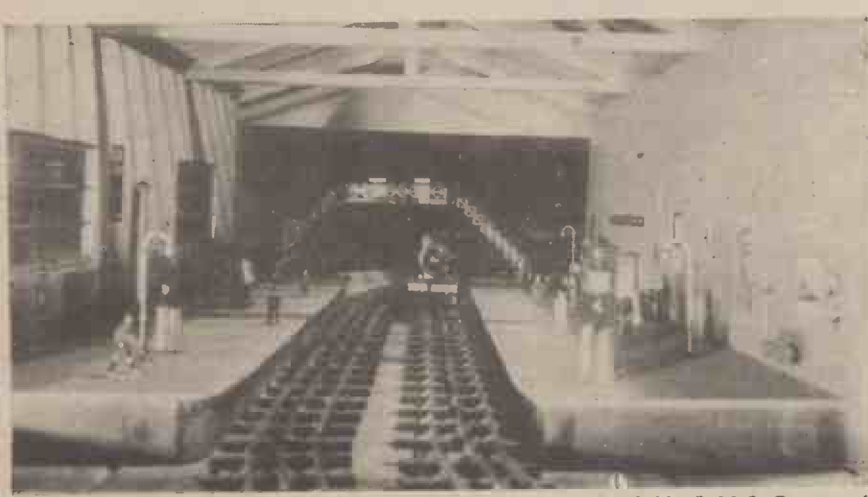
The present line, modified slightly from that at Wollaston, consists of 150 feet of track in an oval layout, laid in small scale sheradised steel permanent way with raised brass centre rail. It is run on a voltage of 8-10 d.c. from the mains through a TM.6 rectifier, and has three controllers, one for each main line and one for the goods yard sidings. The main sections of the track are colour-light signalled, except for the portion running along by the wall, which is controlled by the ordinary lower quadrant semaphores. There is an 8-lever frame for the semaphore signals and the colour lights are operated by switches. The owner has made several ingenious electrical contrivances on the railway. He has insulated the point rods with bicycle valve tubing, and has electrified the Bassett-Lowke turn-table by fitting a shoe to contact the outer circle and electrifying the central pivot. Both the signal box and the coal office light up, and the whole system has telegraph wires and posts—non-working this time!—which the owner has made and is at present wiring up.

His stock consists of an L.M.S. Compound locomotive (Bassett-Lowke), hauling a passenger train (mail van, two first class coaches and one brake third), an 0-6-0 Goods, an 0-6-0 Tank—both black—and a black Hornby tank, adapted to 0-6-0 Goods, with a B-L mechanism fitted by the owner.

A feature of the layout is the large through station built of wood, with a green roof set with glass panels and jokingly called the "greenhouse." A great deal of attention has been paid to the details, passengers ("distinguished" and otherwise) are on the platform, porters, booking office, book-stall, automatic machines—the fire buckets even are filled with sand. A present-day note has been introduced by the appearance of a Bren gun carrier on the road, and a camouflaged air raid shelter in the station goods yard which has been made very realistic with wagons, loading crane and goods of different kinds.



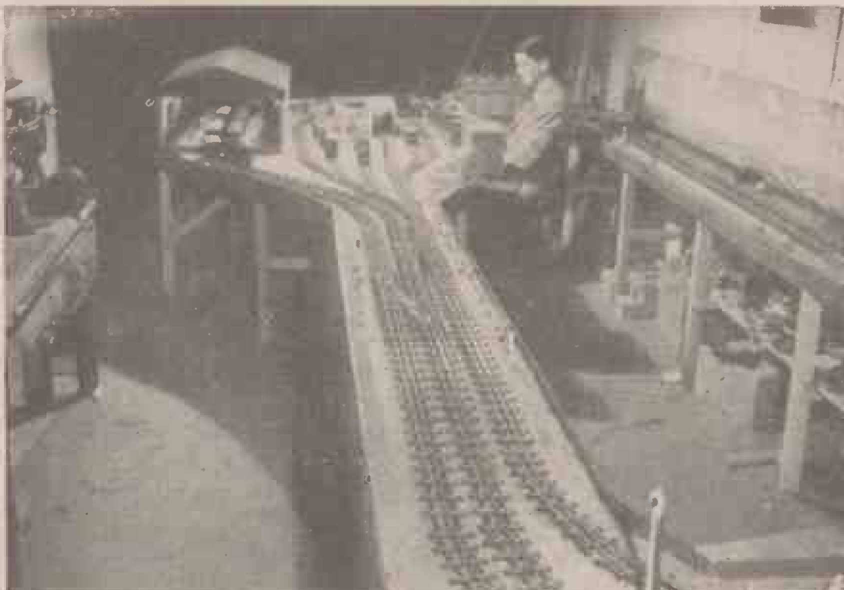
The T.T.R. private-owners wagon set offered at a special price.



The interior of the "greenhouse" station, with express entering, hauled by L.M.S. Compound.

Skirting one oval of the layout are attractively contrived fields with cattle, sheep, pigs, the farmer and his dogs, and also a cattle dock by the railside. The scenery along the wall blends with this, and following the track this way we pass through a wayside station, and further along a platelayer's hut with the platelayer himself hard at work. Other small details throughout the system are the distance miles and gradient posts. There is also real coal and wooden logs in the wagons.

The wall scenery was painted on roof sheeting by a poster artist, and the railway consists of L.M.C. track, and B-L and Hornby rolling stock and engines. There is still plenty to do on the railway, even in wartime, and the general appearance might be enhanced by the introduction of ballast on the track, but altogether it is neat in its construction, clean and tidily kept, and the operation by its owner is everything a model critic could desire.



A general view of the layout and terminus of H. G. Hall's model railway, showing the work bench on the left-hand side.

A Special Offer

Since the Government regulations came into force that no metal is to be used for toys, they have been getting scarcer and scarcer, and when in Bassett-Lowke's shop in High Holborn, the other day I suddenly realised I had never seen their shelves—even at the end of the last war—so empty of model railway supplies. Nevertheless, I was told their enormous stock at the outbreak of war has stood them in good stead and enabled their numerous clients to obtain, for a long time, their good, though necessarily limited, war service. I notice, despite the shortage, that they are making a special offer to Trix "OO" gauge owners of four of their Bassett-Lowke Private Owners wagons and a goods brake van, either L.M.S., L.N.E.R., or S.R., at the special price of 12s. 6d. the set, "over the counter" at London or Manchester, or post free from Northampton, *while* the supply lasts. The wagon offered is their well-known Private Owners design of standard dimensions, and the colouring is quite attractive, being lead colour with a slanting yellow band and the words Bassett-Lowke Ltd. in black.

Here is an opportunity for Trix fans who will welcome more goods rolling stock on their model lines, to represent the pressure on goods traffic on the real railways these days. They may like to try their skill at re-painting some of these wagons to their own Private Owners designs, but, out of courtesy to the firm making the offer, I suggest they leave one in the original B-L colours!

Miniature Scale Model Ships

The name of Winteringham should be known to some of our readers, especially to those who were interested in model railways round about the year 1900. About that time, Mr. George Winteringham, who was living in Hamble, Hants, and making a hobby of scale models, came to Northampton and with Mr. W. J. Bassett-Lowke, introduced to the model railway world scale model permanent way. This was originally produced in $\frac{3}{4}$ in. to the foot, and has ever since been a standard for this size. Later on, as the demand for smaller models became apparent, a smaller edition of this permanent way was placed on the market. This is $\frac{1}{2}$ inch to the foot, and is now used as a standard of gauge "O" up to $2\frac{1}{2}$ in.

Mr. Winteringham has a large family and most of his sons worked with him at Northampton in models in their younger days, served in the last war, and then went their various ways. The youngest son, Mr. Francis Winteringham, took to "fire fighting," and eventually became head of the Fire Brigade of the city of Leicester. Soon after the heavy blitzes on Birmingham, he was dramatically appointed to become head of the City of Birmingham Fire Brigade, which post he now holds.

You may ask where this preamble is leading, and what has this to do with models, but a love of models is evidently inherent, and the son of Francis Winteringham therefore, grandson of George Winteringham, is a keen and expert model maker. He is named Graham, and has been a Trix fan since the early days of the T.T.R. Gauge "OO" railway. He had a neat layout at his father's Leicester home, but since his parents moved to Birmingham, he has stayed on in Leicester to study for examinations at the Leicester School of Architecture. He has recently taken up the modelling of "OO" gauge road vehicles, and as his railway is in Birmingham, has interested himself in all types of models. He says: "Apart from my railway, which is still running very well, for the past eighteen months I have been making scale model water-line ships. I make them to a scale of 100 ft. to an inch. I find this an ideal scale, just big enough for much detail, and small enough for easy storage for a fleet. So far I have built 47 ships, with a range from tugs to the Queen Mary, and from naval auxiliaries to the Ark Royal. I have made the Ajax and Achilles, and several other famous warships. In 1940 I entered fourteen warships for a Leicester exhibition—the "Sir Jonathan North Competition," and won a bronze medal along with a guinea's worth of books. This was ample reward for my very interesting labours, for apart from about sixpennyworth of wood

A model battleship, and a full-rigged ship—the work of Graham Winteringham.

and pins, they cost me nothing.

Apart from this type of modelling I have made models of one or two of the designs I have produced at College. The most successful was one of a Day Nursery, which was constructed of Bristol board."

A photograph of this Day Nursery, superimposed on the plan and elevation of it, appears in the brochure of the Leicester College of Arts and Crafts—School of Architecture—and has the distinction of being the only First Year student's work reproduced. Graham is working very hard for his exam. now, but the few spare moments he does get are devoted toward the further development of either his Merchant or Royal Navy.

A.R.P. Instruction Train

I wonder how many of our readers know of the A.R.P. Instruction Train shown in our illustrations here. The first demonstration of this was given before the outbreak of war—in June 1939 at Waterloo. It is a small but efficient two-coach train, escorted by a squad of specially trained railwaymen, strangely garbed but all ready to meet any emergency.

The Southern Railway A.R.P. train.

The Truth About James Watt

Seldom-told Facts Concerning the So-called "Inventor" of the Steam Engine, showing that he was a Cheat, a Thief, and a Swindler, and without Knowledge

It is not infrequently the case, as Mr. Bernard Shaw has justly remarked, that lies are printed as history for two or three centuries until they become accepted as fact.

In no instance more than in the official history of James Watt, and his connection with steam engine development, is the truth of this dictum being made plainly evident as the result of modern research into the origins of steam power in Britain.

Pick up any textbook on the social, economic or industrial history of our country, refer even to standard treatises on engineering pioneers. In every instance you will find James Watt, the "inventor" of the steam engine, exalted almost to the status of a national hero. Without Watt, we are led to believe, steam power in Britain, at least during the latter quarter of the eighteenth century, would have been non-existent. Watt, indeed, is held out by nearly all authorities to have been engineering's master-mind, to have constituted a born genius, a brilliant mechanic, and an able scientific theoriser whose chief aim in life was to benefit the Nation through the industry which he set up. To most textbook writers, Watt is the noble Scot, gentle, ingenious, magnanimous, self-effacing, a veritable paragon of scientific and philosophical virtue and, withal, an historic benefactor to the world at large.

Inaccurate Information

That is the official view of Watt's character which has been built up upon countless text-books, and histories, all copying one another, and all originally derived from inaccurate and untrue information contained in the early biographies of James Watt.

The new research into engineering and industrial history, however, brings a different light to bear upon James Watt and his activities. So far from characterising him as a natural genius and an apostle of scientific truth and honesty, it mercilessly shows him up as a despicable rogue, as a hypocrite, and a scheming impostor, whose innate powers of mechanical construction were but feeble, a man who relied greatly upon the counsels of his equally nefarious business-partner and who, with him, by methods which were as contemptible as they were relentless, not only exerted a stranglehold on steam-engine development in this country for a quarter of a century but, in addition, hounded down and ruined every inventive individual who dared to devise any type of improved engine operating by steam power.

The true story of James Watt has never yet been written in full. It is naturally impossible to give a detailed narration of Watt's many crooked activities within the confines of this article. All we can do in this instance is to afford the reader some indication of Watt's Gestapo-like methods.

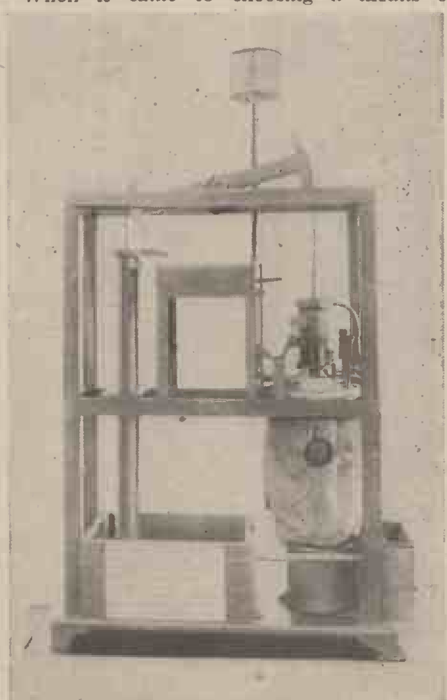
The "official" details of Watt's life are well known, and are to be found in any text-book dealing with the history of invention, and related subjects. He was born at Greenock on January 19th, 1736, the fourth child of a certain James Watt who was employed in the local shipbuilding yards.

Watt's parents were honest and thrifty folk, both the father and the mother being persons of rather unusual ability. But, somehow or other, the fourth child, James, developed into a sickly lad, unhealthily shy, and one who anxiously sought to avoid all human society. James Watt the younger grew up, it would seem, with a grudge against the world and against everyone in it. His schooling was not productive of any particularly good results, although he did well at mathematics.

James Watt

At Glasgow University

When it came to choosing a means of livelihood, Watt determined to become a mechanic. At the age of 18, in 1754, he went to Glasgow to learn the trade of a mathematical instrument maker. He was placed under an "optician" in that town, a jack-of-all-trades, who made spectacles, repaired spinets and harpsichords, sold fishing-rods, and made the simpler drawing instruments. Watt, however, did not get on well in Glasgow, feeling unsettled in that town. He, therefore, decided to try his fortunes in London, and in the following year he made the journey to the Metropolis on horseback. It was only with difficulty that he found a place as an apprentice in London, and he appears to have done so badly in this venture that he was back again in Glasgow at the age of twenty.



An illustration of the actual Newcomen engine model associated with Watt in his early days at Glasgow.

The Glasgow University authorities, at the instance of one or two influential patrons of the Watt family, offered James Watt a cellar to use as a workshop. Thus Watt became "instrument-maker" to the University.

It is in this situation that Watt's connection with the steam engine began. In passing, it may, perhaps, be desirable to emphasise the ridiculous nature of the well-known legend relating to Watt's supposed steam engine inspiration after contemplating the dancing of a kettle lid under the action of the steam in the kettle. This fanciful story of Watt's youth, in common with the myth concerning King Alfred and the Cakes, and the seashore episode of King Canute, is merely the product of school textbook writers. It definitely has no basis of fact, for Watt did not begin his dabblings with steam power for at least ten years after the date ascribed to the kettle story.

Newcomen Model Engine

In his position of instrument maker to the Glasgow University, Watt was supposed to attend to all the mechanical models in the possession of that seat of learning. The University possessed but few models, but it did own a model of a Newcomen atmospheric engine which was used occasionally for lecture demonstrations.

The Newcomen model got out of adjustment. In this condition it was given to Watt for repair. Watt tried his hand at the task, but he never managed to get the model working properly. It would merely give a few strokes of the piston and then come to rest. This fault, Watt ascribed to the mode of condensing the steam under the piston, whereby the latter was driven down into the cylinder by the pressure of the external atmosphere on the upper side of the piston.

Watt hit upon the idea of facilitating the action of the Newcomen model by fitting it with a separate condensing chamber connected directly with the underside of the piston. The steam was condensed in this chamber which was separately cooled. This, in principle, constituted Watt's "steam engine." It was merely Newcomen's engine (invented in 1710) with a separate steam-condensing chamber added. The engine was not a steam engine in the true sense of the term, for the piston was driven downwards in its cylinder by the pressure of the external atmosphere, the function of the steam being merely to create a vacuum under the piston as a result of its condensation. Furthermore, the engine was totally incapable of giving rotary motion.

Nevertheless, Watt was shrewd enough to make as much as he could out of his "steam engine." With the aid of a few Scotch friends (Scotch "fellosophers," as old William Cobbett, the English reformer, was wont to call them) a model was made and a patent specification was evolved. **Despite the fact that the Watt patent specification contained the most appalling rubbish, and made the most ludicrous of claims; in spite of the fact that the only mention of any working part of the engine was implied in the word "pistons" ("the force of steam to press on pistons or whatever else may be used instead of them"), the Patent was granted to James Watt on 5th January, 1769.**

It is obvious that the Patent Office of the day never gave much consideration to the claims of Watt and his partners, otherwise they would never have allowed such unutterable rubbish to bear the official stamp of sanction, for Watt's patent of 1769 consists merely of a series of headings without any description of parts or components, and no indication whatever of any definite steam engine construction is contained therein.

Legal Protection

Armed with legal protection, Watt's next move was to link up with Mathew Boulton, a Birmingham manufacturer, who, for the greater part, acted as his business manager and adviser. Mathew Boulton was an influential man. He had friends in high quarters and he was shrewd enough to see that there was money in Watt's "invention," provided that it was handled in the right manner. Watt, a weakling by nature, allowed himself to be controlled by Boulton, who, recognising the manner of man that Watt was, formed a closer association with him in order to further his own ends.

About this time, other inventors were beginning to bring out steam engines for use in mines. Particularly was this the case in Cornwall, where the famous family of Hornblowers had become recognised as the leading engineers of the tin-mining Duchy.

Another individual, a clergyman named Gainsborough, had invented a steam engine, but Watt opposed Gainsborough's specification at the Patent Office, and thus countered this inventor.

Watt was not slow in realising that he was not the only individual associated with the development of steam power. Hitler-like, he determined to put down all opponents. Although his 1769 patent had never been worked, and in spite of its still having eight more years to run, Watt and his friends applied to Parliament in 1775 for what he called a "prolongation" of his Patent. He actually introduced into Parliament his own Bill, which had been devised to give him an absolute monopoly of steam power in virtue of his absurd (and illegal) patent of 1769, the appeal to Parliament being made "for such time as may enable him to obtain adequate recompense for his labour, time and expense, and to the end that James Watt may be enabled and encouraged to prosecute and to complete his invention so that the public may reap all the advantages to be derived therefrom to the fullest extent."

Scandalous Monopoly

Although many members of the House voted against Watt's monopoly Bill, it was forced through, and on 22nd May, 1775, the Act was made law and received the Royal Assent. It gave to Watt the complete monopoly of steam power for a period of 25 years.

Of this scandalous monopoly, Watt took every possible and unfair advantage. "Our patent is as safe as an Act of Parliament can make it," he declared.

Between 1780 and 1800, Watt compelled the payment to him of about £210,000 in engine-taxes from the Duchy of Cornwall alone. This colossal imposition, of course, placed a great strain on the financial stability of the mines, with the result that many of them worked at a loss or ceased working altogether. The Watt taxes were applied to all kinds of engines, the tax on any large engine with a 5 ft. diameter cylinder being upwards of £2,600.

Naturally, Watt attacked the Hornblowers in Cornwall with his greatest ferocity. Jonathan Hornblower-the-younger invented, in 1781, a direct-acting "compound" steam engine in which the downwards pressure of the steam operated the piston. Hornblower patented his engine. Watt's next move was to try to counterfeit Hornblower's engine, which he did in a very impracticable manner. He patented his version of Hornblower's engine in July, 1782, and, when so doing, actually had the audacity to declare that this new patent of his constituted the "complete specification" of his original 1769 patent, which, as regards moving parts of the engine, mentions only the word "pistons."

Thus Watt assumes, for the second time, the role of steam engine "inventor." His engines (made in Birmingham from cylinders bored by John Wilkinson, a noted ironfounder), proved inferior to the Hornblower engines. In one particular instance, a Hornblower engine, under conditions of practical test, showed a 66 per cent. superiority over a Watt engine of equal size.

Unable to conquer Hornblower by the imposition of excessive engine taxes, Watt resolved to liquidate his rival in the courts. Hornblower applied for an extension of his patent. Countering this application, Watt put in the appeal to the effect that: "Messrs. Boulton and Watt are unable to continue silent spectators or to permit an infraction to be practised so injurious to their just rights; they therefore undertake to prove, by competent evidence that Mr. Hornblower's engine is a direct and palpable plagiarism of Mr. Watt's invention."

A "direct and palpable plagiarism" of an engine from which the Watt engine of 1782 had been directly copied! The audacity of Watt's claims, and the manner in which they were put forward is truly astounding, for had the Patent Office known its own business, Watt's "invention" of 1782 should never have received patent rights, since it was definitely copied from the Hornblower model.

Sought to Ruin Hornblower

Watt and his faction were successful in their countering of the Hornblower patent extension. This was their first direct attack on Hornblower. Watt's major attack on the Hornblowers came in 1796-99, when Jonathan Hornblower was accused of infringing the Watt patent. After Hornblower's application for an extension of his patent term in 1792 had been refused, everything was set against this heroic pioneer. The Hornblower patent had actually expired in 1795, and in the following year, the Watt faction began their case against the unfortunate Hornblower. Watt gathered together a small army of "experts"—astronomers, poets, medical men—who vouched for the perfectly ludicrous Watt patent of 1769 with its sole mention of "pistons." Hornblower pleaded his case almost alone and unaided. Yet he had one distinguished individual on his side. This was the great Joseph Bramah, the mechanician and inventor, who actually, in 1797, published a specially printed address to Lord Chief Justice Eyre, who was trying the case. Bramah, an essentially practical man, demonstrated the absolute absurdity of Watt's claims, and his "Address" contained a most damning critical analysis of the original Watt patent specification upon which the whole of the scandalous Watt steam engine monopoly was based. Bramah also protested against the "expert" witnesses who gave evidence at the trial.

The Watt interests, however, were all-powerful and the verdict against the Hornblowers was practically predetermined. The Hornblowers were financially ruined by Watt's persecutions, and Jabez Hornblower was even sent to prison through not being able to pay debts incurred through Watt's taxes.

In 1799, Watt drew up the terms of another Parliamentary Act with a view to getting his monopoly further prolonged. He even tried to get a Bill passed forbidding the use of steam pressures in excess of 6 lb. per square inch. Watt had a horror of steam pressure. He considered 3 lbs. per sq. in. an ample pressure, and he was amazed when, even in 1781, he found that Jonathan Hornblower was using 14 lbs. per sq. in. steam pressure.

Very fortunately, Watt's second projected monopoly did not come to pass. Neither did his attempted restriction of steam pressures. In 1800, the Watt incubus passed, leaving Cornwall enormously the poorer for Watt's "benefactions" and Watt himself enormously the richer for his activities.

During his mature years, the chief aim of James Watt comprised the acquisition of money. For riches, particularly in those days, meant power. And Watt sought power (not merely steam power) equally as he strove after wealth.

Entertaining Royalty

Whilst James Watt was grinding down engineers in Cornwall, and exacting his iniquitous taxes, he was at the same time entertaining Royalty (British and Foreign) at his Soho foundry, near Birmingham. Like his partner, Mathew Boulton (who had some educational pretensions), he wormed his way into the august Royal Society, becoming one of its Fellows.

Watt believed that a steam locomotive would never be successful. He chided his own foreman, William Murdock, for attempting to make one, and he subsequently endeavoured to wreak his vengeance upon the brilliant Cornish inventor, Richard Trevithick, for devising a runabout steam engine.

Watt also dabbled in chemistry, and he claimed to have discovered the true composition of water, and with such success that even to this day Watt's claims in this respect have never definitely been ruled out.

Watt, of course, throughout his life, was a sick, ailing and a melancholy man. Yet he was an individual possessed of relentless energy. He was essentially a copyist by nature, and as such he may be held up as a unique example to posterity.

He died on 19th August, 1819, aged 82, and was buried in Handsworth Church. Honours galore were showered upon him during his later life, and even after death he has been accorded numerous monumental honours, ranging from the large statue of him in Westminster Abbey, to the innumerable representations of his features which are to be seen elsewhere.

There are no books which give the true history of James Watt. But one day, such a volume will appear. And its author (if he is not ostracised) will possibly be hailed as something of a hero, since, no matter how great one's basis of truth may be, it still remains a task to convert a traditional inventor gifted with alleged genius and nobility into a mean-spirited scoundrel, an incorrigible copyist, and an inveterate kleptomaniac, all of which epithets describe very accurately the character of James Watt, the self-styled and so-called inventor of the steam engine.

The Story of Chemical Discovery

No. 12. Tracking the Movements of Molecules.

THE science of colloids has attained a very high importance in our generation. For not only has the study of the colloidal state given us a greater insight into the still unravelled mystery of the constitution and the inner meaning of matter, but it has, in addition, reacted to a surprising extent in the economic and industrial sphere. Entire industries nowadays operate in the domain of colloids, and the number of manufactured materials which are colloidal in nature is being increased every year.

What exactly is a colloid? Such, indeed, is a very justifiable query for the reader to put, but since, in this series of articles, we are following the historical development of present-day chemical marvels rather than their mere technical details, we had best, before entering more deeply into the subject, go back to the days of Thomas Graham, the Victorian scientist, who, during the course of a lifetime of patient work, devoted almost exclusively to the elucidation of physico-chemical problems, worked out the basic details upon which the present edifice of colloid chemistry has since been reared.

Graham was a Scotsman who went to London and became Master of the Mint.

Ever a scrupulously accurate, conscientious worker, he became one of the "Fathers" of physical chemistry, particularly in view of the fact that he consistently exercised his energies and genius upon problems of a most fundamental nature.

Graham's Early Years

Born in comfortable circumstances in Glasgow on December 21st, 1805, his father being a prosperous manufacturer, Thomas Graham, after his earlier years of school training, entered the University of his native city at the early age of fourteen. Five years later he graduated as a Master of Arts of Glasgow University.

It was the intention of Graham senior that the youth should enter the ministry, but Thomas Graham, even although he had obtained a degree in Arts, had other views. So strong a love had he for the natural sciences and, in particular, for chemistry, that he perforce had to range himself against his parent's expressed wishes. The difference in opinion between father and son terminated in an estrangement and a separation, the father refusing to make the son any allowance whatever.

Thomas Graham, therefore, was left to struggle almost alone. He left Glasgow and went to Edinburgh where, aided by his mother's support, he continued his studies in physics and chemistry. Here he also found a little literary occupation, and the income from this avocation, together with the returns which he derived from sundry teaching duties, enabled him to live in a very frugal manner for the next four or five years, during which time he continued his studies in physics and chemistry.

In 1829, Graham was appointed Lecturer in the Mechanics' Institution at Glasgow, and in the following year he received the more important post of science lecturer in the Andersonian Institution which was then so famous in that city. This position he occupied for seven years. Then came his election as Professor of Chemistry in the University of London (now University College), an appointment which, so far as the scientific world was concerned, placed Graham "on the map" once and for all.

He had by no means rested upon the benefits of a well-earned position during his stay at the Andersonian Institution in Glasgow. During his period as lecturer there he had begun to found certain fundamental principles which were subsequently to make his name famous in chemical history as the originator of an entirely new department and branch of that science.

Study of Gases

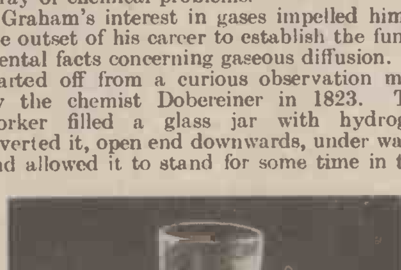
Graham was always more interested in what we may call the physics of chemistry rather than in actual chemical processes themselves.

Thomas Graham

For example, he found himself very strongly attracted by the study of gases because, as he rightly considered, matter is simplest in its gaseous condition, and in that state it is easier to attain a true appreciation of atoms and molecules than it is with any other form of matter.

To a large extent Graham extended the pioneering work of old John Dalton, the modern-world prophet of atoms. He began where Dalton left off and when, eventually, he went to London as Professor of Chemistry, he enriched the science by a remarkable period of vigorous investigative work which opened up new paths and shed fresh light upon a wide array of chemical problems.

Graham's interest in gases impelled him at the outset of his career to establish the fundamental facts concerning gaseous diffusion. He started off from a curious observation made by the chemist Dobereiner in 1823. This worker filled a glass jar with hydrogen, inverted it, open end downwards, under water, and allowed it to stand for some time in that position. After a time, Dobereiner noticed that the water had risen to some extent up into the jar. A minute scrutiny of the jar disclosed the fact that a tiny crack existed in it, through which, Dobereiner considered, the hydrogen gas had escaped. The jar was afterwards filled with other gases—oxygen, nitrogen, carbon dioxide, and so on—but, curiously enough, these gases did not show any tendency to escape in the way that hydrogen did.



"Dialyzing" a solution of iron hydroxide—a simple process of colloid chemistry

It was in 1831 that Thomas Graham began his investigation of the peculiar energy shown by hydrogen gas in escaping through an almost invisible crack in the walls of a glass vessel. In general, he studied the passage of gases through minute apertures, and by means of apparatus which he designed, he found himself able to study the rates of *diffusion* or the passage of gases through porous plates and other permeable bodies. He found that the rate at which a gas passes through a porous partition is inversely as the square root of its density.

Graham had now, in his mind's eye, formulated a true picture of what a gas essentially consists of. He saw a volume of gas as a space occupied by innumerable molecules, each endowed with a perpetual motion, and each molecule darting madly about here, there and everywhere in an entirely haphazard and fortuitous manner in much the same way as a cloud of midges may be observed to perform their unceasing gyrations on a fine summer's evening. Graham saw that a gas *in mass* cannot pass through a solid body, no matter how porous it might be. He perceived that the gas must only pass through such a body molecule by molecule.

The lighter a gas, the more rapid is the motion of its particles or molecules. It is for this reason that the lightest gases (hydrogen is *the* lightest of all gases) escape through or *diffuse* through a porous medium very much more quickly than do the heavier gases.

Diffusion of Liquids

Following up his experiments on the diffusion of gases, Graham turned his attention to the diffusion of liquids. He made a large number of experiments with the object of finding out the exact rate at which a dissolved salt in an aqueous solution diffuses through various porous media. Graham regarded the dissolved particles of the salt in the water in much the same manner as he regarded molecules of a gas. He visualised the dissolved salt particles as darting to and fro in their watery medium and endowed with an energy akin to that possessed by the gaseous molecules. Hence, thought Graham, these dissolved particles should pass through a porous partition or membrane with at least some of the facility characteristic of the gaseous particles.

Patient experiment with even the simplest of apparatus proved Graham's suppositions to be correct in many instances. He found that a large number of dissolved salts would pass through permeable membranes such as parchment and porous pot.

The experiment which Graham made the most use of is one which can be copied by any interested reader. A cup made out of softened parchment is suspended in a vessel of clean water. The parchment cup contains a solution of a salt, say, potassium bichromate. Very soon, the water in the outer vessel will be coloured yellow, showing that some of the dissolved bichromate has actually passed through the parchment walls into the surrounding water.

Crystalloids and Colloids

Graham found, however, that not all apparently dissolved substances possessed this property of passing through permeable membranes. All crystallisable substances, such as common salt, potassium sulphate, copper sulphate, etc., when dissolved, passed through a porous membrane, and to all such substances Graham gave the name of *crystalloids*. To those materials which either refused to pass through a similar porous membrane or which but passed through at a very slow and incomplete rate, Graham imparted the name of *colloids*. This appellation he coined from the Greek word *kolla*, meaning "glue," because most of these difficultly diffusible substances investigated by Graham were jelly-like in nature, much resembling glue.

One of the commonest of colloids—glue swelling up under water

To the simple arrangement of a porous membrane surrounded by or immersed under water, such as the one above-mentioned, Graham gave the name of *dialyser* (from Greek words meaning "to loose"), the process carried out therein being termed "dialysis."

According to Graham, all or most substances could be divided up into two great classes, *crystalloids* and *colloids*. This assumption we now know to be incorrect because it is possible to obtain even highly soluble salts (which Graham called *crystalloids*) in a condition almost glue-like or colloidal. Hence, nowadays, it is not correct to speak of the colloidal *form*, but rather of the colloidal *state*, for the colloidal state or condition is one which a large number of varying substances can be made to assume.

In 1854, Thomas Graham received the important position of Master of the Mint, succeeding Sir John Herschel in this post. Until 1860 he became completely engaged with the detailed duties of his new office, but after the latter year he again returned to his studies in molecular chemistry, and it was during this portion of his career that he introduced into chemical science the conception of the colloid.

Graham worked incessantly, and his holidays were few. Gradually his health failed, and ultimately he died of pneumonia on September 16th, 1869.

Ultra-microscope

The science of colloids made but little progress after Graham's death until the invention of the ultra-microscope, an instrument which views ultra-microscopic particles in a beam of light.

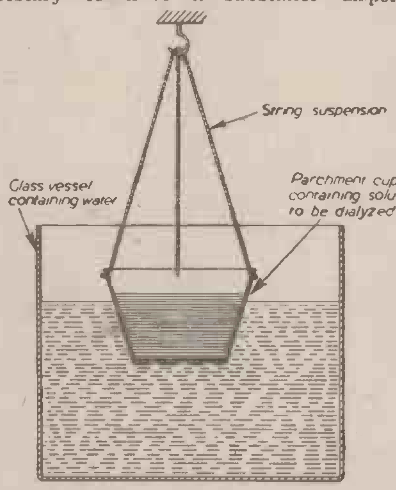
Then it was found possible to form some estimate of the sizes of colloidal particles between the limits of a ten-thousandth of a millimetre (0.1μ) and a millionth of a millimetre ($1\mu\mu$). A new terminology relating to colloids gradually came into use. We may distinguish between an ordinary solution and a colloidal solution, but nowadays the latter is more usually known as a *sol*. There are two substances in a sol, and the one which is continuous is called the *dispersion medium*, whilst the one which is distributed through it is known as the *disperse phase*.

Consider, for instance, a colloidal solution of iron hydroxide. The whole liquid material is known as the sol. The water is the "dispersion medium," whilst the iron hydroxide is termed the "disperse phase."

A sol of this nature is very easy to make. Add to a solution of iron chloride a few drops of ammonia. This will form a reddish-brown precipitate of iron hydroxide. When no more of the hydroxide is precipitated, add a few drops of hydrochloric acid, which will dissolve the iron hydroxide. Now pour this solution into the inner cup of the previously mentioned "dialyser" and allow it to stand for several days surrounded by water, the latter liquid being changed frequently. During this time, the non-colloidal portion of the solution will pass through the parchment membrane, leaving in the inner container a true colloidal solution or "sol" of iron hydroxide. This is sometimes used in medicine under the name of "dialysed iron." If the almost blood-red iron sol is allowed to stand for some weeks it will become jelly-like.

Later Experiments

Subsequent work after the time of Graham has shown that, in the colloidal state, it is not necessary to have a substance dispersed through a liquid medium. In fact, a colloidal "sol" may, strictly speaking, be either liquid, solid or gaseous, whilst the dispersion medium, also, may comprise any of those three states. Thus, for example, many coloured minerals comprise one material colloidally dispersed or scattered through a continuous "dispersion medium." The colouring of glass is, also, another example of this phenomenon of a "solid colloidal solution," coloured glass being due to the colloidal dispersion of extremely minute metallic or oxide particles through the "dispersion medium" of glass.



A simple form of "dialyser," or apparatus for the making of colloidal solutions.

A gas which is colloidally dispersed through a liquid generally gives rise to froth or foam, whilst a solid dispersed through a gaseous dispersion medium assumes the form of smoke or fine atmospheric dust. Furthermore, one liquid can be colloidally dispersed throughout another liquid, the result being termed an "emulsoid" in contradistinction to a "suspensoid," which consists of a solid colloidally dispersed throughout a liquid dispersion medium.

Electrical Problems

Thus the study—and the terminology—of the colloidal state has proceeded from small beginnings until it has reached the status of an important science. Apart from its many commercial applications, the study of the colloidal condition of matter is still proceeding, because it is found that many obscure electrical problems are associated with it.

For example, the colloidal particles in a "suspensoid" (i.e. a solid colloidally dispersed through a liquid) are all electrically charged in a manner which is not clearly understood. Nevertheless, this charge is essential to the stability of the colloidal suspension, for if the charge be neutralised in any way, the colloidally-suspended matter at once comes out of suspension, and settles down to the bottom of the containing vessel. The electrical precipitation of smoke particles and atmospheric dusts is, of course, a commercial application of this principle.

Matter in the colloidal condition is matter which presents a maximum amount of surface area, and it is precisely in view of this truly enormous surface area that the whole of colloidal phenomena depends. Colloidal matter is finely-divided matter. It is, indeed, matter in its finest possible state of sub-division. But it is, also, matter which is fraught with many peculiar and, as yet, incompletely discovered possibilities.

Many writers nowadays use the term "colloid" as a euphemious cloak for assumed mystery. There is, however, nothing mysterious about a colloid. Regard it merely as non-soluble matter which is extremely finely-divided and which, by reason of its fine division, has many unusual attributes. And occasionally, too, cast a thought backwards at Thomas Graham, the Scotsman Mint-Master, who, through endeavouring to track the movements of molecules, stumbled upon the colloidal state and thereby founded that which, in the eyes of many scientific workers, is still one of the most fascinating and promising branches of modern chemistry and physics.

Condensation in Anderson Shelter

IN our September 1941 issue we published an enquiry from a reader concerning condensation trouble in an Anderson shelter, and in connection with this subject we have received the following information from two other readers:—

"A good dodge is to obtain some waterproof glue, and paint the inside metallic surface, and then obtain some cork dust like grapes are packed in. Scatter it thickly over the surface while it is still tacky. This is a practical idea which is used in the electrical trade to combat the condensation in metallic substation kiosks. The glue should be painted on fairly thickly for best results."

John F. Carr (Horley).

"I cured my Anderson shelter of the same trouble by giving it several coats of white paint; to get the first coat on, I had to wipe down as I painted. The next thing (which should have been done first) was to remove the soil from over the entrance, and exit, and place some sheet iron to keep the soil (on replacing it) away from the corrugations to allow the passage of air from the interior. No moisture has accumulated since, and the surface is perfectly dry."

F. Thornton (Leicester).

Radiant Heat in Industry

A Brief Description of a Paint Drying System Developed by the General Electric Co., Ltd.

THE recent announcement that the R.A.F. has now reached parity with the Luftwaffe is one of the indications that the bottlenecks of production are being gradually reduced.

Though many industrial operations can be speeded up by mechanical means, and others by the sheer concentration of human effort, there are still some processes, mostly those which rely on physical and chemical reaction, that demand some fundamental change in procedure before appreciable progress can be achieved. The drying of the various kinds of paints and varnishes used in industry has always presented a special problem in peacetime, and in a time like the present this problem has, naturally, become much more urgent.

For Paint Drying

With the solution of this problem and, of course, the removal of another bottleneck to industry, as the ultimate goal, the Research Laboratories of The General Electric Co. Ltd., have continued pre-war investigations into the application of radiant heat from incandescent filament lamps to paint drying and kindred problems. Naturally, these investigations have been biased towards those applications that have a special significance in relation to the war effort.

Fig. 1. The Osram radiant heat lamp is of 115 volts, 250 watt rating.

Though it is perhaps a little early for a complete explanation of the mechanics of drying by radiant heat (that must await post-war research), the results achieved to date show that the system is essentially practical. The convenience, economy and flexibility of the system are firmly established, and the reduction in heating and drying times which it has so far effected are, in some instances, most remarkable. The high rate of heat transfer which can be obtained from radiant sources is, no doubt, the factor which distinguishes it fundamentally from convection methods of drying.

Fig. 2. The gold-plated reflector with adjustable focussing device giving narrow or wide beam projection.

The salient features of drying or heating by radiant heat are—

(a) The drying period is extremely short; much shorter in many cases than is achieved by enclosed convection ovens.

(b) Objects to be dried can be more quickly raised to the correct temperature than by any other method.

(c) Because of the shortened drying time, the space which has to be devoted to the drying process can frequently be substantially reduced. An important point in factories seeking for means of increasing output.

(d) Since the heating of the materials or part is practically independent of the air temperature, free circulation of air can be effected, resulting in the rapid dispersal of the volatile constituents of the paint, and the elimination of the gas pockets which may be so troublesome in enclosed ovens.

(e) Many industrial processes necessitate the special heating of articles such as pre-heating at one temperature and baking at another, or the heating of different parts of the same article at different rates. Where these conditions exist, the flexibility of the radiant heating system has many times demonstrated its superiority over convection ovens.

(f) Heating a convection oven from its cold state at starting or maintaining the temperature before a new charge can be inserted requires a considerable amount of energy. With radiant heating, the full heating effect is obtained immediately the current to the lamps is switched on.

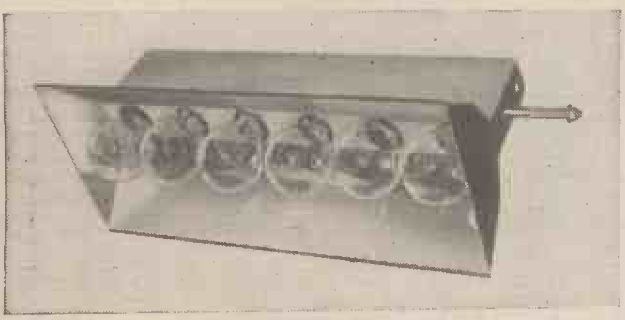


Fig. 3. Gold-plated trough reflector providing concentration of radiant heat in small space.

Infra-red Rays

The radiant energy, or infra-red rays from incandescent filament lamps can be controlled and directed much in the same way that light rays are controlled, i.e., by means of suitably designed lamps and reflectors, and to this end the G.E.C. has produced special lamps and reflecting equipment possessing the required characteristics.

The Osram Radiant Heat Lamp (Fig. 1) is of 115 volt, 250 watt rating, and is operated at a temperature which ensures a satisfactory performance under most working conditions. The low voltage filament makes really robust construction possible. On 230 volt supplies, two lamps may be operated in series.

Two types of fitting have been designed for controlling the heat radiation from the lamps: (a) a shallow circular reflector (see Fig. 2) with adjustable focussing giving either narrow or wide beam projection; (b) a trough reflector (Fig. 3) which will accommodate six lamps so that concentration of radiant heat can be achieved in small space and with a minimum of equipment. A feature common to both types is the gold-plated reflector surface which not only ensures a high factor of reflectivity, but also tends to reduce maintenance costs, since the surface is highly resistant to corrosion and can be readily cleaned.

Complete Drying Plants

Although these fittings are the only two to be standardised at the moment, the G.E.C. has erected several complete drying plants at the Research Laboratories. These plants are flexible in design and are capable of being adjusted to suit a wide variety of possible conditions obtaining in industry. Thus, many industrial problems may be considered each on its merits, and suitable equipment accordingly designed.

One of these installations is composed of two banks, each comprising forty-eight 250-watt Osram Radiant Heat Drying Lamps set in circular and focussing type reflectors. (Fig. 4) The total consumption is 24 kw. One can readily appreciate the potentialities of the system and the intense concentration of radiant heat that can be achieved the moment current is applied to the lamps.

Fig. 4. One of several radiant heat plants installed in the G.E.C. Research Laboratories.

QUERIES and ENQUIRIES

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

Winding Motor for 230 Volts

CAN you tell me what gauge of wire I will require and from where it may be obtained (also the quantity) for re-winding a small 12-volt series motor so that it will run off the 230-volt A.C. mains? The armature contains seven coils each of 45 turns. The field, two coils each of 110 turns.—B. Terry Aspin (Wrexham).

THE re-winding of this small motor, having a 7-slot armature 1$\frac{3}{8}$ in. diam. by $\frac{5}{8}$ in. long, for 230 volts instead of 12 volts is hardly to be recommended, owing to the small number of commutator segments and the excessively fine wire it would require. The present gauges of armature and field wire as samples enclosed with your enquiry measure 0.014 inch diam. and 0.026 inch respectively, and correspond approximately with No. 27 and No. 22 B. & S. gauge, both of which are easy sizes to handle. If you attempt to re-wind to run direct on a 230 volt circuit, you will need to employ No. 44 S.W.G. for the armature and No. 38 S.W.G. for the field wire. The armature will be an extremely difficult job, and owing to the few sections there will be a great deal of sparking at the commutator. It will be far preferable to obtain a small step-down transformer reducing the 230 volts on the A.C. mains to 12 volts as originally, and repeat the original winding of 45 turns per coil and 7 coils for the armature, and 110 turns and 2 coils for the fields, with Nos. 27 and 22 respectively. The estimated weight of wire required would be 2 oz. for the armature, and 6 oz. for the field coils.

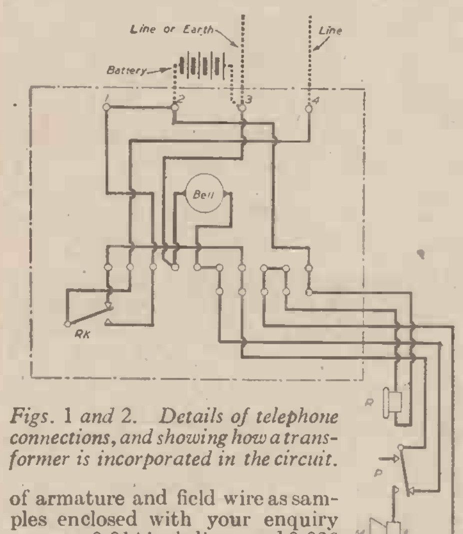
Telephone Connections

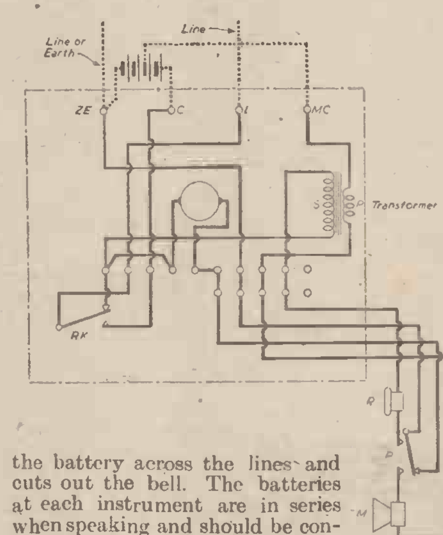
CAN you tell me how to wind up the two telephones as per sketch enclosed? What battery voltage should be used for a distance of about 500 yards, point to point? Also, could I fit a transformer in each for greater distance, say half a mile? What are the connections to different phone terminals marked Nos. 3 and 4 on the sketch?—Eric Shawforth (Belford).

SLIGHT modification of the baseboard wiring of the telephones marked 1 and 2 in your diagram is advisable. An amended diagram for each instrument is shown in Fig. 1 of the accompanying sketches. The essential points are that the bell should be connected across the lines when not in use, the ringing key connects the battery across the lines, whilst pressure on the key marked P in sketch connects microphone and receiver in series with the battery across the lines and cuts out the bell. The batteries at each instrument are in series when speaking and should be connected so that their voltages add together and are not in opposition.

The size of batteries to be used depends on the size of line wires and also the resistance of the bells (not stated). Using a 14 or 16 S.W.G. copper wire for the line, a 6-volt battery at each instrument will probably be ample for ringing the bell. If this voltage is found to be rather high for clear speech, the connection between terminals 1 and 2 (Fig. 1) should be removed, and the battery connected between terminals 1 and 3; taking a lead from terminal 2 to a suitable low voltage tapping between the cells.

Fig. 2 indicates revised connections using a transformer in each instrument. A suitable size of transformer would be one having a primary winding resistance of 1 ohm, and a secondary winding resistance of about 25 ohms.





Figs. 1 and 2. Details of telephone connections, and showing how a transformer is incorporated in the circuit.

Speed Regulator for Motor

I HAVE a small electric motor (particulars given below) which is of foreign manufacture, and has a starting resistance which is burnt out.

Could you give me length, make, size, etc., of insulated wire to use for starting purposes?

Starter: Six studs. Motor: $\frac{1}{8}$ h.p.

A.C. and D.C.: 240 volts.—T. E. Wood (Gateshead).

A 6-STUD starter and speed regulator for a motor rated at 1/8th h.p. 240 volts universal D.C./A.C. type would require about 300 ohms total resistance, divided into five steps of 60 ohms each, and consisting of No. 26 S.W.G. "Eureka" enamel covered resistance wire. This wire has a resistance of 2.14 ohms per yard, so that approximately 140 yards are necessary, say $\frac{1}{2}$ lb. in weight. It can be obtained from the London Electric Wire Co. Ltd., 24 St. Annes Gate, Westminster, London, S.W.

If a very wide range of speed control is desired, the above resistance must be increased, but with motors having "series" speed characteristics which depend entirely on the load for the moment no rule can be laid down, but that of trial and error, unless the conditions of loading are accurately known.

Removing Boiler Scale

CAN you inform me if there is anything which will remove the fur formed inside a small domestic boiler, due to hard water? I propose removing the boiler to carry out this job, and I wondered if caustic-soda solution or some similar chemical would have any effect on the scale to be removed.—W. H. Griffin (Hayes).

IF you are going to remove the boiler for the purpose of de-scaling, you will find nothing better than actual scraping of the inner sides of the boiler. If, however, this is not possible, put in a few spoonfuls of caustic soda and add boiling water. Allow to stand, and swill out with fresh water. Repeat this process several times, and the scale will be removed.

Caustic soda is usually the basis of all "boiler compositions." If you use a dilute solution of it, it should be possible for you to remove the fur or scale from the boiler without actually taking the latter down. Merely add a little of the caustic to the boiler system water and heat the boiler. Do this several times, flushing out with fresh water after each treatment.

Rewinding a Motor

I HAVE an electric motor working on 200/230 volts, 1.3 amps, 50 cycles, r.p.m. 2,500. There are 27 slots in the armature and 54 segments on the commutator. As there are two wires to each segment, I assume that it is duplex wound. The armature has been burnt out and I shall be glad if you will give instructions for re-winding it for use on 250 volt mains.

Also, could you tell me if there is anything I could use to remove the insulating varnish off of the existing wiring? I have tried methylated spirits, amyl acetate and acetone without success. Are there any books published dealing with the subject of armature winding for small motors?—A. Jayes (Hinckley).

IT is almost impossible to give an accurate winding specification when all details as to size of armature in diameter and length have been omitted. It would appear that the motor would be intended to give between 1/6th and ¼ h.p. on a 200/230 volt circuit running at 2,500 r.p.m. in which case the armature would be about 3¼ in. diameter by 2 in. long, and a suitable winding will be 54 coils each containing 26 turns per coil of No. 28 S.W.G. d.s.c. copper, grouped two coils per slot and connected to a 54 part commutator. Presuming the fields are correctly wound and free from faults, they will be series-connected with the armature. About 1 lb. of wire is needed for the armature, and the whole process of winding, forming and assembling the coils and connecting to the correct commutator segments is explained in detail in "Practical Armature Winding," by A. H. Avery. It is too wide a subject to be dealt with in a letter of advice. Varnished coils cannot be softened down if they have been in use for any length of time; it is easier to saw through the end windings and pull each coil out of the slots by force.

Moulding Powders

I WISH to procure moulding powders able to resist a 250 centigrade open glass-flame heat of approximately 3-4 minutes. I am desirous of forming such powders into a paste, moulding same cold or luke-warm under pressure into small tubes, the material to have 1.2 mm. to 1.5 mm. thickness, afterwards letting it "harden" in its own time.

What suitable powders are there to resist such heat and yet not be brittle but hard and tough? I was thinking of asbestene powder, and some sort of silicious earths, or ceramics. What liquids are best suitable to mix ultimately used powder ingredients into a paste? As I wish to work a cold process, I am not interested in bakelite powders, as this requires hydraulic presses and expensive moulds.—A. Behrman (London, N.W.).

APART from bakelite and similar thermo-setting resins, there are no suitable materials which will exhibit the characteristics you require.

The nearest preparation which we can suggest is calcined magnesite mixed to a paste with a solution of magnesium chloride of 40 per cent. strength. This sets in 24 hours to a hard, enduring, tough mass, but the product is somewhat brittle. The material is very suitable for accurate moulding, for it slightly expands on setting, thus ensuring a perfect pattern of the mould.

Before moistening to the consistency of butter with the magnesium chloride solution, the calcined magnesite may be mixed with up to 50 per cent. of any inert filler or pigment. For this purpose, asbestos powder is very useful, since its fibrous nature gives added strength to the final product. Fine sand is also good, but not silicious earths such as kieselguhr, since these latter tend to "dry" and mix too thoroughly.

Thermo-electric Effect

CAN you inform me if lead and nickel bars when placed together in series and warmed up produce an electric current, and if so, how much? Also, can you inform me where I can obtain metallic sodium, and metallic potassium, and the price of it?—B. France (Hitchin).

WHEN a nickel bar and a lead bar are placed in contact at one end, the opposite ends not being in contact, and when there is a temperature difference of approximately 100 degrees Centigrade between the contacting and the non-contacting ends of the bars, the current generated by each pair of bars is of the order of approximately 0.00246 volts. This, of course, is a very small current. It can be increased by increasing the temperature-difference between the free and the contacting ends of the bars.

You cannot obtain metallic sodium or potassium from any retail druggists' shops. You can obtain these metals from any firm of laboratory suppliers, as, for example, Messrs. Becker & Co., Hatton Wall, London, E.C., or from Messrs. Brandson & Reynolds, Ltd., Leeds. Messrs. Harrington Bros., Ltd., Oliver's Yard, City Road, Finsbury, London, E.C.1, would also be able to supply small amounts of these metals, and it should be possible for you to order them direct from Boots Pure Drug Co., Ltd., of Nottingham, through your local branch of Boots the Chemists.

Sodium and potassium are somewhat dangerous metals to store and to handle. They are normally kept under naphtha, since they could cause a dangerous fire if they were allowed to come into contact with even a trace of water.

The retail price (pre-war) of sodium metal was 2s. 6d. per lb. (in lb. lots). The price of potassium metal (which is much dearer) was 3s. per ounce.

THE Cyclist

Editor: F. J. CAMM

VOL. X MARCH, 1942 No. 241

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Phone: Temple Bar 4363

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Comments of the Month By F. J. C.

Modernise the Rules

REPORTS which we have received from various District Councils concerning matters discussed at their Annual General Meetings indicate very clearly the strong opinions felt throughout the country concerning certain of the rules which govern the sport. These discussions were provoked by the proposal to set up a Trust Fund which would be created by deferring the award of prizes until after the war when the Fund would be disbursed to the various prizewinners in the form of prizes. There seems to be much to commend this idea because at the present time many of the items from which prizes are selected are either in short supply, or no longer available.

Cups, Trophies and Medals

Cups, trophies and medals are now difficult to obtain, and as from January 1st of this year, no item of gold can be manufactured beyond those made in 9 carat. But the exploratory discussions at Annual General Meetings indicated very clearly the flaws. It was pointed out that there would be considerable difficulty in tracing the prizewinners after the war. Some of them may not return and there would be the difficulty of handing the prize to the next of kin. Chiefly, however, the scheme drew attention to the rule which defines what can be awarded as a prize. The general guiding principle seems to be that it must be something which is engravable. It must not be a cycling accessory, nor an item of cycling clothing. The thought of awarding money in lieu of goods during the war seems to have shaken the foundations of cycledom, for, in this cleanest of all sports, anything which savours of money is unclean. It is professionalism which, for some reason we have not been able to discover is regarded as unclean. There are those who think that because a man after a long period as an amateur turns professional, he changes from the lillywhite and pure amateur to the scheming avaricious earner of coins, and he is popularly supposed to be quite unscrupulous and to be without care as to the methods he adopts to gain the money.

Professionalism

Now, we are well aware that many years ago professionalism was definitely unclean. The trade in the early days of the sport were keen to advertise the successes of riders using its wares, and there was great rivalry between the various firms. Some of them spent thousands of pounds each year on trade supported riders; many of them had, in the days when such was permitted, teams of professional pace makers, and there are many well authenticated stories of nefarious practices in order to ensure that a particular team won. In fact, the riders themselves would "pull their punch" in a race in order to let their rival team win, of course, sharing in the spoils on an agreed percentage basis This led to the anti-advertising cause in road sport, but it has not entirely eliminated the possibilities of a man receiving trade assistance *sub rosa*. It is well known that amateurs receive tyres and accessories "free of charge" in return for the advertisement which the use of an accessory by a well-known rider brings to its maker. The trade has long ceased to place any value upon time trials as a means of drawing attention to the merits of particular bicycles. The fact that a Classic Event is won by a particular make of bicycle will not sell one extra machine. And so we have now reached a stage where we need no longer fear that the nefarious trade practices of the past would bring the sport into disrepute. That rule could quite conveniently be relaxed, especially as it is so easy for the rule to be broken.

Rule Evasion

A rule which cannot be enforced is a bad rule. For example, a man may not allow his name to be used in connection with any particular make of bicycle if he wishes to maintain amateur status. This rule can easily be evaded by using a chain wheel, a pair of front forks, or some other feature of a particular design which can only be associated with one maker. The rule concerning the use of inconspicuous attire by racing cyclists is another absurdity which reeks of the moth ball, antimacassars, and narrow-mindedness of the Victorian era, and of those who lived in it. Many cyclists, indeed, still live in it. Why there should be opposition to shorts we do not know. Certainly they are less conspicuous, as is pointed out elsewhere in this issue, than tights, which at present are specified to avoid drawing public attention to the fact that the cyclist is racing!

Committee Meetings

Then, on the question of prizes, the rules are out of joint. There is no valid reason why a cyclist should not be allowed to have a cycling accessory or an item of cycling clothing as a prize. In fact, there is less chance of the amateur rule being disobeyed, than if the cyclist chooses some item from a jewellers which is promptly handed back to the jeweller after the prize-giving in exchange for less cash than the club paid for it. We agree, therefore, with the suggestion that it is time that all National bodies overhauled their rules to bring them up to date. There are loopholes in many of them, and omissions in all of them. For preference, such a Committee should be formed of those not associated in official capacities with any existing organisation, to avoid any possibility of arriving at a solution representing a mixture as before.

Committee Meetings are confidential. How can they be kept so when one man may serve on perhaps three Committees? He will naturally import into debate views and opinions expressed by other Committees on which he serves. Some of the bodies are not independent bodies, whilst members of their Committee are permitted to have plurality of office.

Many of the rules could be omitted, and the whole framework of cycle sport simplified. At present, the rules are too cumbrous, so that many are honoured in the breach rather than in the observance.

Appeals to National Bodies should be heard by independent tribunals with the Committee as respondents to the appeal. They should not be allowed to sit as judges.. That is a defect in constitution which recent litigation has illumined.

The Tyre Shortage

ALTHOUGH it is still possible to obtain certain tyres they are not so readily available as hitherto. It therefore behoves every cyclist to take more than ordinary care of the rubber shoes with which his machine is shod, and to examine tyres which have been discarded because of some small defect. Carefully pick out any flints which have buried themselves in the tread, carefully filling any of the larger incisions with tyre stopping. See that the tyres are inflated to their correct pressure, remembering that it is better to run them over-hard than too soft. A more frequent examination of the treads to remove the tiny flints which in time cause tyre failure is necessary. In this way tyres will last for several more thousand miles.

Cycle tyres, if the casings are good, can also be retreaded for a small cost. If you have worn covers with good casings, it is as well to put the retreading in hand now, for firms undertaking this type of work are now overwhelmed. Your local cycle dealer will undertake to get the work done for you.

Without Comment

MR. S. INGLEBY ODDIE (late Coroner for Central London) states in his book "Inquest," "I must confess I am terrified of young lads on push cycles. They tear about swiftly and silently, and only too often are utterly regardless of the safety of either themselves or other people. And apart from the contemptuous disregard they so often show for all the rules of the road, their chief danger lies in their speed and their silence. When we rode a penny-farthing bicycle nearly 60 years ago, we all carried a little jingling bell which gave audible warning of our presence. . . . If such a device were carried on pedal cycles to-day there would be fewer accidents in our streets."

Blitzed Spaces for Bike

THE leading general chain stores have been asked by the National Committee on Cycling to consider whether they can provide cycle accommodation for the protection and storage of customers' cycles. The Committee are also exploring the possibilities of using for the same purpose spaces now cleared by the demolition squads.

Paragrams

Ex-Champions Promise Come-Back

JACK TAYLOR and Jimmie Berwick, two ex-Scots champions, promise a come-back this year.

Bicycle Receiver Gets Imprisonment

AT Falkirk Sheriff Court recently, a receiver of stolen bicycles was sentenced to two months' imprisonment.

Polo Star in Army

ANDREW DUNCAN, of the Royal Albert C.C., one of the hardest hitters in pre-war Scots bicycle polo, is now serving in the Army.

Champion Climber Released from Army

HARRY GARDINER, for six years almost unchallenged as a Scots hill-climber, has been released on medical grounds from the Army.

For Those in Forces

JOHN MILLER, the Dagenham cycle dealer, has again presented N.C.U. diaries to serving members of his old club, the Royal Albert C.C.

For the Duration

OFFICIALS of the Ayr Road Club have been elected for the duration, or until called up. The club intends to run off six club events for the club championship.

Increased Charge at Scots Hostels

IT is possible that in the near future the charge for an overnight stay at a Scottish youth hostel will be raised to 1s. 6d. from 1s. for members over 21 years of age.

Stole Cycle to Go Abroad

A SOLDIER told the Biggleswade magistrates recently that he stole a bicycle and committed other offences so that he would be sent to serve abroad.

More Light Needed

THE West of Scotland Cyclists' Defence Committee has decided to support the National Committee on Cycling's plea for improved front lighting for cyclists.

Saved From "Ark Royal"

PETTY OFFICER JACK MILTON and Stoker Alec Saunders, formerly of the Letchworth C.C., and the Nomads (Hitchin) C.C., were amongst those saved from the Ark Royal.

Escape by Bicycle

ANOTHER story of a war-time escape by bicycle comes from Malaya, where Mrs. Donald McLeod, wife of a mining engineer, ended a trip on a "borrowed" bicycle from Thailand.

Pedestrian Crossing Turned Down

BECAUSE it might give pedestrians a false sense of security, a proposal to place a new pedestrian crossing on the Great Cambridge Road at Edmonton was abandoned.

Road Records in Scotland

THE Road Records Association of Scotland is not calling an annual meeting this year. There were no record attempts in 1941, and officials and subscriptions stand for the duration.

No Damages for Cyclist

AT Carlisle recently, Judge Allsebrook decided that the owner of a terrier puppy which ran into the front wheel of a bicycle, throwing the rider into the road, was not guilty of negligence.

Hostel Beds in London Area

AT the end of the 1941 financial year, there were 759 beds available in the hostels of the London Regional Group, compared with 746 a year previously, and 1,382 at the peak at 30th September, 1938.

Clarion Clubroom Closes

CLYDESIDE Clarion members have wound up the affairs of the Clarion Cyclists' Fellowship, an organisation founded four years ago to provide headquarters for Clarion members in Glasgow.

Hamilton Secretary Married

GEO. H. RANKIN, honorary general secretary of the Hamilton C.C., was married last month to Miss Catherine Macdonald. R. J. Campbell, ex-time trials secretary of the club, acted as best man.

New Issue of Ordnance Maps

THE Ordnance Survey Department is proceeding, despite previous reports to the contrary, with a limited re-issue of one-inch maps. Apart from stocks held by booksellers, these maps have been unobtainable for a year.

Interest in Bucks

BUCKINGHAMSHIRE magistrates are now taking more interest in lightless cyclists. For instance, the Princes Risborough magistrates have stated that they will take a more serious view of cases involving lightless cyclists in future.

Successful Racers' Reunion

A "RACERS' Reunion," held recently at Dunblane youth hostel, Perthshire, was a great success, some 50 Scots time triallists attending. The speedmen use the hostel for sleeping during the time trials season, and attended the reunion at the invitation of the hostel warden.

Tricycle Boy Offered £3 Per Week

BOYS and girls riding carrier bicycles can now obtain high wages owing to the shortage of labour. But a Glasgow man who offered £3 per week to a youth aged 17 or 18 willing to do tricycle deliveries has probably set a new record in this direction.

Old Cycling Papers for Salvage

DAVID WOOLER, a Lochee, Angus, cycle dealer has given a lead to other traders in the district by handing over old journals and catalogues to the local authorities for salvage, first of all cutting out articles and illustrations likely to be of interest in future.

George Edwards Expects Papers

GEORGE EDWARDS, the speedy Glasgow Nightingale star, expects to receive his calling-up papers shortly. He registered recently with the 18½'s. A colliery surface worker at a pit near Glasgow, Edwards has won road and track events in the past two seasons, and is regarded as one of the best six 25 milers in Scotland.

Mid-Scotland Plans for 1942 Season

THE Mid-Scotland T.T.A. met at Airdrie at the end of November, and approved of a preliminary list of open time trials for 1942, two by the Association, and the remainder by the Shotts Wheelers and the Royal Albert C.C. Other clubs in Mid-Scotland are being invited to promote, but it is not expected that one of the most important of them, the Hamilton C.C., will be able to hold opens.

Turner as a Stoker

GEORGE TURNER, the cheery Central Scotland Wheeler, does not expect to be riding in time trials this year, as he is joining the Navy as a stoker. Turner, who is a moulder from Larbert, near Falkirk, is popular in all parts of Scotland, and has won prizes in many open events.

Notes of a Highwayman

By LEONARD ELLIS

Halzaphron Cliff, Cornwall

A Cyclist's Thoughts of Peace

I SUPPOSE that one of the commonest effects of the war is the intense longing to be transported to some spot where peace reigns and nothing exists to remind us of the horrors of the time. Such thoughts are perfectly justifiable whatever our feelings of patriotism. It is in this connection that the cyclist has a great pull over other travellers, as although he does not belong to a favoured class, he certainly, in practice, succeeds in getting where the motorist simply does not, or, in many cases, cannot. The bicycle is unobtrusive and so portable that even supposing it can no longer be ridden it can still be carried. And what delightful memories are stored up when natural obstacles have to be overcome in such manner. By being able to go where others cannot, we reach places where others *are* not, and so finally reach those places that inevitably conjure up thoughts of peace and utter tranquility—truly, "far from the madding crowd's ignoble strife." One of my war-time dreams of sheer peacefulness and tranquility is a tiny little bay called Gruinard, between Loch Ewe and Little Loch Broom in Wester Ross—wild and lonely. Some hundreds of miles to the south is Gunwalloe in Cornwall, where the Atlantic breakers pound ceaselessly on the black cliffs of Halzaphron.

A Renovated Abbey

MALMESBURY Abbey was begun in 1115, or as some say, in 1150, and was originally cruciform. Legend has it that the steeple, no longer in existence, was twenty feet higher than that of Salisbury Cathedral. The work is largely Norman, but the changes in style can be seen in various parts; the slightly pointed arches replacing the purely Norman round arches. The massive circular pillars, nearly 16 feet in circumference, appear to be short and stumpy, due to the fact that the floor was considerably raised at a later date. A point of interest to be noted is the Watching Loft high up in the triforium. One of the glories of the Abbey is the elaborately sculptured south door of pure Norman work. The sculptures tell the story of the Creation, the Deluge, and the Nativity. An old fire-engine will be found inside the building, and it is said that this was made about the year 1700 and last used in 1845. A curious story that should be told, particularly in the light of modern conditions, relates to a monk who believed that he could fly. He made wings for his arms and legs, and launched himself from the top of the tower. Alas! He was many years too soon, and he ended his adventure with two broken legs. At the dissolution of the monasteries, under Henry VIII, the buildings were sold to a local clothing manufacturer for £1,500, but he gave back part to the town as a parish church, and used the remainder for workshops. Even worse was his crime of using the priceless library of books and manuscripts for filling up bung-holes in barrels. Within recent years a great deal of restoration and renovation have been carried out, and the result is extremely pleasing. Standing inside, it is difficult to realise that we are looking at the actual stonework that was erected over 800 years ago.

Stone at a Premium

ONE of the numerous caverns in the neighbourhood of Castleton is known as the Blue John Mine. This is said to be the only place where the beautiful fluor spar, known as Blue John, is mined, although it is fairly certain that veins can be traced in other Derbyshire caves. The stone is so rare that its output was at one time limited to three tons per year. The mine itself is of considerable interest, and may be visited on payment of a small fee. The spar, however, worked into all sorts of fascinating little vases and ornaments can be purchased in the village. It is by no means cheap, but on account of its beauty it commands a ready sale, and is famous all over the world.

O'Connell Street (formerly Sackville Street), Dublin. It is claimed to be the widest street in Europe. In the foreground is O'Connell Bridge spanning the Liffey, backed by a statue of the Liberator. In the distance can be seen the Nelson pillar.

Around the Wheelworld

By ICARUS

Norwood Paragon Celebration

OVER 90 members and guests attended the annual dinner, dance and prize distribution of the famous Norwood Paragon C.C., held at the Manor Arms, Streatham. In spite of war-time restrictions, and without a breach of the Woolton regulations, the food was excellent. Mr. F. A. Burton, responding to the toast of the Club, drew attention to its successes during past years. Three members of the Club, C. Armstrong, L. Bidewell, and S. Beedon, had lost their lives in the war, and many other members were serving with the Forces. W. J. Mills responded to the toast of the Visitors and the Press, which was proposed by Alan Gordon, whilst the toast of the Chairman was proposed by W. Hitchmough. Dancing followed, and an excellent evening was spent, well in accord with Norwood Paragon traditions.

150,000 New Bicycles

CLOTHES rationing has led to a concession in the design of the extra 150,000 bicycles which are being built specially for women cyclists during the present year. The bicycles will be reserved mainly for use between their homes and factories of the army of women now being called up for war work.

In deciding the specification for the machines the British cycle industry was in a difficulty. To save steel, no more bicycles are being fitted during the war with speed gears or with oil-bath gear case. It was felt, on the other hand, that this special war issue of bicycles could not be left with chains completely unprotected, otherwise stockings might be ruined and valuable clothes coupons used up as a result.

It has, therefore, been decided that the woman war worker is to be given her choice between the chain guard, known as the "hockey stick" type, covering the top run of the chain, and a chain cover which keeps the whole run of the chain from possible contact with skirt or stockings. Both clothes and rider will thus be protected.

Death of Mr. James Blair

I REGRET to record the death of famous old timer James Blair, at Caterham. He was 77 years of age, and had been in control of the Nippon Yusen Kaisha Shipping Lines in this country until his retirement in 1930, when he was appointed to a special advisory office. Another old timer passes on.

It will be recalled that Mr. Frederick George Dray recently died, and in his will he left his bicycle to his cycling companion who was also his butler, whilst he left his Rolls Royce to his chauffeur! Mr. Dray was prominently associated with the cycling pastime, and was partly responsible for introducing danger boards at the top of steep hills, warning cyclists that the hill was dangerous.

Puncture-proof Compounds

THE shortage of tyres has revived interest in methods for rendering them puncture-proof. There have been many puncture-proof compounds in the last 50 years, but none of them has survived. It was found that there were disadvantages which more than out-weighed their puncture sealing properties. However, at the present time it might be wise for such a compound to be made available. Here is a recipe for a good puncture-proof compound. Mix three volumes of glycerine with one volume of waterglass. The resulting jelly is diluted with three additional volumes of glycerine and from 4 to 6 oz. of this fluid is placed in each tyre. In cases of puncture, the internal pressure forces the fluid into the hole and seals it.

The Bidlake Prize Awarded

THE Bidlake Memorial Prize is awarded each year for the most outstanding contribution to the cause of cycling. The trophy perpetuates the memory of the late F. T. Bidlake, who did so much for the cause of cycling. Readers will remember that there is a Memorial Garden at Girtford Bridge on the Great North Road to his memory.

Each year a committee meets to consider the award. In 1940 an award was not made, for there were no outstanding developments or achievements. This year it has been awarded to Mr. A. S. Gilliott, who recently founded the Institute of Cycle Traders and Repairers, upon which there was editorial comment in this journal about two months ago. The committee in making the award, said, "His outstanding services to cycling during 1941 in founding the Institute of Cycle Traders and Repairers, will have a far-reaching effect on the industry."

The Award of Prizes

SEVERAL District Councils have expressed strong disapproval of the suggested scheme to set up a Trust Fund into which would be paid all of the monies usually spent in buying prizes. The Fund would be administered after the war to the prizewinners concerned. The feeling in Club circles is that prizes should be promptly awarded, for there would be great difficulty perhaps in tracing the winners after the war. The scheme was originally advanced because of the difficulty of purchasing suitable prizes at the present time, but the District Councils are of the opinion that the rules should be modified to widen the list of things which may be purchased as prizes. There is considerable support for the suggestion that cycling clothes and accessories should be legitimately considered as prizes. The old idea that a prize should be engravable harks back to the 'Nineties; some of the speakers expressed the view that there were too many old men who had not brought their ideas up-to-date exercising control over the sport. All forms of sport must move with the times, and rules must progress with cycling developments. Many of these old timers have their minds back in the days of the Ordinary, and continue to be the apostles of lost causes. The suggestion that it is contrary to the rules of amateurism for a man to purchase as a prize cycling clothing, or cycling accessories, is simply fantastic, and my advice to the Club is that they should use their own discretion in the matter, if governing bodies continue to bury their heads in the sand and exercise a sort of dictatorship. As I opined last month, we really need a new definition of what constitutes a professional. Every man who sells a prize after he has won it is a professional, according to the ideas of some. A man is, however, entitled to realise his assets for cash.

The West London District Council of the R.T.T.C. at its Annual General Meeting, passed the following resolution: "Having regard to existing circumstances, this meeting recommends its promoting Clubs to adopt a broad sympathetic attitude so far as the suitability of prizes is concerned without infringing the present rules on the subject. This meeting recommends the National Committee to review the amateur status with a view to including cycling accessories as prizes for the duration of the war." Many Clubs, of course, have already done that.

"Inconspicuously Attired"

ACCORDING to the rules framed in the early days of record breaking and road racing, racing cyclists must be inconspicuously attired. The inconspicuous attire consists of black tights, and surely no one is more conspicuous on the roads than a cyclist so garbed. There has been considerable discussion during the past 10 years on the question of tights or shorts and the time has come, I think, when the rule must be relaxed. A case cannot be made out for the continued use of tights, which not only look ridiculous, but defeat the very object for which they were introduced, namely, to make the racing cyclist as inconspicuous as possible. It was not desired to let the public know too much about road racing, for fear of police intervention and public opposition. It was for that reason that road racing became disguised under the name of "Time Trials,' and it was for the same reason that the rule was made prohibiting publication of details of the courses, times and dates of road events. A cyclist attired in tights is a fast travelling advertisement proclaiming to all who care to see that a road race is in progress. On that score, therefore, the case for tights falls to the ground.

An Electrically-Driven Bicycle

Constructional Details of an Interesting Conversion

Fig. 1. The completed electrically-driven bicycle.

MOST of our readers are familiar with the auto-cycle which is driven by a small petrol motor, but a reader, A. L. Godier, of Broadstone, Dorset, has gone one better and has produced an electrically-driven bicycle. The finished machine, which is shown in Fig. 1, has a cruising range of 25 miles on one charge, the current being supplied by a "replate" car battery of 100 ampere hours capacity. If nickel-iron alkaline cells could be obtained, this performance could be considerably improved by installing a 200 amp. hour battery. This arrangement should enable 60-mile trips to be made with ease, as Ni-Fe. cells are lighter and more robust. The total weight of cycle and battery is 100 lbs.

Materials Required

To build a machine, as illustrated, the following materials will be required:—

A push bicycle in average condition; a 12-volt car-starter motor (available at five to ten shillings at car breakers); some car-starter motor cable; a car-starter motor switch; a good 6-volt car battery, or, better still, a 5.6 volt Ni-Fe. battery—in either case of as high capacity as possible, preferably not less than 100 ampere hours (two 50 amp. hour batteries may be wired in parallel, but this arrangement is heavier than a single battery of double this capacity); sundries, such as nuts and bolts, small sprockets, etc.

Details of Construction

First of all remove the cranks from the pedal shaft, turn this shaft round, and replace the pedals. This brings the large chain wheel on to the near side.

If the back wheel has a fixed sprocket on the near side, take off the back wheel, remove the fixed sprocket, and replace it with a free-wheel. Screw this free-wheel on "backwards," so that it will engage when turned anti-clockwise. It will now have to be locked to prevent it unscrewing when in use. The best way to do this is to drill an $\frac{1}{8}$ in. hole, parallel to the axle of the wheel, in the join between the hub and the free-wheel, as shown in Fig. 3. Into this hole drive a piece of 9/64 in. steel rod (preferably tapered).

If the back wheel has no sprocket on the near side, it will be necessary to cut a thread on the hub. Use a $1\frac{3}{8}$ in. by 24 die, or get it done at a local cycle shop. This procedure has changed the manual chain-drive from the off-side to the near-side, leaving room on the off-side for the motor-drive.

Next take a large chain wheel (46 or 48 teeth) from the pedal shaft of a bicycle, and saw or turn a round hole in the centre just the right size to "sit" on the shoulder of the off side free-wheel, on the back wheel of the cycle. If there are no holes in the right places, drill about six $\frac{1}{4}$ in. diameter holes around the centre hole, so that they come opposite corresponding spaces between the teeth on the free-wheel. Slip the large sprocket in place and pass a bolt through each hole, putting a nut on each on the near side of the free-wheel, as in Fig. 4.

Supporting the Motor

The motor is fixed, by means of a $\frac{1}{4}$ in. whit-bolt which is tapped into it, at one end, to the mudguard, which is strengthened with a 1 in. by $\frac{1}{4}$ in. bar of iron. This bar of iron is 26 in. long, and is bent into the arc of a circle

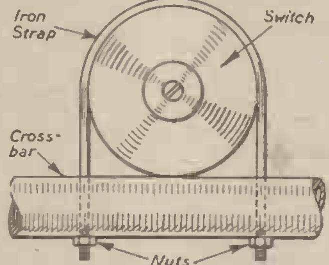


Fig. 2. How the switch is fixed to the cycle cross-bar

of the same radius as the rear mudguard, so as to fit snugly inside it. The bending is best done in a forge, but it may be performed at home, using an open fire or gas furnace to heat the bar. It is bolted to the frame with bolts that hold the mudguard. These bolts may have to be replaced by longer ones to accommodate the extra thickness of metal.

The other end of the motor is supported by two $\frac{1}{4}$ in. diameter iron rods, which at one end are tapped into the motor, and at the other end go one to the back axle, and the other to the bolt which holds the saddle in place. In each case the end of the rod is threaded for about three inches to allow for adjustment.

Motor Drive

The motor drives the back wheel via a chain, which runs over the large sprocket on the offside, and over a small sprocket on the motor shaft. This small chain wheel may be purchased and is keyed to the shaft. A. L. Godier was obliged to make his own and the details may be of interest.

A piece of mild steel, $\frac{1}{8}$ in. thick and about 3 in. square, was marked out as shown at *a*, Fig. 5.

At each of the eight points, A, B, C, etc., a 15/32 in. hole was drilled, and the holes joined by hack-saw cuts, along A, B, C, D, etc. The centre $\frac{1}{4}$ in. hole was also drilled out (this hole will, of course, have to be made to fit the motor shaft).

Next, file the roughly-formed teeth to the correct shape, as indicated at *b*, Fig. 5. Lastly, file the centre hole to fit the shaft which is usually in the shape of a Maltese cross, as at *c*, Fig. 5. A piece of $\frac{3}{4}$ in. internal diameter iron pipe $\frac{1}{4}$ in. long is then pushed on to the motor shaft. The sprocket is then slipped on against the "shoulder" thus formed, and a 1 in. piece of the same pipe next put on the shaft up against the sprocket. Pipe and shaft are then drilled through with an $\frac{1}{8}$ in. hole, and a cotter pin through this hole completes the job of fixing the sprocket on the shaft. (Fig. 6.)

Chain-wheel Alignment

With the back wheel in place and the motor rigidly fixed, check up on the alignment of

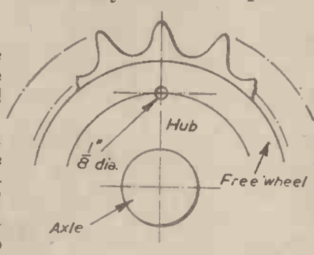


Fig. 3. How the free-wheel is locked.

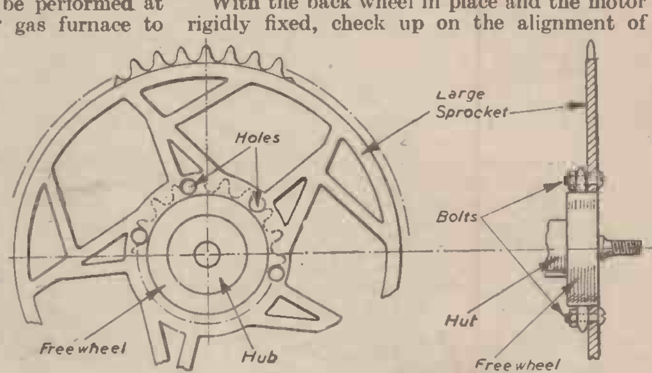


Fig. 4. Showing how the large sprocket wheel is bolted to the off-side free-wheel.

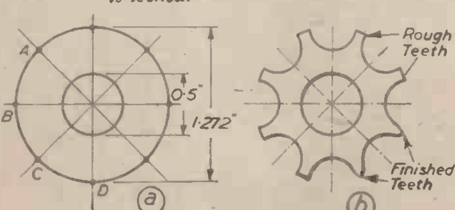


Fig. 5. Marking out the small sprocket-wheel, and side view of the finished wheel.

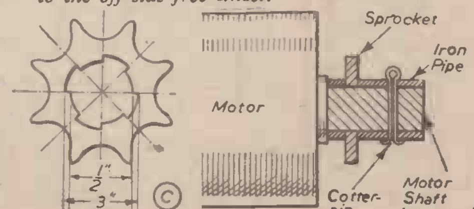


Fig. 6. Sectional view showing how sprocket wheel is fitted to the motor shaft.

the two sprockets. If they are not in line, make them so, for the whole success of the machine depends on the accuracy with which the two gears are aligned. It must not be forgotten that the chain runs considerably faster than on an ordinary cycle, and the chances of its coming off are thereby increased.

When they are in line, put a chain on them, leaving it slack. Also put another chain on the near-side manual drive, and get this to the correct tension first. Then fix a jockey sprocket on to the motor-drive chain, as shown in Fig. 7. The jockey is a 6-tooth chain-wheel (such as is used on motor-car windscreen-wiper drives) fitted in a bearing on the end of an old piece of $\frac{3}{16}$ in. diameter iron rod. The other end is bent over at 90 degrees, and runs in a 13/64 in. hole in the frame. It is kept tight with a small spring, which is clearly shown in Fig. 8.

Battery Carrier

Next, fit an exceptionally strong luggage carrier on the back, to take the battery. If a strong enough one is not available, it may be

Fig. 7. A close-up of the rear wheel showing chain drive and jockey wheel

necessary to make one. Bolt a bit of seven-ply wood, large enough to take the battery, on to the back mudguard, over the end of the strengthening bar. Support each side with a $\frac{1}{4}$ in. diameter iron rod, the other end of which may be tapped into the frame, just above the back axle. The bolts holding it to the mudguard are extended upwards to fit in the fixing lugs on the battery.

Battery Switch

This is an ordinary starter-motor push switch from the dashboard of an old car. It is fixed to the cross bar by means of an $\frac{1}{8}$ in diameter iron rod strap which passes through two holes in the cross bar, and is fitted with a nut at each end (Fig. 2).

An improvement may be made to the ordinary switch, since it is uncomfortable having to hold it down when in use. It may be altered so that it can be depressed, and given a quarter turn to lock it in the "on" position, a further quarter turn releasing it.

All that remains now is to wire up. One wire goes from the motor to the negative pole of the battery. One goes from the motor to the switch, while a third goes from positive pole of the battery to the switch.

Charging the Battery

A very simple method of charging from the A.C. mains is to use a transformer and a Nodon valve. This method does, however, suffer from the grave disadvantage of inefficiency. To make a charger that will charge a 100 amp. hour battery overnight is, in the ordinary way, difficult and expensive, but the Nodon valve is, as mentioned before, very simple.

Nodon Valve Construction

To make a 12 ampere charger (i.e., one that will charge a 100 amp. hour battery overnight), purchase, or wind, a transformer to give an output of 15 amps. at 25 volts; input to suit the mains. Also get a large glass or earthenware jar (a stationary accumulator jar will do admirably) of about 10 litres capacity. Cut a number of plates of aluminium and of iron, tinned iron or lead, to the shape shown in Fig. 9. There must be one more plate of the latter than of aluminium, and the plates should be of such a size as will go in the jar. The total area of aluminium (counting both sides of the plates) should be not less than 250 sq. inches.

Assemble the plates alternately, separating them with sheets of blotting paper. Bolt the lugs together and fit a terminal on each set of lugs.

When all the plates have been assembled, put two thick rubber bands round them to hold them together, and immerse them in a saturated solution of sodium bicarbonate in the glass or earthenware jar.

Charging

Wire up the secondary of the transformer in series with a permanent magnet 0-20 amp. ammeter, the battery, and the Nodon valve, making sure that the aluminium electrode of the Nodon valve goes to the positive pole of the battery.

When the transformer is first switched on, a heavy alternating current will pass round the circuit, but no harm will be done, and after a second or two the current will settle down to

Fig. 11. Another view of rear of machine, showing battery, motor and switch

a steady D.C. value. After a time, the Nodon valve will be very warm, and to ensure adequate cooling, allow plenty of space around it; top up every few hours with clean water as evaporation is very rapid. A sludge will collect on the bottom after several charges, and this should be removed.

Use thick wires for all connections (Fig. 11), and charge until the S.G. at 15.5 degrees C. is 1.300. If the acid is weaker than this, the battery will not work efficiently. Remember, the current may well be 100 amperes when starting, or when climbing a hill, so it is essential to ensure that the internal resistance, and, therefore, the lost volts, are as low as possible.

Cost of Charging

This point also is of great importance, but it may be safely stated that, including the depreciation on the charging apparatus, a 100 amp. hour, 6-volt battery can be charged for 4d. Thus it will be seen that the cost of running the electric bicycle is approximately 1s. 4d. per 100 miles. Also a 200 amp. hour, 5.6 volt Ni-Fe battery (consisting of four cells) could be charged for 7d.

Throughout, the efficiency of the charger has been taken to be 20 per cent. (a very low figure to be on the safe side), and the cost of electricity to be $\frac{3}{8}$d. per kilowatt hour.

Speed

The speed of the electric bicycle obviously depends on the voltage of the battery, but at 6 volts its maximum speed is about 15 m.p.h.

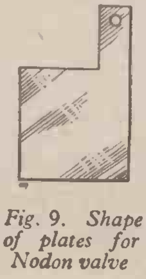


Fig. 9. Shape of plates for Nodon valve

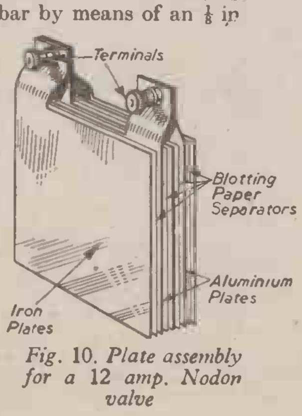


Fig. 10. Plate assembly for a 12 amp. Nodon valve

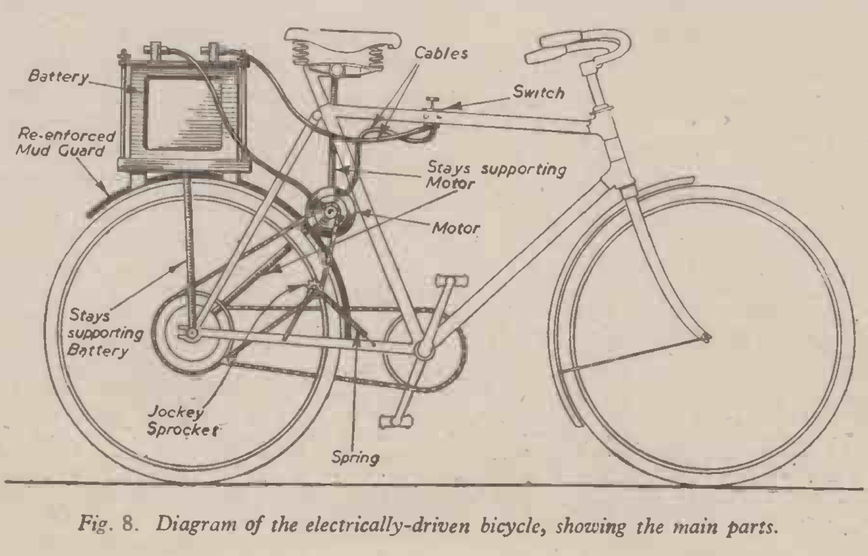
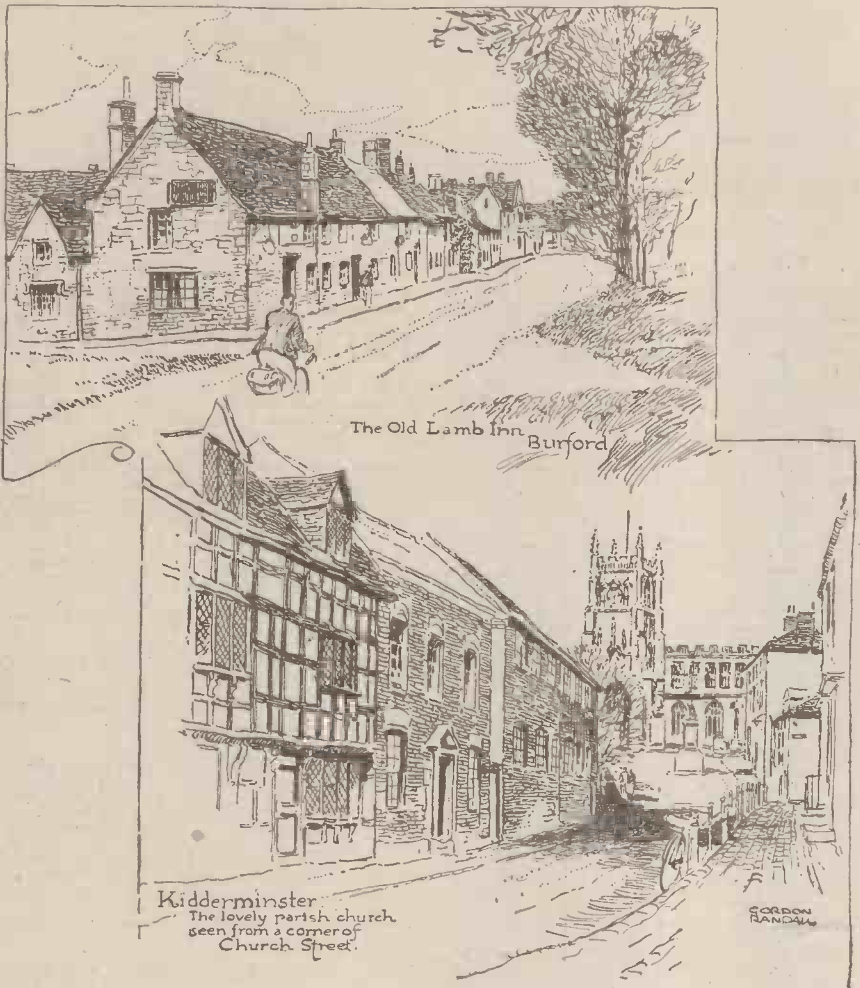


Fig. 8. Diagram of the electrically-driven bicycle, showing the main parts.



The Old Lamb Inn Burford

Kidderminster: The lovely parish church seen from a corner of Church Street.

WAYSIDE THOUGHTS

By F. J. URRY

Poor Stuff

I DO not know if the makers of batteries are to blame for the present poor quality of that product, or if they—and we users—are the victims of shortage of necessary ingredients with which to manufacture batteries. What I do know beyond peradventure is that batteries, and especially rear light batteries are very uncertain in their efficiency, and are liable to let you down with little warning. In the dark days of December I bought a rear-light battery on a Sunday morning, used it for thirty-five minutes that evening, and on the way home on Monday night it refused to function after ten minutes of action. That is the worst example in my experience; but there have been other batteries that have faded out in two and a half hours, and many of my regular riding friends voice similar complaints. This is not a question of old stock, for batteries were scarcely obtainable in the summer, and are not easy to get now; it is just poor quality, and I am wondering if we buyers are the victims of a ramp, or if the circumstances of the times are militating against the production of an article comparable to the pre-war issue. If it is the latter, then surely the makers should give us knowledge of the fact rather than allow us to discover it by bitter experience, for we could then, at least, try and cure the risk by putting our old oil lamps into commission.

The Personal Note

IN this connection I am not at all sorry that some of my motoring friends have been caught without a rear light during their night prowls on bicycles. I do not say that in any unkindness of spirit, but the experience has brought home to them the little difficulties inseparable from the rear lighting of a bicycle, with the result that they do not dismiss "the cyclists' excuse" on this question quite so glibly as was the case when they lacked practical cycling experience. No doubt these trials they now endure will be conveniently forgotten when petrol is free to purchase again, and the very folk who now grumble at the trouble of rear lights on bicycles will dismiss that worry as a sheer exaggeration. For we shall have to fight, and fight hard, to retain the reflector as the night sign of the travelling cyclist, despite the volume of evidence to prove the inefficiency of the live rear light in practice. It may be that cycle lighting will undergo a revision from the point of view of efficiency, and indeed that would not come—if come it does—before it was due. I know the dynamo makers will tell one that that system of cycle lighting is the answer, and my reply is that reliability is not constant with that method, and from a personal point of view I do not want to carry three to five pounds of equipment around the countryside to provide me with five minutes' glim at the stated time. Nor do I want to make labour of my light, to paraphrase Lucas' famous slogan, when I can buy the gleam without adding anything to the muscular exercise. During pre-war times, a battery headlamp lasted me three months, roughly eight hours; but not now, and I want to know why.

A Real Loss

NO more S.A. speed gears will be made during the war, though I understand repairs can be undertaken. But don't count on that, rather take care of the hubs you have in commission by attending to adjustment directly any slip in the take-up of the changes occurs; and oil regularly with the best lubricant: S.A. supply a special oil for one shilling a tin, I think, which I have found excellent. One too frequently notices that speed gears are badly adjusted, and the risk of damage is cheerfully undertaken when a turn of the thumb-screw on the hub end of the change cable would cure the trouble. Perhaps people will take a little more care of their property now they know it cannot be replaced until this international trouble is over. All my machines are multi-speeded with various types of gears, and I'm going to take care of them, for I admit I should not like to miss the comfort of changing gears either on my work-a-day journeys, week-end rambles, or those rare occasions when I can manage a short tour. The change-speed gear will finally be the common equipment to every bicycle, as common as the free-wheel now is, for it is in the line of natural development towards perfection in cycle travel.

It is Good

THE other day I was charged by a man in the trade with investing cycling with a romanticism which, he said, it did not possess, simply because it was a common method of travel. Which of course is nonsense, for romanticism is the very breath of life, and one of the virtues worthy of special cultivation; otherwise what would happen to the human race? To me cycling has always been an adventure of exploration, the desire to see round the corner, to fill my eyes with a new vision, to taste a new experience in some country inn whose threshold I have never previously crossed. Like all romances and all adventures, cycling has its moments of disillusionment, but in the long run the high spirit of exploration is maintained, particularly during those moments when we examine the map, break new ground, and enter the promised land that has stared at us from the printed sheet for many a month. That is touring; as high an adventure in travel without risk or danger, but with peace, quietude and grandeur as accompaniment, as these modern times can provide.

And its Utility

APART from its romantic possibilities, however, the bicycle was never rated higher in Government circles than at this moment. At last authority is beginning to understand something of the part it is playing in personal transport, both as a war worker's vehicle, and as an accessory to Service needs. The allotment of nearly a million machines and spares—about equally divided—for sale to the public during 1942, has now been increased by another 150,000 bicycles, mostly for the use of women war workers. The difficulty will be to find the labour necessary to give the production, and I should not be at all surprised if the Government made what is left of the cycle manufacturing trade an essential industry, and so give to it the protection necessary to keep such labour that is left in the business, and satisfied they are doing a war job. As an ardent rider I do hope the makers will see to it that these war-time models are reasonably geared, not more than 60 in. for women and 63 in. for men, and thus give the newcomers the easy form of cycling activity that a low gear presents. Change gears cannot be obtained in the hub type, and the derailleur is not easy to get, so moderation in single-geared machines should be one of the specification items to be closely watched. It was the late F. T. Bidlake who always said in connection with low gears, "you can always pedal when you can't push," an axiom from the very fount of experience, which the trade and the rider would be wise to remember.

The Cost To-day

I HAVE just bought a bicycle for a young friend of mine, the best model of a famous make, and the invoice figure is £17 9s. 10d., of which £3 9s. 2d. is Purchase Tax. That makes you sit up and think, though I must confess the boy for whom this machine was made is delighted with it, and the high figure of cost has had no effect on that appreciation. At the moment he is earning good money, says he has waited years for this chance to fulfil his desire to own the best, and now says he will start saving to buy war certificates. "It's like this," he said, "in a couple of years or less I shall be involved in this fight: now I have a trifle of leisure and I want to use it in the best way: maybe I'll never have the chance again of so thoroughly understanding the country I shall fight for." And it was this point of view that won over his parents and made me his coadutator. The mention of this figure of cost revives memories of the price of bicycles at the end of the last war. I paid £16 (and there was no Purchase Tax) for a very indifferent machine with a famous transfer, and that was supposed to be a special price. Our big makers have told us that whatever happens, quality will be sustained, and I sincerely hope that self-imposed condition will be kept, for many a good reputation was smirched in the years between 1918-21 because makers thought anything would do.

Ways of Answering

THERE are various methods by which people answer your enquiries as to whether the way you are travelling is correct for So-and-so. In Ireland where—usually—a question is replied to literally, you get "It is, sorr!" or "It is not, sorr!" with, occasionally, as a change, a bluff "On straight!" The negative piece of information quoted is supplemented only if you put the further obvious question. (Once I asked a peasant whether it was possible to obtain a meal in the neighbourhood through which I was travelling, and his reply was "It is, sorr!" Having literally given me all the information for which I asked, he readily amplified it in response to a further question!) Sometimes, by way of variant, the reply to your enquiry is "Noine moiles," or "Four moiles—Irish." For perhaps obvious reasons (I being one who adores touring in Ireland), I prefer any of those replies to the frequent "home" method which consists of a confused mass of "lefts" and "rights," accompanied by arm exercise—frequently enough the left arm being used to indicate a right-hand turn, and vice versa. But perhaps the "best" answer you can get to an enquiry is the good-natured (if ridiculous) offer to provide you with personal convoy. Example: One very dark night as I was cycling through an unfamiliar village in a hurry to reach my destination. I paused to enquire the way of an old couple who had just descended from a bus. I appreciated the good intentions and the kindness contained in the reply: "We're going that way if you care to walk with us." I didn't care, not having the time to spare, and, having received a general direction, I thanked my friends and rode on.

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

My Point of View

BY "WAYFARER"

Their Way Best

THE bicycle has been in the war news lately. The Russians announced the capture of much booty, "including motor-cycles and bicycles," and from Singapore we are told that the Japs left behind them "200 motor-cycles and push-cycles." Thank you: I like the Russian way of giving the news

The Signal is — Pump!

WE cyclists may advantageously take a hint from a tyre manufacturer's advertisement which has recently appeared in the daily press. That announcement concerns motorists, and is prompted by the embargo which has been placed on the sale of tyres. The obvious need for taking care of all tyres at present in use is emphasised, and a point is made of the necessity for correct inflation, this process tending to prolong life. That is where we cyclists come in. I believe it is still true to say that the majority of us (i.e., cyclists, and people who ride bicycles) do not sufficiently inflate our tyres. One need not fear over-inflation—unless, indeed, one's tyres are in a bad state of repair, the cure for which is obvious. Properly pumped tyres give comfort to the rider (while also being good for the covers in every way), whereas flabbiness is the acme of discomfort. So, to paraphrase a current war savings poster, the signal is PUMP—and pump harder.

Unwanted Sympathy

PROVOKED by a picture of Glencoe, the talk among a small group of us the other day fell on the best way of traversing that noble pass. "Cycling," I jerked out—as usual throwing my hat into the ring. "No!" said one who has "progressed" from the bicycle to the motor-car: "No! go by car, put up somewhere, and spend two or three days tramping the district. Then move on and repeat the operation elsewhere . . . I've felt sorry for the cyclists I have seen plodding wearily up some of those slopes of Glencoe!" Whereupon I assured my friend that such sympathy is wasted on cyclists: we don't want it. We take the rough with the smooth, and put up with all that the "rough" may connote. If we choose a hilly region for our cycling expeditions, we hang out a figurative notice which says, "No flowers by request."

In any event, we realise that every hill is a two-way affair, having a downward as well as an upward trend. We reap what we sow. True, it takes a lot longer to climb to the ridgeway than to romp down the slope that follows, but the climbing process is not of necessity a matter of "blood and sweat." Strange though it may seem, the up-hill slog may be quite enjoyable, and ours is the sense of achievement. Victory belongs to us, and is not given to us by some outside agency. And, if I may repeat myself, we cyclists do not want the sympathy of others—especially as sympathy may imply that we are congenital idiots. Believe me, we are anything but that!

An occasion which sticks prominently out of my memory when motorists were ultra-sympathetic was an Easter of snow and ice a few years ago. I was in Wales, and had obviously chosen the hilliest route findable. Very low temperatures and frequent flurries of snow occupied most of the meteorological menus, but I was profoundly happy, and completely filled with the joy of living. So far from desiring the sympathy of passing motorists, I wanted to condole with them, for they were shut up in their boxes, whilst I was enjoying the glorious out-of-doors. I, near to the heart of things and in intimate contact with the elements—mercilessly blown about by those same elements—was, I felt, "quids in."

Side-Light

A SIDE-LIGHT on the value of travel shone through my mind the other day during perusal of a book called *An Irish Journey*. Had I not been interested in and familiar with Ireland, thanks to the many cycling tours carried out in that country of contradictions, the probability is that I would never have troubled to read the book, let alone buy it. But, knowing Ireland as I do, I read the "story" with avidity—and with the aid of my maps—learning much from what the writer had to say. When he trod ground which was known to me, I felt very much at home. On the other hand, when he invaded those parts of the land to which my whirring wheels have not yet taken me, I was no less interested, and I was conscious of a strong desire to improve and extend my knowledge—as, please the pigs! I shall do at the earliest possible opportunity, meanwhile making notes of some of the things remaining to be achieved. What is true of this Irish book is true of all travel books. It is inevitable that you peruse them with greater interest if you are travel-minded—and especially, I suggest, if you have become so through the medium of cycling, the best and the most intimate mode of travel.

"Ersatz" Moonshine

HOW useful to cyclists some of our searchlights prove on these dark winter nights! The silver fingers of light which stretch over the sky illuminate our road, in much the same way as does the moon, and facilitate our movements. When, suddenly, the searchlights are switched off, we are plunged into gloom, and it is dark indeed—and very disconcerting for a moment.

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PRACTICAL MECHANICS
March, 1942.

Published about the 30th of each month by GEORGE NEWNES, LIMITED, Tower House, Southampton Street, Strand, London, W.C.2, and Printed in England by The Sun Engraving Co., Ltd., London and Watford, Herts. Sole Agents for Australia and New Zealand—Gordon & Gotch, Ltd. Sole Agents for South Africa—Central News Agency, Ltd. Subscription Rates: Inland 11s. per annum. Abroad, 10s. 6d. per annum. Canada, 10s. per annum. Registered at the G.P.O. for transmission by Canadian Magazine Post.