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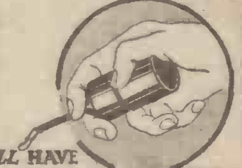

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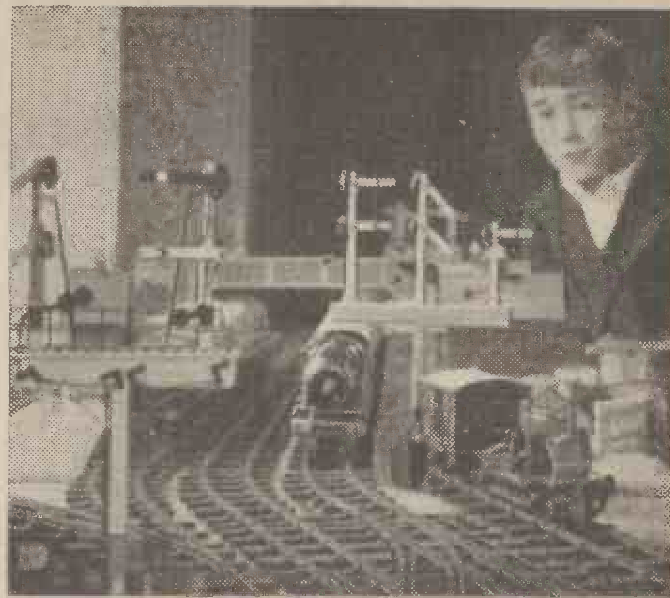

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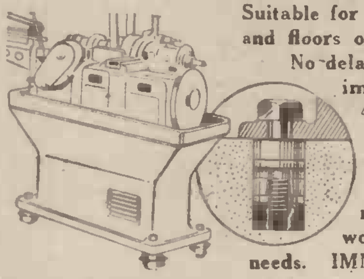

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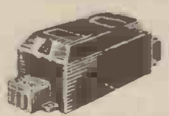

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PRACTICAL MECHANICS

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

Editor: F. J. CAMM

VOL. XII OCTOBER, 1944 No. 133

FAIR COMMENT —— BY THE EDITOR

Some Recent Technical Developments

IN the interests of national security the Press is not permitted to publish details of technical developments until they have been removed from the secret list. We are, of course, permitted to publish details of the technical developments and inventions of our enemies, in certain instances, for it is not always politic for us to let the enemy know what we know. It always happens during a war that vast sums of money are available for the development of new ideas, so it is inevitable that wars have a constructive as well as a destructive influence on our lives.

The aeroplane, wireless, television, and many other scientific achievements have only been made possible by war, for private enterprise has been unable to find the millions necessary to bring them to perfection. Many of these developments will not be released for publication until after the war, and those readers who are impatiently awaiting the details should remember that the technical Press, whilst being aware of what is going on, are not able to publish what they know.

When it is obvious that the enemy knows of our inventions there is no objection to publishing details in this country. The enemy, of course, loses no time in publishing details of our inventions in the Press of his own country, and it has not been found possible to devise any means of preventing one country from obtaining the newspapers of another whilst they are at war. By this means we are enabled to check the enemy's intelligence. There is also an interchange of technical information between the Allies so that each country may make use during the war of the inventions of the others. Certain of these developments we are enabled to reveal. A summary of some of them is here given.

Outstanding Inventions

In the realm of aircraft a new type of landing mechanism has been produced to absorb the shock of landing, take-off and taxi-ing. The air in the mechanism is confined in a flexible rubber container, operating somewhat like an accordion bellows. The principle is much the same as that operating the conventional landing mechanism in which oil is forced through a small hole at high pressure, except that the new system expels a large volume of air at low pressure. The design eliminates the need for pressure-type sliding joints and their resultant leakage and friction problems.

Magnesium is now being used for British aircraft petrol tanks, and this permits a 12 gallon increase in fuel capacity, a 9lb. decrease in weight, and a diminished "tulip-ing" of bullet holes which hitherto has interfered with self-sealing devices.

Blasting the carbon from engine pistons with acetate pellets has considerably reduced the time taken by the former method of using a solvent. A new constant speed propeller mechanism has been produced for light aircraft. It is a self-contained unit, mechanically actuated by the energy of the rotating propeller shaft. An automatic governor and pilot's selector control are located in the housing of the constant speed mechanism, which consists of two V-belt pulley systems linking the propeller shaft with an adjacent governor shaft. One pulley system has a fixed drive ratio, and the other a variable ratio, and the difference between the two ratios causes a change in blade pitch.

The phototheodolite is a new device to improve accuracy in recording aircraft performance data. It consists of a rigidly mounted movie camera equipped with long focal length lens that can photograph an aeroplane, time counter and the elevation and azimuth angle scales simultaneously.

Plastic shielding is now being applied to aircraft parts susceptible to damage in process. Clutch drive shafts and similar parts which tend to roll against each other, causing nicks and scratches, are protected in this way.

The soldering of steel parts of radio equipment has always presented a problem and a new flux has been developed. Levulinic acid, a derivative of ordinary starch, is being blended with resin to form this satisfactory fluxing agent. Resin alone is too inactive for this purpose, and zinc chloride requires extensive washing after soldering to prevent corrosion.

A new coolant which considerably reduces tool failure in metal cutting operations is made by mixing 2½oz. denatured alcohol, a teaspoonful of corn starch, and a pint of cutting oil of the soluble type.

In a new type of liquid-immersed high-voltage potential transformer, solid insulation is so arranged that it provides nearly all of the dielectric strength and drastically reduces insulating oil requirements. Line and ground shields encircle the outer and inner coil peripheries, assuring uniform voltage distribution under all conditions. This more compact potential transformer weighs less than half as much as one of conventional design, is much smaller in size, and requires so little oil that costly insulating liquids can be used with nominal additional expense.

New Electronic Instrument

A recently installed electronic device gives immediate signals if a 60,000 KVA. frequency changer falls out of synchronism. The changer links the 60-cycle-per-second lines of the Los Angeles Bureau of Power and Light with the 50-cycle-per-second Southern California Edison system. The electronic instrument consists of a pair of 2in. cathode-ray tubes so connected that machine currents produce horizontal signals, and line voltages produce vertical signals. By making it possible to cut the changer free from the system at once if it drops out of step, this simple device has already saved considerable time and expense, which would otherwise be necessary to restore the station to normal operation. It may not be possible for the operator to determine from the usual electro-mechanical instruments that such a condition exists, if the machine has dropped completely out of synchronism by the time he looks at the meters.

By removing absorbed gases, a dry flux has been found effective for eliminating pin-holing in aluminium alloy castings. A typical flux of this type is composed of 2 parts sodium chloride and one part sodium fluoride. The metal is first heated to 750 deg. C. An amount of flux equivalent to 0.5 per cent. of the metal weight is spread evenly over the top of the bath and then pushed under the surface by an iron skimmer until it appears fused. After the metal is stirred several times and the iron skimmed off, the metal is cooled to pouring temperature.

An automatic sorter in use at Bausch and Lomb Optical Co. is claimed to do the work of twenty human sorters and weighers. The device consists of a revolving ring of 30 balances which accurately weigh small squares of optical glass and automatically toss each piece in its proper bin. The only labour required is an operator to place a piece of glass on the balance as it passes.

An anodic type of protective coating for aircraft magnesium alloys has been developed by Consolidated Vultee Aircraft Corporation. The new film increases the weight of the magnesium sheet only 0.8 per cent., being 1/7th the weight of a prime coat of paint and two coats of lacquer. Other favourable features are its tight adherence, resistance to abrasion, very smooth finish, and ability to withstand a potential of 110 volts. It is possible that dyes can be introduced into the anodic solution to produce a wide variety of colours.

Earth Moving by Machinery

The Various Types of Machines, and How They Work

By E. GOWER

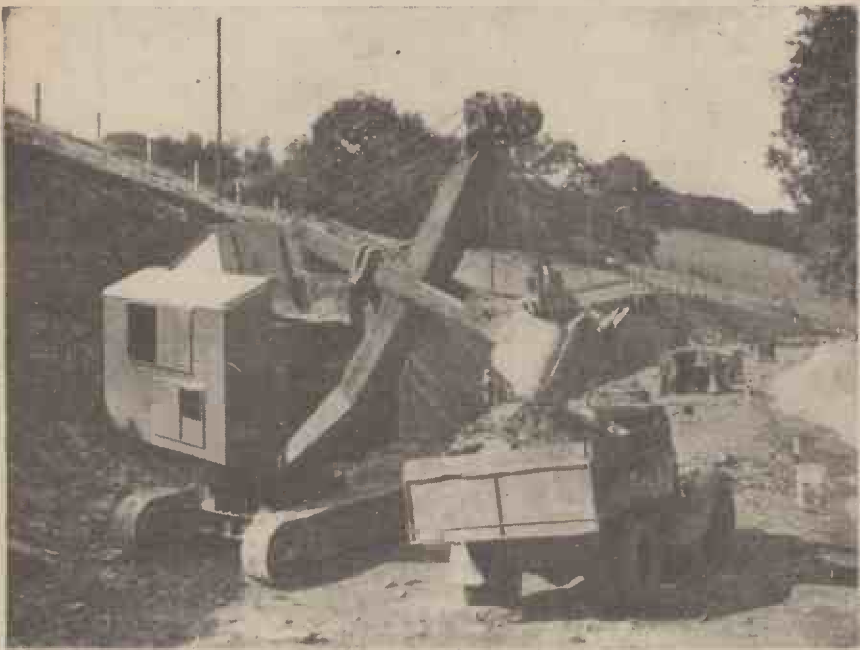


Fig. 1.—A ½ cubic yard mechanical shovel with crowding gear.
(By courtesy of T. Smith and Sons, Ltd.)

EARTH moving by mechanical means on a large scale was comparatively little practised in this country before the war. The needs of the Army and Air Force have, however, compelled us to turn to the methods used by the Americans on their huge short-term contracts, which to them are commonplace. Bulldozers have become front-line machines, and are among the first supplies to be landed on a new front. Excavators and scrapers have played and are still playing important rôles in aerodrome and camp site construction. Outcrop coal, which is supplementing our fuel needs, is mined, not by pick and shovel, but by excavators, with huge outputs at little expense and man-power.

The main types of machines in use are:

1. Excavators or Power Shovels.
2. Bulldozers and Angledozers, etc.
3. Scrapers.
4. Graders and Elevating Graders.
5. Rooters, Scarifiers, Rollers and Sheepsfoot Rollers.

We will discuss the excavator first, as it is perhaps the best known machine and is very versatile.

Less than fifty years ago steam navvies, as they were called, were cumbersome, inefficient and restricted in operation, often being converted steam cranes. To-day the excavator is comparatively small, handy and has a multitude of uses.

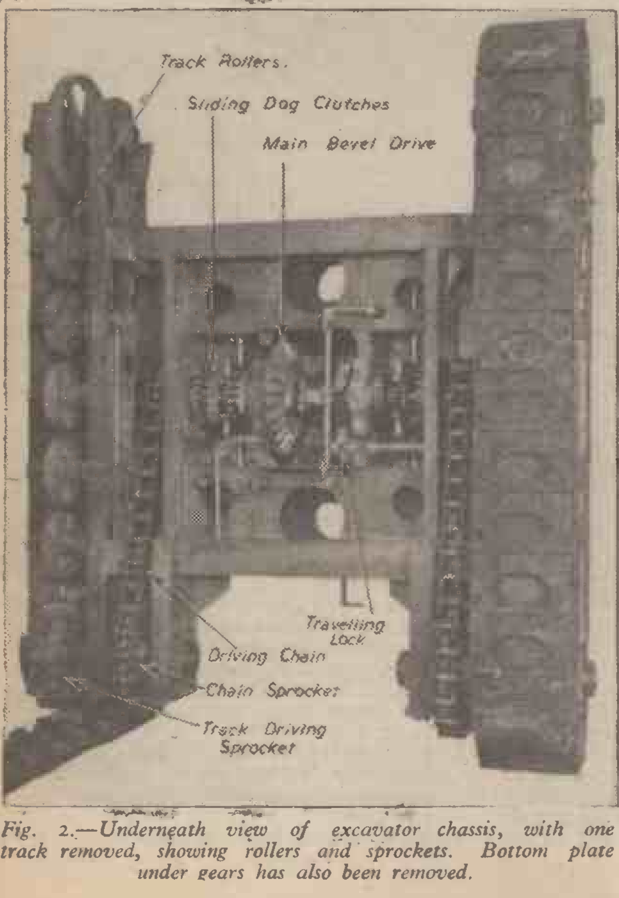


Fig. 2.—Underneath view of excavator chassis, with one track removed, showing rollers and sprockets. Bottom plate under gears has also been removed.

Face Shovel or Navvy

The most common type is the face shovel or navvy (Fig. 1). This digs forward and upward, the bucket having removable steel teeth on its front edge. The superstructure which carries the machinery and the digging equipment is mounted on a carriage having caterpillar tracks, and is able to revolve through 360 degrees on a number of steel rollers, thus allowing the machine to dig at one side and slew round to dump its spoil in a waiting wagon at the other side or in the rear. The motive power is supplied usually by a diesel engine which drives the barrels or rope drums by a chain (usually in an oil-tight case) and spur gears (Fig. 2). Also, by means of a set of clutches, it transmits power to revolve the superstructure, or "slew," and propel the caterpillar tracks. The wire ropes, operating from the drums, which have clutches at one end and brakes at the other, lift the bucket up or down and raise or lower the jib. On some types, having what is known as "crowding gear," the bucket on its arm is propelled backwards or forwards on a steel rack, to give thrust to the teeth. This racking gear is operated from the rope drum by either ropes or chain, the latter being used on quarry work and heavy digging, because of its positive propulsion.

The carriage, mounted on caterpillar tracks, is propelled by heavy forged steel chains, and is steered by levers from the driver's position. The driving pinions for these chains are secured at the ends of stub shafts, which, by means of spring-loaded dog-clutches, allow each track to be locked or "sprogged" independently, to permit the

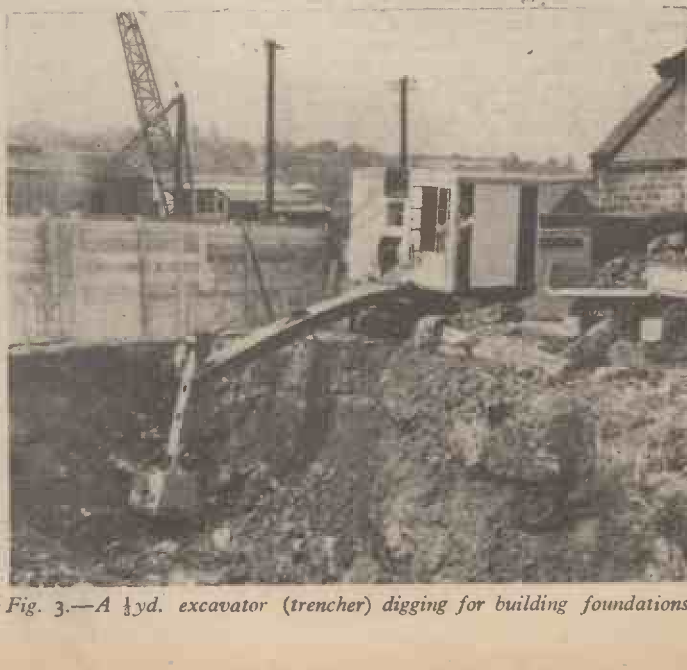


Fig. 3.—A ⅜yd. excavator (trencher) digging for building foundations.

machine to be steered to either side or turned in its own length. On some types of machines powerful springs are fitted in each track to absorb travelling shocks caused by the trapping of stones in the track lines. To prevent the excavator being pushed back from the face when digging, a locking device is sometimes fitted which allows travel in one direction only. This is sometimes in the form of a spring-operated ratchet on the centre shaft of the travelling gears.

This type of machine, because of its upward cut, is used for digging at faces, such as quarries, claypits, sandpits, outcrop coal faces and for removing banks of earth or debris. The outputs for a ⅝ cubic yard machine are 75 cubic yards (between eighty and ninety tons) per hour in moderate material and about 40 cubic yards per hour in rocky clay. This is a common size of machine in this country, but the Americans use much bigger ones, up to seven and eight cubic yards, with electric power plants installed. The average type of shovel in this country can travel at about 1½ to 2 miles per hour and weighs for a ⅝ cubic yard machine about 18 tons. It has a 56 h.p. diesel engine. The ground pressure, which is very important on many sites, is low, due to the area of the caterpillar tracks, and is usually about 11lb. per square inch.

Fig. 4.—A ¾yd. skimmer on road widening work.
(By courtesy of T. Smith and Sons, Ltd.)

Dragshovel or Trencher

By changing the front end digging attachment, the excavator can be converted in a few hours to a dragshovel or trencher (Fig. 3). This, as its name implies, digs backwards, in the opposite way to the face shovel. The bucket on its arm is pivoted at the end of the jib. It is thrust outwards to its fullest extent, then pulled backwards, digging a trench as it comes backwards to the jib foot. To dump the earth the jib is raised and the bucket pushed outwards, allowing the earth to drop out into the waiting wagon or on to the pile. If space is restricted the bucket is often fitted with a door which, when opened by the trip rope, allows the earth to drop out.

A ⅝ cubic yard trencher is capable of digging a trench 19ft. deep by 3ft. wide at the rate of 60 cubic yards per hour.

Skimmer Scoop

This machine, as its name implies, is for making shallow cuts in a horizontal direction, the bucket moving backwards and forwards on the jib, held parallel to the ground. It is used for levelling work on new roads, grading and loading loose material (Fig. 4). Skimmers have even been used for shifting piles of snow in city streets. Apart from the digging attachment the remainder of the machine remains as that for shovel and trencher.

Dragline Excavator

This is a very important type of excavator, having usually a long lattice type jib with a detached bucket operated by ropes (Fig. 5). The bucket is thrown out on to the ground and dragged back to the machine, its teeth digging and filling the bucket as it moves. The bucket when full is hoisted up and the machine slews round to dump the spoil in wagons or on a heap. It is used for a variety of tasks, such as cleaning and widening drainage ditches and rivers, digging gravel or sand from pits or under water, removing overburden or topsoil from outcrop coal sites or building excavations, and moving loose earth already dug by other machines. To enable these machines to operate on boggy ground or unsafe river banks they are sometimes fitted with extra wide caterpillar treads to reduce still further the ground pressure and increase the stability.

Excavators are also adaptable for use as grabbing cranes, cranes and piledrivers.

Multi-bucket Trencher

There is also another type of excavator used for special jobs. This is the multi-bucket

Fig. 5.—A 17ft. dragline on river widening work.
(By courtesy of T. Smith and Sons, Ltd.)

Fig. 6.—A trench-digging machine used by the Canadian Army in this country. It can dig a trench 5ft. deep and 500yds. long in one day, and is operated by one man.

trencher. The caterpillar tractor is fitted with an arm carrying either a large wheel or a belt fitted with a number of small buckets. As the machine travels slowly backwards the wheel or belt revolves and the buckets dig a continuous trench to a constant depth, which can be adjusted to requirements. The earth from the buckets is deposited on to another belt which carries it out at one side on to a waiting lorry or forms a continuous bank. The trench, which may be 6ft. deep and narrower than is possible by hand labour, is cut very quickly. In moderate ground a multi-bucket machine may cut more than half a mile of 3ft. deep trench in one day. The average weight of one of these machines is about 6 tons, and they can travel at varying speeds up to four miles per hour. They are invaluable on contracts for sewer or water pipes and electric cables. (Fig. 6.)

Fig. 7.—A bulldozer (American "caterpillar") at work.

Before we pass on to the other types of digging and earth moving machines, we must consider the unit which is essential to nearly all of them—that is, the caterpillar tractor. These consist usually of a high-powered, water-cooled diesel engine driving through a multi-speed gearbox to large caterpillar tracks. These tracks are mounted on ball-jointed frames and permit individual oscillation of each track, allowing one side to mount an obstacle while the other stays at a lower level. They are controlled, not by a steering wheel, like small agricultural tractors, but by two hand-levers and brakes. Multiplate friction clutches transmit the power. A number of sizes are in use, from 30 h.p. up to 120 h.p., the 50-70 h.p. sizes being very popular. They have usually six forward speeds, one and a half to six m.p.h. and two reverse speeds one and a half to three m.p.h. They are economical in use, a 60 h.p. tractor using less than two gallons of fuel per hour doing heavy work.

The Bulldozer

From the tractor we come to that important machine the bulldozer (Fig. 7). This is a tractor fitted with a large steel cutting plate held in position in front of the tractor by two powerful arms. These are capable of quickly raising the blade by hydraulic power, or by pulleys and cables. Earth, trees, debris and nearly anything movable is pushed forward on to one side by these powerful monsters that now form part of the Allied front-line equipment. The angledozer is an adaptation of the bulldozer, having its cutting plate set at adjustable angles to guide the earth to one side.

Fig. 9.—A grader towed by a diesel-driven "caterpillar."

Scrapers

Usually towed by a caterpillar tractor, the scraper is a big box-like machine mounted on low-pressure balloon tyres (Fig. 8). The body, called the bowl, has at the front edge a cutting plate set at an angle. As the tractor drags the scraper along the earth is chiselled up and backwards into the bowl, the back of which, called the tailgate, moves back as the earth piles against it. When filled, the scraper is moved to the position where it is to drop its load, and the tailgate is then pulled forward by power-operated cables, distributing the earth in an even spread, the gate moving forward until the bowl is completely empty. A common size of scraper is of 8 cubic yards capacity (about 9 tons), and the machine itself weighs about 6 tons. They can spread earth about 1ft. deep. Scrapers have played an important part in aerodrome construction.

Graders

Also towed by a tractor, with additional power for operating the blade, these machines are usually mounted on steel wheels which are able to lean in either direction for working on slopes (Fig. 9). The blade, often 8 to 10ft. long, is suspended between frames and can be adjusted to almost any angle or position, from parallel to the ground, to a position nearly vertical at the side of the machine for grading banks and slopes. Due to the light construction of these machines by using alloy steel, the weight of a scraper with an 8ft. blade is only 2 tons. Power for operating the blade is often taken from the auxiliary pick-off drive at the rear of the tractor which tows it. A 50 h.p. caterpillar tractor is required for pulling a machine of this size.

An adaptation of the grader called the elevating grader picks the earth up as it is cut and carries it to one side on a moving belt, where it is deposited into lorries moving parallel with the grader. Machines of this type were practically unknown in this country before the war.

For breaking up hard ground or old concrete, rooters or scarifiers are used. These massive machines, having a number of huge teeth suspended beneath a wheel-borne framework, are towed by a tractor and tear up the surface as they pass over it. Scrapers or bulldozers then follow to remove the loosened earth.

Dumper

There is one more important item to mention, and that is the dumper. Quicker and handier than the normal wagon, they are mounted on large balloon tyres and the driver sits behind the receiving bowl, which can be tipped forward for dumping the earth. They are highly manœuvrable and can operate on very rough ground which would greatly impede the progress of ordinary wagons.

Fig. 8.—A scraper towed by a "caterpillar" diesel tractor.

Testing by Wind-tunnel

Used for the Observation and Measurement of Forces to Which an Aircraft in Flight is Subjected

By R. J. PACKMAN

IF we look back to the early development of the aeroplane we find that experimenters employed various means of studying airflow round aerofoils, and for measuring resulting forces in most cases models were used. Some experimenters released model gliders from the tops of tall buildings, some attached the models to rotating arms, as did Sir Hiram Maxim, who designed the giant flying machine in the grounds of the Crystal Palace. However, the most successful means was that employed by the Wright Brothers, which was the wind-tunnel. This had the advantage that the air was made to move in relation to the model, which remained stationary, thus facilitating observation and measurement of forces. This means has been used ever since and will certainly play its part in future development.

There is no doubt that the wind-tunnel has played an extremely important part in bringing the aeroplane to its present advanced state. Although aerodynamic theory has been developed to such a state that remarkably accurate estimations of lift and drag of aircraft and their component parts can be made, wind-tunnel experiments provide very useful data, especially with regard to corrections to be applied to estimations for unknown factors. For instance, it is possible to make a good estimation for the drag of a wing and for that of a fuselage, but when the two are joined together the extra drag caused by the interference between them is difficult to estimate; a wind-tunnel investigation will provide the data for this unknown quantity. Full-scale tests can be made on such parts as air intakes and cooling ducts to ascertain the most efficient shape, an almost impossible task to carry out by theory alone.

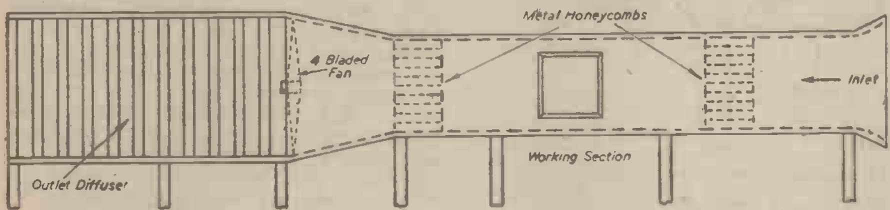


Fig. 1.—(Above) Simple N.P.L.-type wind-tunnel.

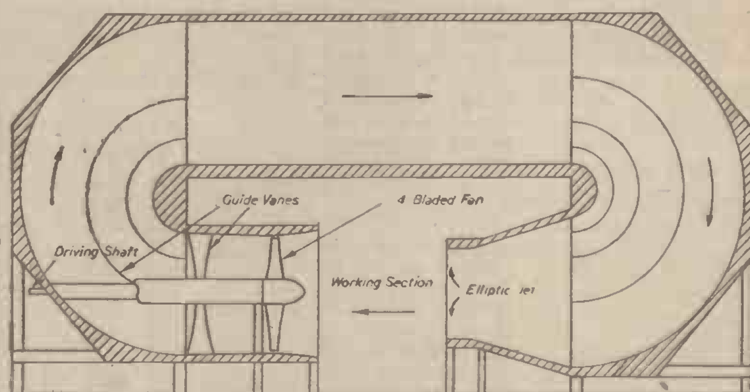


Fig. 2.—(Right) R. A. E. - type open-jet wind-tunnel.

A simple type of tunnel is that shown in Fig. 1, which is similar to that used by the Wright Brothers. It is of the enclosed section type, consisting of a long rectangular open-ended box through which air is sucked by a fan at one end. The working section, where the model is suspended, is in the middle of the tunnel. In order to obtain as near as possible streamline flow through the working section, the entrance is bell-mouthed, and a thin metal honeycomb is placed just inside the entrance. The tunnel gradually changes section towards the fan where it is circular. The fan is similar to a wooden airscrew blade, with ends shaped to run with only a small clearance inside the circular section; it is driven by a 35-h.p. electric motor, giving tunnel airspeeds up to 90 ft./sec. This type of tunnel has survived the passage of time, and is still used to a small extent, mostly in the laboratories of universities and technical colleges. It has the advantages of being simple and cheap to construct, the tunnel wall being built up with wooden planks.

Open Jet Tunnel

The open-jet tunnel (Fig. 2) is the type most commonly used in modern research and design departments. In this type the air is passed round a continuous circuit which usually consists of a square section duct leading round to an elliptical jet. The air passes from the jet across the working section, which is open to the atmosphere, to the fan situated just inside the beginning of the duct. The air is guided round the corners in the duct and prevented from surging to the outside of the corners by semicircular guide vanes as in the tunnel illustrated, or by cascades of specially shaped vanes at the corners where the end sections of the channel are straight. In addition a metal honeycomb is placed before the working section to eliminate turbulence from the flow.

The open-jet tunnel has the following advantages over the previous type:

(a) More economical in power, as once the air is in motion the only power required is that absorbed in friction between the air and the walls, guide vanes, etc.

(b) Greater accessibility to the working section, where the model can be more easily worked upon and observed.

This type of tunnel, originally developed by the R.A.E., has been built in various sizes, the largest being capable of taking small aeroplanes and parts of large aeroplanes, such as engine nacelles.

The channel can be built up of composition board, wood, or sheet metal, providing the wall is sufficiently stiff to prevent resonance. Resonance troubles have been cured by fixing a number of small projections at the lip of the jet.

However, there is a limit to speed of air which can be produced in these atmo-

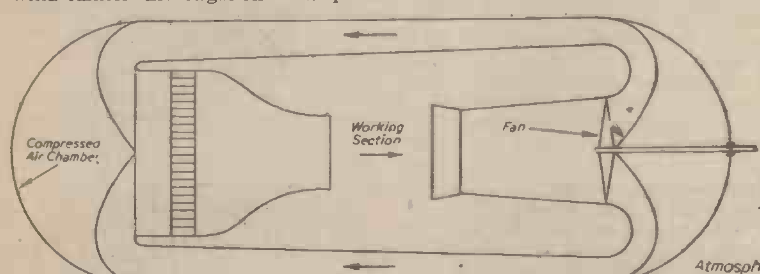
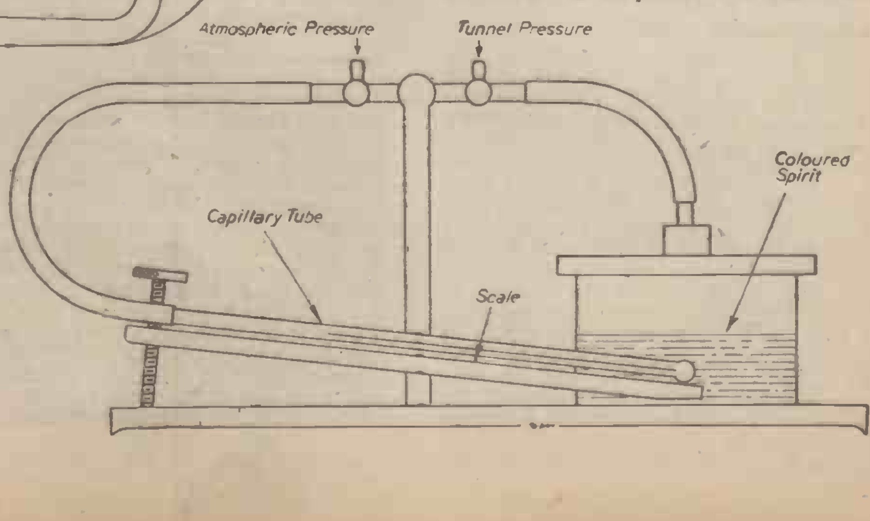


Fig. 3.—(Left) Compressed - air tunnel.

Fig. 4.—(Below) The micromanometer, a sensitive form of U-tube manometer.



spheric wind-tunnels for reasons of economy and of the effect of compressibility at high speed, and they are not normally designed for speeds above 300ft. per second. Now the force on an object is proportional to the Reynold's Number, and in order to convert the results of model experiments to full-scale conditions the Reynold's Number for the model tests must be the same as that required for the full-scale conditions.

Reynold's No. = airspeed (ft./sec.) × chord length (ft.) × air density ÷ air

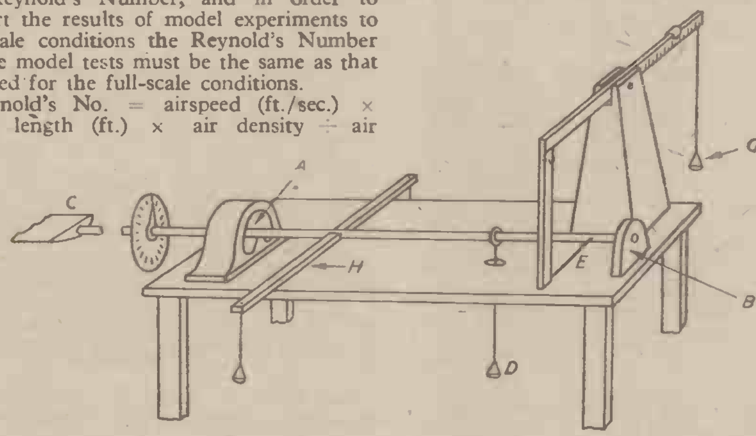


Fig. 5.—Simple balance for measuring forces and moments on models being tested.

viscosity. If, for example, it is required to test a 1/20th scale model of the wing for a 400 m.p.h. fighter, the tunnel speed required is 8,000 m.p.h., which is obviously impracticable, but if the air density is increased 200 times, an airspeed of 40 m.p.h. can be used. This is where the compressed-air tunnel becomes necessary.

Compressed-air Tunnel

The compressed-air tunnel consists of an open-jet wind-tunnel placed within a steel shell, the latter being pumped up to the required pressure. Fig. 3 shows a compressed-air tunnel used in the N.P.L., in which the return ducts are built annular to the working section. It can be seen that all model adjustments have to be made prior to the commencement of the test, and any subsequent movement and the adjustment of the balances carried out by remote control.

The measurements required to be made in a tunnel are:

(a) Airspeed.
(b) Lift.
(c) Drag.
(d) Pitching and rolling moments.

All tunnel measurements must be taken with a high degree of accuracy, as the forces produced on a model are usually very small.

If a pitot static tube is inserted into the airflow for measuring the tunnel airspeed it disturbs the flow, so in practice the static pressure at a point in the tunnel downstream from the working section is calibrated against airspeed. The static pressure is measured by means of an accurate form of U-tube manometer (see Fig. 4).

Measurement of Forces

For the measurement of forces and moments on the models, various types of sensitive balance are used. A simple type for measuring lift, drag and pitching moment is shown in Fig. 5; this type is often used with the closed section tunnel. It consists of a long arm which passes through a small hole in the tunnel wall. This arm is balanced on a ball joint A, and its movement is limited by the hole in the bracket B. The model is attached to the end of the arm at C, and the lift force in the direction of the arrow is balanced by adding weights at D until the pointed end of the arm is in the centre of the hole in bracket B. The drag force is transmitted through the wire E to the bell crank and is balanced by weights on G, with fine adjustment by means of a rider on the horizontal arm. The pitching moment is balanced by adding weights to the scale pans on arm H. A well-made balance of this type can measure forces on the model of as little as one-hundredth of a pound.

In modern open-jet wind-tunnels the model is usually suspended by fine wires from a frame situated above the working section. Two pairs of wires are connected to the wings, forming a longitudinal V with

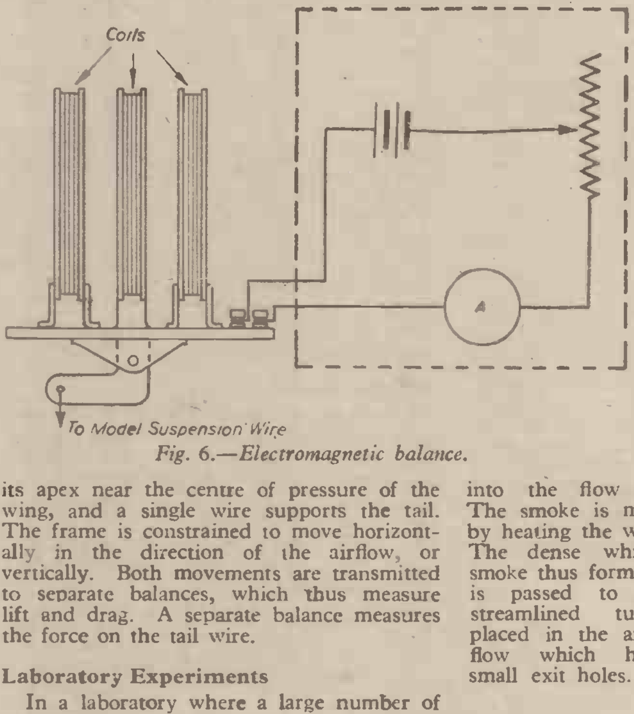


Fig. 6.—Electromagnetic balance.

its apex near the centre of pressure of the wing, and a single wire supports the tail. The frame is constrained to move horizontally in the direction of the airflow, or vertically. Both movements are transmitted to separate balances, which thus measure lift and drag. A separate balance measures the force on the tail wire.

Laboratory Experiments

In a laboratory where a large number of experiments has to be carried out the movements of the model in the tunnel, such as alteration of incidence and the adjustment of the balance, are carried out by remote control. Having set the model in the tunnel, the operator carries out the test from a control desk situated in front of the working section and protected from the draught by a transparent screen. The alteration of incidence is done by altering the length of the tail suspension wire by having the top end of the wire wound round a pulley driven by a small electric motor. The remote control of balance adjustment is facilitated by the use of an electro-magnetic balance (Fig. 6). There is a set of three coils for each force to be measured. The centre coil is pivoted at its base and is connected through a system of levers to the model. The two outside coils are fixed. The coils are connected in series in such a manner that when a current is passed through the system one coil repels the centre coil and the other attracts it, it being arranged that these forces tend to move the centre coil in opposition to the force on the model. The operator adjusts the current by means of a rheostat on his control desk until he observes, by means of a suitable optical device, that the centre coil is vertical, that is when the electrical forces on the centre coil exactly balance the aerodynamic force. He then reads off the force from an ammeter, the dial of which has been calibrated in pounds.

Construction of Models

The models used for wind-tunnel experiments must be strongly built and very accurately formed. Their construction is a skilled trade, and for large wind-tunnels a full-time model-maker is employed. The models are usually built up of laminations of mahogany with a highly polished and varnished surface. Hinges for movable control surfaces are made up from brass sheet. Putty is used for blocking holes and making minor modifications to shapes of fairings, wing roots and other parts. For compressed-air tunnel work, where forces are much greater, die cast metal models are used.

There is only space here to describe one or two of the tests that can be carried out in a wind-tunnel in addition to routine tests on lift and drag. The effect of airscrew slipstream is studied by placing a model airscrew in front of the model fuselage or engine nacelle (Fig. 7). The airscrew is mounted on a long streamlined arm projecting up from a platform on the floor below the working section. On the platform is an electric motor which drives the airscrew through a flexible drive passing through the arm. The arm is mounted on a pivot at its bottom end to allow the angle of inclination of the airscrew to be varied with change of incidence of the model.

It is sometimes convenient actually to see the airflow, and this is made possible by introducing a series of thin but dense jets of smoke into the flow in front of the model. The smoke is made in a special producer by heating the wood of a rotten apple tree. The dense white smoke thus formed is passed to a streamlined tube placed in the airflow which has small exit holes.

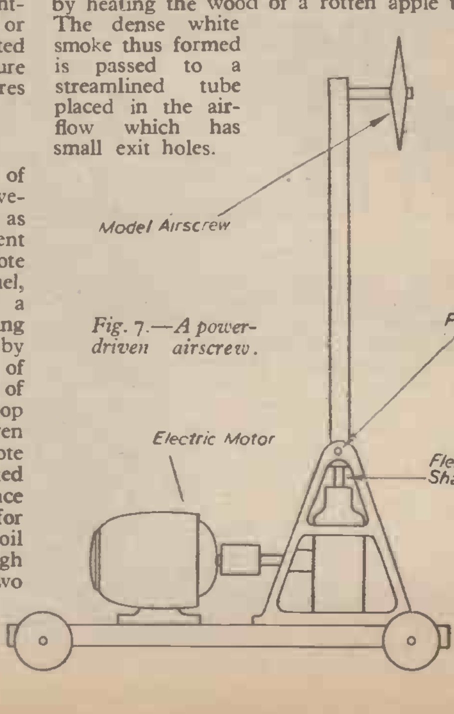


Fig. 7.—A power-driven airscrew.

Naval Bombardment

How the Co-operation of Heavy Naval Guns Plays an Important Part in Modern Warfare

By J. A. SPAR

(*Concluded from page 405, September issue*)

THE coastal road and railway at Toarmina in Sicily were completely blocked at a moment critical for the enemy, when the fire from a 15in. gun monitor caused a great landslide. The monitor, a small shallow-draught vessel mounting two heavy guns, designed to work close inshore, is one of the oldest types of armoured ships, but still proves of great value, having a fair turn of speed and being capable of being navigated among shoals and sandbanks. In the early days of the North African campaign a monitor entered Bardia harbour and impudently opened fire, causing tremendous destruction and eventually withdrawing undamaged because the Italian batteries could not depress their guns sufficiently to bring them to bear on her.

Battleships versus Shore Batteries

When the assault on Italy itself began, the battleships *H.M.S. Rodney* and *H.M.S. Nelson* shattered the defences and shore batteries of Reggio di Calabria before the landings took place. At Salerno large numbers of naval craft supplied artillery support at close range inshore. When the Germans counter-attacked, the destroyers *Laforey, Loyal, Lookout, Tartar, Nubian, Mendip, Brecon, Blankney, Dulverton, Titcott*, and *Beaufort* opened fire at point-blank range. One strongly sited battery was knocked out by *H.M.S. Laforey* at only 800 yards range. On the first day *H.M.S. Loyal* fired 1,714 rounds.

The battleships *Warspite* and *Valiant* also closed the range, coming inshore to deliver a terrific bombardment by direct fire.

Between September 5th and 15th the cruiser, *H.M.S. Uganda* fired 816 rounds of 6in. On September 15th the *U.S.S. Boise* fired 563 rounds against enemy troops and tanks. On the same day the battleships *Warspite* and *Valiant* fired 30 rounds of 15in. at long range, of which 19 fell exactly on their target. The following day they fired 32 rounds, of which half were dead on the target, and 8 more within 100 yards. Traffic concentrations were pounded and ammunition dumps blown sky high. Between September 15th and 28th, the cruisers *Aurora, Penelope, Sirius and Dido* fired 5,085 rounds of 6in. and 5.25in.

Altogether, between September 9th and 28th, 270 targets were engaged by ships by direct fire, or by indirect fire at long range. During the Sicilian and Italian campaigns alone there have been well over 800 naval bombardments. In a country whose mountainous nature restricts the use of land artillery the influence of this support from the sea can hardly be exaggerated. As on the coast of Normandy, the Navy spoke in broadsides.

In the past this was not the case, largely because naval guns lacked the necessary range and accuracy. That is, of course, compared with guns used in fixed defences ashore.

In Nelson's Day

In Nelson's time it was generally accepted that shore guns could drive off warships, particularly when they were well protected and had the advantage of superior height from which to fire. It was no use expecting a wooden ship with only the thickness of her hull to protect her guns' crews to tackle land guns protected by earth and stone.

Those were the days when solid shot was mainly used, shells being considered a new-fangled experiment and not very sporting at that. In any case, the shells of Nelson's day had very little destructive power.

All the same, warships were continually being used in actions with shore guns, and there were many instances of large-scale bombardments. Long before Nelson, in 1657, Robert Blake, the English "general at sea," destroyed 16 Spanish treasure ships lying at anchor at Santa Cruz, Teneriffe.

After the action Blake wrote: "After we had destroyed shipping we plied our guns upon the forts and beat them from some of them; the Spaniards at the first onset plied their business closely, but liked not the continuance of it. Seven or eight of their ships we had possession of, but they were either disabled by shots or by then set on fire; so that we could not get any of them off.

"By that time it was three o'clock, everything of theirs was destroyed, and by the closing of the daylight our whole fleet was in safety under sail. To the great Jehovah be ascribed all praise, and thankful acknowledgments for so great a mercy vouchsafed to the English nation."

Following on this, other names made familiar by the assault on Normandy made their appearance. Following on the famous battles of Barfleur and La Hogue, in which, by the way, an earlier Warspite took part, a systematic attempt was made to destroy the French Channel ports by naval bombardment.

Between 1693 and 1695 Admirals Shovell, Benbow, Lord John Berkeley, and others attacked Dunkirk, Calais, Dieppe, Havre, and St. Malo. Cherbourg was not at that time of any significance. The general results, however, were not of any great importance.

Famous Naval Bombardments

In the Mediterranean, the combined British and Dutch fleets under Rooke captured Gibraltar by an amphibious landing from boats, preceded by a very heavy bombardment, though it must be admitted that the Spanish shore defence was not particularly vigorous.

Another famous naval bombardment in the course of combined operations was that let loose by Admiral Sir Charles Saunders against Montcalm's defence positions along the St. Lawrence River below Quebec. But this was merely a diversion to cover various movements by Wolfe, including his famous final landing below the Heights of Abraham.

Coming down to 1801, when Napoleon was trying to achieve in Egypt what Rommel also attempted and failed to do, the British Army, under Sir Ralph Abercrombie, landed in Aboukir Bay. But on that occasion the Fleet, under Lord Keith, was unable to give the Army a covering curtain of fire against the French Army drawn up on shore to oppose it.

That landing, by the way, was in many respects similar to our landing in Normandy. The limited help given by the warships on that occasion was due to the inaccuracy of long-range naval gunfire at that time, the modern type of carefully controlled barrage being then quite impossible.

The first entirely successful naval bombardment by a major fleet was that carried out by Sir Edward Pellew, Lord Exmouth, against Algiers in 1816. The object was to wipe out the pirate stronghold which had so long made the Mediterranean unsafe for our merchant shipping. The pirates went out of business.

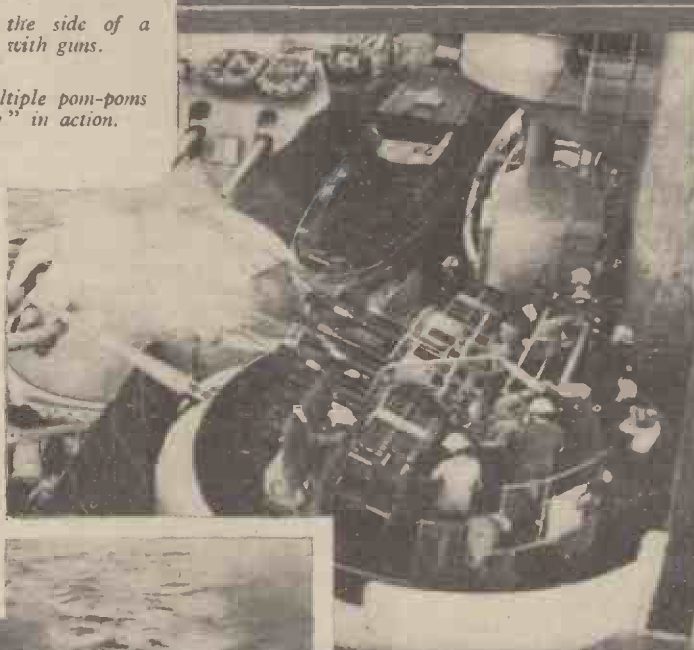
The bombardment of Algiers in 1816.

Much the same was the bombardment executed in 1840 by the British Fleet under Sir Robert Stopford and Sir Charles Napier against Mehemet Ali's Egyptian Army occupying Acre. Finding the water too shallow for a close-range attack, the Fleet kept out.

Luckily the Egyptians expected the Fleet to anchor farther out still, and raised their gun platforms to such an extent that they could not bring fire to bear sufficiently low. The result was that the Fleet, though heavily punished, completely succeeded in its object by blowing up the central magazine and putting an end to all resistance.

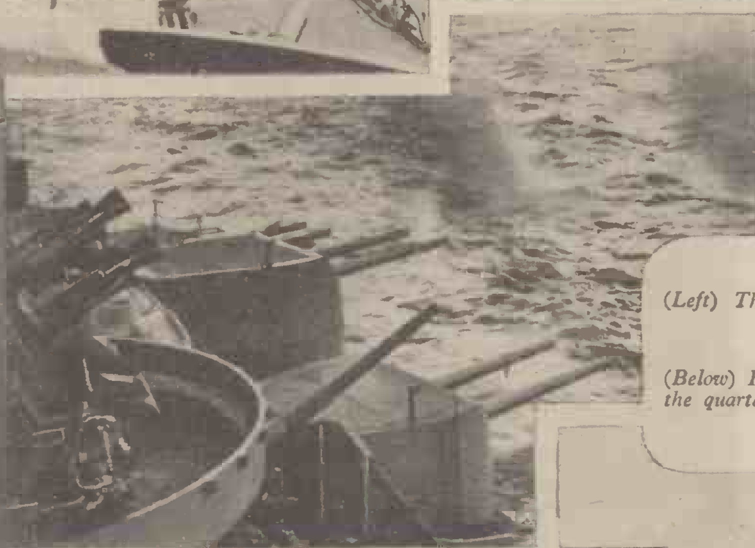
But by far the most famous of all naval bombardments of recent history occurred in the Anglo-French attack on the shore

Guns of the Royal Navy



(Left) *A close-up of the side of a battleship bristling with guns.*

(Right) *One of the multiple pom-poms of H.M.S. "Rodney" in action.*



(Left) *The secondary armament of a battleship.*

(Below) *Fourteen-inch guns firing from the quarter-deck turret of a battleship.*

British and U.S. units on the way to bombard Cherbourg. Left to right: U.S.S. "Nevada," a U.S.N. destroyer, U.S.S. "Quincy," another U.S.N. destroyer, and H.M.S. "Glasgow."

defences of Sebastopol on October 17, 1854. In that attack the heavy shell-firing guns mounted by the Russians inflicted heavy damage on the British and French ships, causing many fires and tremendous splintering—splintering was one of the chief causes of casualties in wooden ships.

The lessons learned in this action led not only to the further development of shell-firing guns in the Navy, but drove home the necessity for the immediate need for iron-clad battleships. Nor would a mere iron hull be enough to meet the case; in the absence of armour plating even an old-fashioned solid cannon ball could do considerable damage to a thin iron skin.

The lesson was learned. Exactly twelve months after this disaster the Allied Fleet bombarded the Russian forts at Kinburn at the entrance to the estuary of the River Bug. This time the British and French wooden ships of the line kept at a respectful distance, only using their guns at extreme range.

The French, however, brought up three floating batteries, whose protection of heavy armour enabled them to anchor within 1,200 yards of the forts, on which they inflicted heavy damage. They themselves got off scot free, the Russians' solid shot bouncing off their armour like peas from a pea shooter and the Russian shells breaking up without being able to penetrate.

Advent of the Ironclad

This was the start of the gradual development of the ironclad with armour plating, which, with general improvements in naval ordnance, resulted in placing warships more on an equal footing with shore defences. But it was not until this war that really large-scale naval bombardments were attempted.

The mass bombardment of the coast of Normandy and Hitler's much-vaunted Atlantic Wall had this advantage in our favour: it was delivered against a selected strip of the enemy-held coastline rather than against a specially defended port or naval base.

The only reason that we have been able to devote such a massive force to the Channel fortifications is because we first succeeded in putting both the German and Italian battleships out of business by sinking, damage or, in the case of the Italians, surrender. Only these preliminary operations freed us from the necessity of having to keep a large fleet some distance off the landing beaches to safeguard the landing operations from attack by the enemy battle fleet.

The last has not yet been heard of naval bombardments either in Europe or in the Far East. There is history still to be made, and a good deal of it will be written by the mighty broadsides of the battleships of the Royal Navy.

An Ellipsograph

A Novel Machine for Drawing Ellipses

By H. F. KING, A.F.R.Ae.S.

THE well-known methods for drawing ellipses are given in every textbook on technical drawing. Some illustrate the "Elliptic Trammels" which have two slots at right angles, and a slider bar upon which a point will trace out an ellipse, on suitably manipulating the bar.

An alternative device occurred to the writer recently and is described herewith as a matter of interest. Fig. 2 gives the clue to the mechanism. C is the point on the ellipse from orthodox construction. Since the angle in a semicircle is a right angle C will travel around the circumference of the circle of radius $\frac{a-b}{2}$ for uniform angular movement of radial arm OA. From inspection the gearing ratio is seen to be 2 : 1.

Fig. 1 illustrates a conception of the resulting mechanism. Gear "X," to which a handle and adjustable needle point are attached, is held in a fixed position, whilst gear "Y," together with the bar and sprockets or gears of 2 : 1 ratio are rotated. An adjustable pencil is attached to the smaller sprocket or gear to trace out the required ellipse.

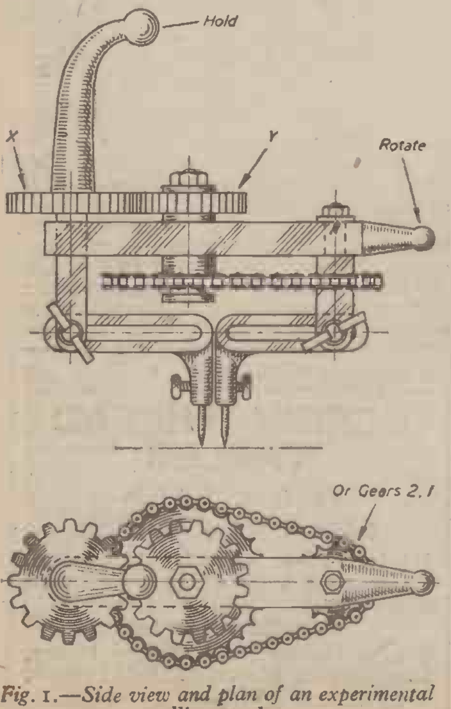


Fig. 1.—Side view and plan of an experimental ellipsograph.

A crude wooden model indicates reasonable results, but a more accurate demonstration can be obtained by the improved model shown in Fig. 3. It is realised that some limitations in practice are imposed by the proximity by which the points can be arranged.

Referring again to Fig. 2, the co-ordinates of point C are

$$\left.\begin{array}{l} y = b\cos\theta \\ x = a\sin\theta \end{array}\right\} \quad \ldots\ldots\ldots\ldots(1)$$

OC can readily be obtained by solving Δ OPC,

where $PC=\frac{a-b}{2}$ and $OP=b+\frac{a-b}{2}$

then $OC^2=\left(\frac{a-b}{2}\right)^2+\left(b+\frac{a-b}{2}\right)^2-2\left(\frac{a-b}{2}\right)\left(b+\frac{a-b}{2}\right)\cos 2\theta$

which reduces to

$OC^2 = a^2\sin^2\theta + b^2\cos^2\theta\ldots\ldots\ldots(2).$

which is obviously in agreement with 1 on adding and squaring.

Having acquired suitable gears, an instrument was constructed, as shown in Fig. 3.

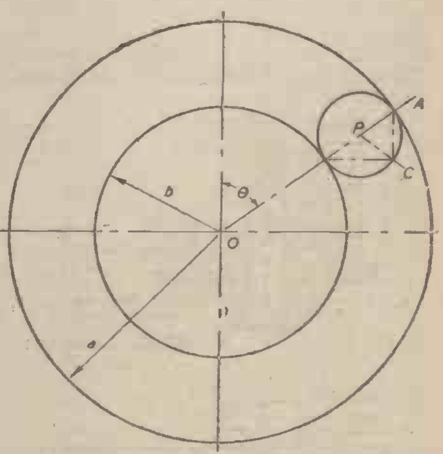


Fig. 2.—Diagram illustrating the principle of operation.

The first model was made on the compass principle, which obviously has limitations wherein the pencil leg would foul the fixed needle point, thus curtailing the range of the instrument. On account of this defect the needle leg has been removed, and the second model gives satisfactory results. A further improvement on the existing instrument could be obtained by incorporating an additional gear enabling the pencil rotating holder to be set central with the operating knob,

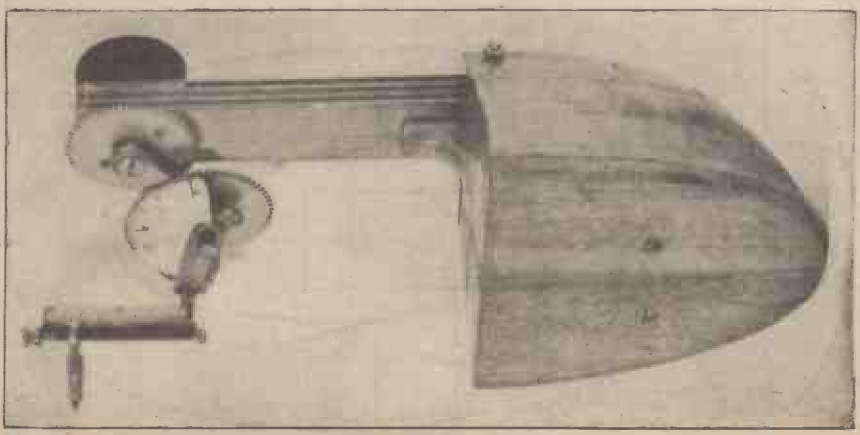


Fig. 3.—An improved ellipsograph.

whence ellipses of extremely small range could be described. This stage has not been attempted as the instrument does not appear to have commercial possibilities, although a responsible opinion has been expressed that its range of adjustability is probably greater than other existing devices.

Construction

The main points are to ensure that the spindles are a good running fit in their bearings, and the avoidance of backlash in the gears.

The wooden lever arm has brass plates attached to provide additional bearings for the operating spindle which is a running fit in the stationary gear attached to the lever arm. The lower end of the operating spindle is sweated into one end of a brass link, the other end of which is a split bearing for the tube which acts as bearings for the intermediate gear spindle and also forms the pivot for the radial links which are sweated to it. The clamp screw shown on the small split bearing locks the radial links. The outer ends of the radial links are sweated to a tube which forms the bearing for the pencil swivelling arm.

The base upon which the wooden lever arm and operating mechanism are mounted is made of hardwood laminations, and is shown in Fig. 4. Statical balance is maintained by lead counterweights recessed in holes in the largest of the laminations (counterweights not shown on the drawing). The nut and bolt shown at one end of the spring are used to vary the tension of the spring which is required to be just sufficient to keep the pencil point off the paper when not in use. Pointers are located on the centre line of the base, and this line produced should pass through the centre line of the operating rod.

Setting the Instrument

1.—A semicircular scale calibrated from 1½in. to 3in. in 1/16in. divisions is used for setting the radial links. The straight pencil leg scale is calibrated from 0 to 2in. in 1/16in. divisions.

2.—*Pencil Leg.*—Subtract CD (see Fig. 5), half the length of the minor axis from AD, half the length of the major axis. Set the pencil leg to half this dimension = AB or BC.

3.—*Radial Links.*—Determine dimension BD which is the difference between the semi axes. Rotate the radial links so that dimension DB is read on the semicircular scale.

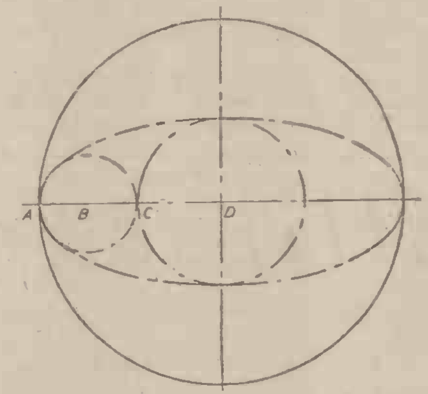


Fig. 5.—Diagram for setting of instrument.

Drawing the Ellipse

Set the instrument to be 4.4in. from the drawing centre to the front of the base of the instrument, alignment being maintained by pointers marked for this purpose on the base of the instrument.

To draw the ellipse with the major axis in any required direction, the intermediate gear wheel may be disengaged by means of its spring pin and the pencil leg pivoted to suit.

Hold the base firm with the left hand, apply slight pressure to the knob in order to bring the pencil into contact with the paper and turn the knob with the right hand.

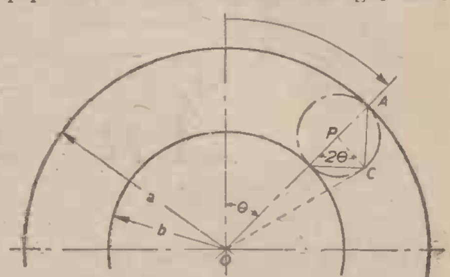


Fig. 6.—Diagram of co-ordinates.

Summary

The instrument is designed on the epicyclic principle, the ratio of the fixed gear to the small gear being 2 : 1. The radial links with fulcrum at the intermediate wheel provide adjustment for variations in ellipses of constant difference between the major and minor axes. Adjustment of the pencil leg enables the difference between the major and minor axis to be varied. The formal proof from the mathematical viewpoint is as follows:

Referring to Fig. 6 the co-ordinates of point C are:

$$\left.\begin{array}{l} y = b\cos\theta \\ x = a\sin\theta \end{array}\right\} \qquad (1)$$

OC can readily be obtained by solving triangle OPC,

where $PC = \frac{a-b}{2}$, and $OP = b + \frac{a-b}{2}$,

$$\text{then } OC^2 = \left(\frac{a-b}{2}\right)^2 + \left(b + \frac{a-b}{2}\right)^2 - 2\left(\frac{a-b}{2}\right)\left(b + \frac{a-b}{2}\right)\cos 2\theta$$

which reduces to:

$$OC^2 = a^2\sin^2\theta + b^2\cos^2\theta \qquad (2)$$

which is obviously in agreement with (1) on adding and squaring.

As a point of interest it may be noted that with the pencil leg set at zero on the scale, circles can be described, and further, with the radial links scale set at the same dimension as the pencil leg scale, the instrument will demonstrate a straight line.

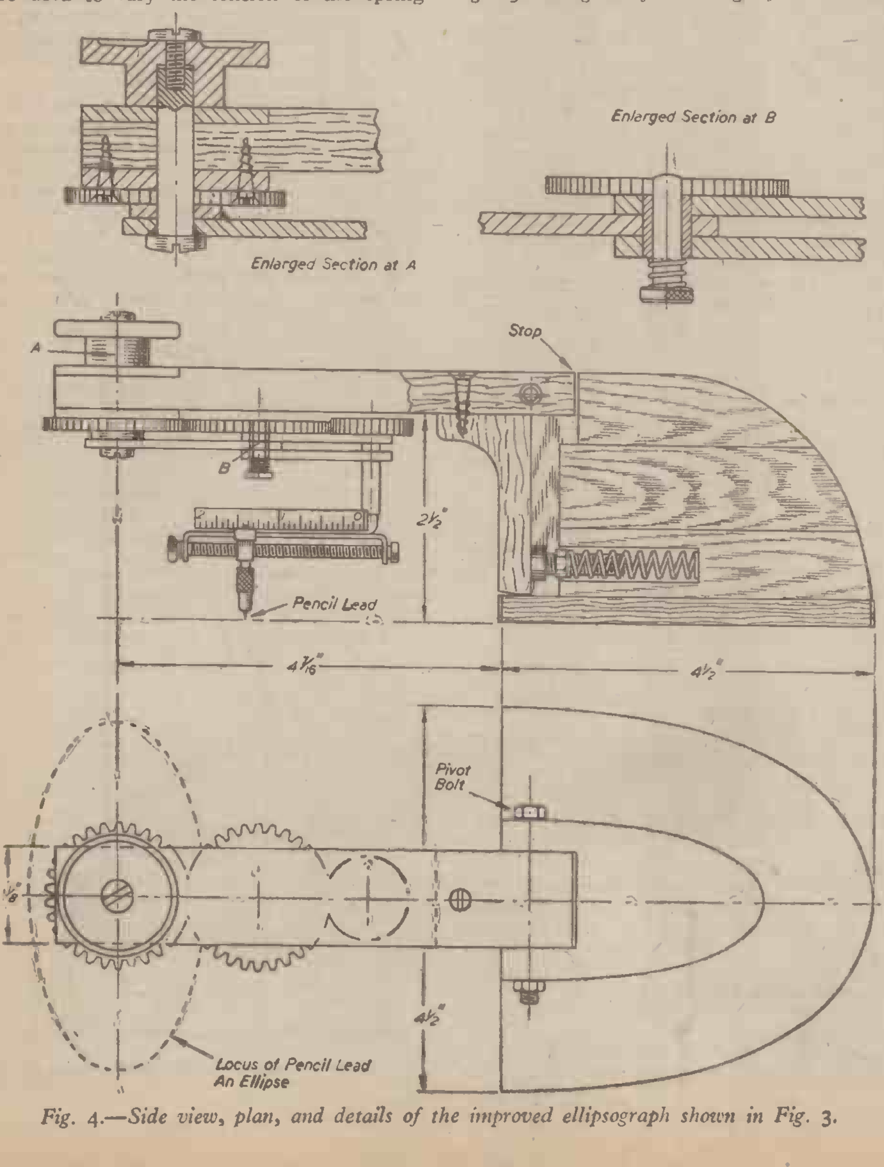


Fig. 4.—Side view, plan, and details of the improved ellipsograph shown in Fig. 3.

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The Fulham Grate

Fig. 1.—The Fulham grate in a sitting room.

Details of the Latest Domestic Grate for Burning High-temperature Coke

THE Committee of Inquiry on Coke Quality appointed by the Institution of Gas Engineers has recommended that "Coke should be regarded as a prepared fuel, requiring properly designed appliances, in the same way as other fuels—gas, electricity, oil, anthracite—require special equipment for their efficient use." For some time to come most people in this country will demand at least one open solid fuel fire in order that the living-room can be kept at a comfortable heat for long periods at reasonable cost. The use of smokeless fuels in these grates is essential if smoke is to be abolished, and of these coke is the most generally available in the largest quantity.

The amount of low-temperature coke available is relatively small, and its price per ton is high. High-temperature coke, on the other hand, is already available to the extent of millions of tons annually, and by building more gas retorts and coke ovens the supply can be increased sufficiently to replace the whole of the 40,000,000 tons of coal now used in the domestic grate. The problem of designing a grate suitable for burning this coke is thus of the greatest importance. Since we are about to embark on an extensive housing programme, the problem is also one of some urgency if the new houses are to be smokeless, and considerable progress has in fact been made. Among the outstanding designs produced during the war is the Fulham grate, which is the result of extensive experimental work at the Fulham laboratories of the Gas Light and Coke Co.

The technical problems in designing a satisfactory open domestic grate for burning high-temperature coke are many.

(1) Compared with bituminous coal, coke has a high ignition temperature and must be raised to some 550-600 deg. C., and kept at that temperature if the fire is to light and remain alight. That is an inherent characteristic of the fuel that the designer must take into consideration.

(2) The fire must be controllable, which means in practice that it must be possible for the user to regulate the temperature of the room by a simple adjustment that anyone can make.

(3) The fire must entail the minimum of work.

(4) The efficiency must be high in order that the cost of heating may be as low as possible.

(5) Unwanted variations in temperature must be reduced to the minimum. These variations occur, for example, when fresh fuel is put on a fire that has burnt low.

(6) The grate must have a long life, and the bars must not burn out frequently.

It is of interest to examine the Fulham grate, a photograph of which is shown in Fig. 1 and a drawing in Fig. 2, to see how it fulfils these conditions. The firebars, A, are supported on the frame, B, and the shelf, C. Four studs are provided along the front of the firebars so that conduction of heat to the front of the grate is reduced to a minimum. The frame, B, is rigidly fixed to the hearth; it is adjustable to fit closely to the firebricks, and the sides are sloped to direct the ash into the ashpan, D. Connecting straps join the frame, B, to the front of the grate, which is pulled tightly against the firebricks to prevent air entering the ash-pit at this point. Along the front of the fire runs a shaped brick, E, which so reduces the rate of the conduction of heat from the base of the front of the fire that the coke is kept hot. The result is that the ignition temperature of the coke is reached in a shorter time and the fire burns up quickly. An additional advantage of keeping the front of the fire hot is that the radiant efficiency of the coke is increased from 29 per cent. to 34 per cent. When recharging the fire with fresh coke, the hot coke can be pulled forward to the front and the fresh charge dropped at the back, thereby keeping the room temperature more constant.

Air Supply Control

Perhaps the most important individual feature of the fire is the close control of the primary air supply that is rendered possible by the adjustable damper, F. Laboratory experiments have shown that the air entering the ash-pit has a very much greater effect on the rate of combustion of coke than the air which passes over its surface, and that, providing the fireplace opening is not less than 20in. high, the rate of combustion can be controlled by the ash-pit damper. This damper is operated by a simple movement of the lever, G, whereby the primary air supply passing under the grate can be regulated from any amount between nil and the maximum that the draught can induce. The spacing of the louvres has been found by experiment, so that when the damper is fully opened the same amount of air can pass under the grate as when the front of the grate is removed altogether. The front, H, is virtually airtight, being machined, and pressed against the grate front by two pairs of wedges, so that when the damper is closed practically no air can enter under the grate. Thus by the regulation of the air supply the fire can be reduced to slow combustion, which enables a room to be kept warm at a cost of about ¼d. an hour, and yet is ready to burn up again quickly when the room is to be occupied. The advantages gained are that the heat output is more uniform, the grate can be completely filled with coke without fear of overheating, the fire will last for a longer time on one charge of coke, and is more economical. The adjustable air inlet in effect provides for the domestic appliance the same sort of control that is now established practice for combustion on a works scale. When the primary air inlet is closed the standard 16in. grate burns about 1lb. of coke an hour. The average burning rate to heat a room of 12ft. by 16ft. in winter is about 1¾lb. per hour.

Igniting the Fuel

The fuel is ignited by gas, the gas ignition burner, I, being incorporated in the grate. Experience shows, of course, that gas ignition is a certain and inexpensive method of lighting fires that is likely for the future entirely to supersede the old paper-and-sticks method in every type of solid fuel fire.

Across the front of the ash-pit, and forming a seal with the hearth, is the ash-pit sealing strip, J. In the centre of this strip the vertical edge has been sloped off towards the hearth. This has been provided so that ash from the hearth may be swept into the ash-pit.

When the fire is to be lighted, the first step is to rake the ash through the bars into the ash-pan, leaving the cinders behind on

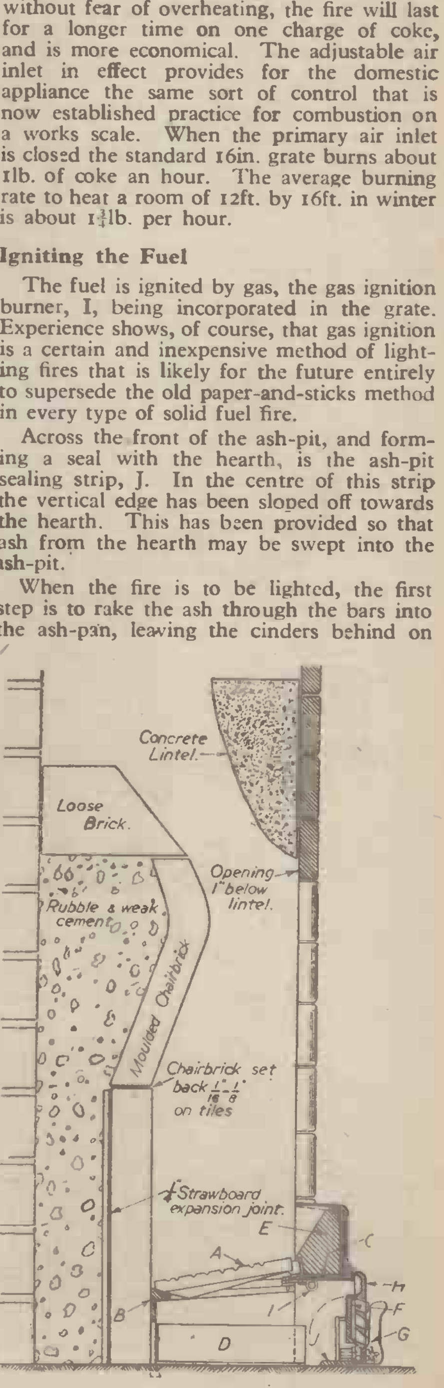


Fig. 2.—Sectional view of the Fulham grate.

the grate. The grate is then filled with coke, the amount used being about 8½ to 11 lb., according to the type of coke. The ash-pan is then emptied, and the gas-burner lighted. While the gas is on, the ash-pan is replaced, but the front of the fire is left off as a reminder to turn off the gas. After about 15 to 20 minutes the gas is turned off and the grate front replaced, with the damper fully open; a full fire is then obtained in 40 minutes from lighting the gas. If a draw-plate is used, gas ignition is only required for 10 minutes, and the fire burns up to full heat within 20 minutes. The rate of combustion is then adjusted as required by the damper. On the coldest day the fire will need to be replenished about every two to three hours; when the damper is closed and the fire is "banked" it will last for some six hours without recharging. The fire should not be disturbed with the poker more than is necessary to induce the ash to fall through the bars into the pan.

During a typical day's run, after four hours (3½ hours after the fuel was beginning to burn well) it was found necessary to refuel; fresh coke was thrown directly on to the top of the glowing embers, with the result that the radiation curve shows a marked minimum for a very few minutes. The fire was hot, however, and quickly recovered. After the fire was allowed to die out some 2lb. of cinders were left on the grate after raking the ash through the bars; these cinders would serve as the foundation for the fire on the next day, it being a well-known fact that cinders help quick ignition. Over the complete nine hours during which the fire was alight the fuel was consumed at an average rate of 1.72lb./hr., a cost of less than ½d. an hour.

The Story of Chemical Discovery

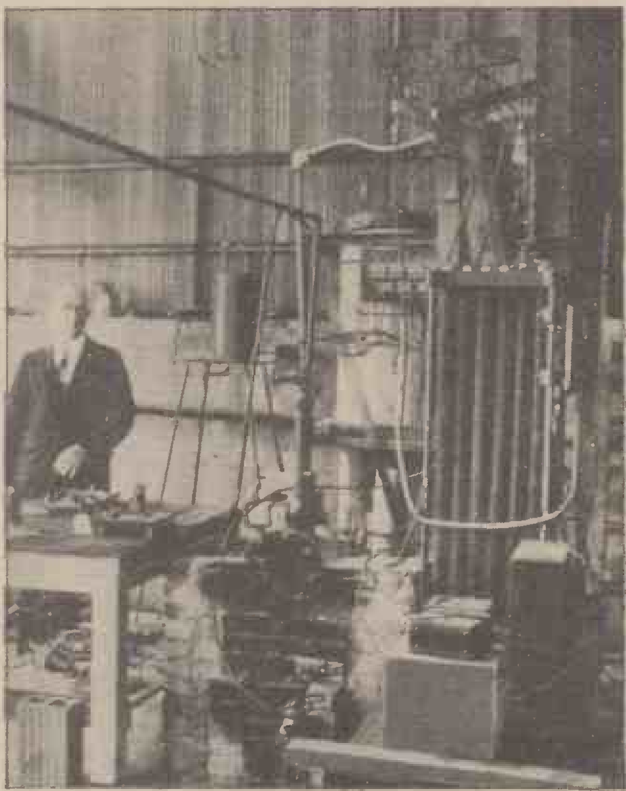
Petrol and Its Products

A Glimpse at the Vast Manufacturing Industry Which the Chemistry of Petroleum has Made Possible

WHEN, in 1859, the first petroleum well was opened up at Titusville, in Pennsylvania, interest in its products lay almost entirely in the "lamp" oil which was obtained from it. The petrol engine was unknown, and even the gas engine was then in a very crude and imperfect state. Apart, therefore, from the extraction of "lamp" or burning oil and a little lubricating oil from the crude petroleum obtained from that pioneer Titusville well, there existed no industrial call whatever for its products.

With the coming of the motor-car towards the end of the last century it began to be realised that in the lightest oils which were yielded by the distillation of crude petroleum the world had a product of first-rate value. Thus it was that the petroleum industry as we now know it was born.

It was a haphazard enough industry at first. Very little, if any, of chemical science was applied to it. All you did in those now far-off days was to take your "crude" from the well and to distil it in suitably designed stills. The light, almost water-white liquid which distilled over first you used as "petrol." The other "fractions" or portions of the distillate were sold as paraffin oil, white spirit, burning oil and, also, as various grades of lubricating oil.



An experimental still for the chemical investigation of fuels and lubricating oils.

Raw material of a new industry. Waste gases spouting from an American oil well.

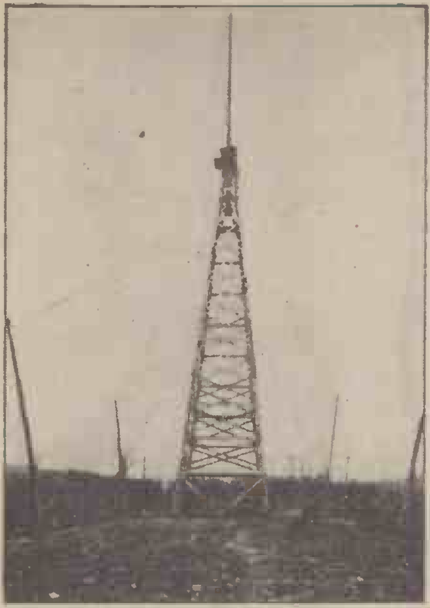
Such was the position up to the conclusion of the last world war. From the beginning of the century the petroleum industry had expanded enormously. Yet it had expanded entirely on its capital. As the demand for petrol and petrol products grew, the oil companies merely opened up more oil wells; and so the furious race between the ever-increasing demand for petrol and oil and the bringing into production of new oil wells went on for a couple of decades.

The Modern Petrol Industry

It was about 1921 that the petroleum industry established itself upon a really scientific basis. The realisation by the larger and more responsible companies that the wealth of crude petroleum which lies under the land is not unlimited, coupled with the continual and ever-increasing demand for more and more petrol, was, in the end, responsible for the bringing of the brains of the trained chemist to bear upon the many practical problems of oil production.

All this, as we have remarked, matured about the year 1921, and it is from that year that the modern and intensely fascinating industry of oil production has arisen.

One of the first attacks which industrial chemists made on the petrol supply problem was to obtain some of the higher boiling-



A newly-drilled oil well at Oil City, U.S.A. Note the central drill shaft at the top of the tower.

point petroleum distillates and to "crack" them carefully. The academic chemist would term this a process of thermal decomposition, but "cracking" is a more realistic word in industry; and it is really a perfectly accurate appellation, because in the production of petrol from a heavy oil the molecule of the latter is, by subjecting it to high temperatures, actually disrupted, split up, or, in other words, "cracked" into the smaller molecules of the petrol liquids.

It was in these circumstances that the chemical process of oil cracking came into being. The oil is vapourised and sent through high-temperature tubes at a predetermined rate. A portion of it is broken down into the light petrol liquids. The remainder is changed into heavier oils and even carbonised into coke.

In general, the cracking process was eminently successful. It was improved considerably and was then extensively brought into use in view of the fact that it conserved the use of "straight-run spirit," which latter was the petrol obtained by direct distillation of the crude petroleum oils.

One advantage of cracked petrol is that it has less "knocking" propensities than ordinary "straight-run" spirit. Exactly why this is the case was, at first, a complete mystery, but, eventually, a little intensive chemical investigation elucidated the problem. It was found that the "knocking" properties of petrol are dependent upon its chemical make-up. The constituents of petrol, which are made up of long chains of carbon and hydrogen atoms are the very worst knockers, whilst those compounds which have branched chains of carbon and hydrogen atoms knock very much less.

Now it happens that "cracked" petrol contains a greater proportion of branched-chain petrol constituents than does the straight-run spirit distilled from the crude petroleum. Thus it was hoped that by suitably mixing the two types of petrol a considerable reduction in the knocking propensities of the petrol would be obtained.

Lead Tetra-ethyl

This, indeed, was found to be the case, but chemical research went further than this. Midgley, an American worker, as a result of trying the effect of innumerable substances on the knocking properties of petrol spirit, discovered that a rather complicated compound known as lead tetra-ethyl has a most powerful influence in reducing the knocking of petrol.

Lead tetra-ethyl was almost unknown in 1923, the year in which it was first introduced for the "leading" of petrol. It was then extremely scarce, because the element, bromine, is used in its manufacture. It so happened, however, that about that time chemical research took up the problem of extracting bromine from sea water, in which it occurs in the form of magnesium bromide to a very small extent. The Dow Company, of America, was the first to solve the problem, and very quickly it had in operation a bromine-recovery plant which was quite capable of supplying all the bromine needed for America's lead tetra-ethyl manufacture. A triumph of intensive chemical research indeed!

Of more recent date still is the "polymer" motor spirit, the everyday use of which, before the war, had even then attained large proportions. "Polymer" motor spirit is material which has been produced from lighter substances through the chemical agency of "polymerisation." This term merely implies a species of chemical condensation whereby, as a result of heat treatment, with or without the use of catalysts, or reaction-activators, lighter materials are combined or condensed together to form heavier materials.

Polymer Petrol

In the instance of "polymer" petrol, the lighter materials are the waste gases which are evolved from the petroleum wells in enormous quantities and which formerly went almost entirely to waste. It is estimated that about 3,000 billion cubic feet of these waste gases are produced annually, and that if all this valuable material could be chemically polymerised or condensed it would give rise to some 1,500 million gallons of high-grade petrol.

"Polymer plants" have been operating in America for several years. The oil-well gases are subjected to heat and to pressure, under which conditions their constituent molecules link up and form heavier molecules of liquid substances, the bulk of which latter appears as motor spirit.

But even polymer spirit is not the last word in petrol production. There has been devised a chemical process of "catalytic hydrogenation," which has been applied with enormous success. Here again the "refinery gas" forms the starting point. This gas is made to undergo partial polymerisation or condensation by which it is converted into substances known as "butenes." These liquid vapours are mixed with hydrogen and subjected to heavy pressures in the presence of chemical catalysts, such as vanadium powder, platinum compounds or even iron oxide. The result of the process is that hydrogen is added on to the Butene molecules, converting them into octane, which is a light petroleum liquid of very high anti-knock rating.

The "bouncing-pin" apparatus devised by John Midgley for determining the knock ratings of petrol fuels.

A dozen years ago octane cost about £6 per gallon. Nowadays, even in its purest form, it is produced for less than as many shillings.

There are other practical systems of petrol production which are now in daily use. These, of course, all depend upon a supply of raw petroleum material, whether it be liquid or gaseous. They are necessarily all the invention of the modern chemist, and it is by their aid that the "breed" of motor spirit has been so enormously improved in recent years.

When, with the cessation of the war, a general return to petrol usage is again made, consumers will discover engine knock to be a thing of the past, for the modern chemical science of petrol production has made it readily possible to manufacture a motor spirit which will function efficiently under the highest degrees of engine compression.

Oil Purification

Thanks to the chemist, modern petrols are purer than they were in former days. The old system of crude petroleum purification comprised a treatment of the once-distilled spirit with concentrated sulphuric acid in order to destroy the impurities. But usually the petrol was rendered acid thereby. Lubricating oils particularly suffered by this treatment. Owing to their acid nature, they became chemically unstable. They slowly extracted oxygen from the air and became gummy and resinous. Moreover, they frequently corroded the metal parts with which they made contact.

Cracked, polymer and other synthetic petrols need little refining, other than a mere distillation, and the era of acid-refined oils has now gone by in consequence of the introduction of what is termed "solvent refining."

In this process, the crude oil is dissolved in certain mixed solvents, as, for example, a mixture of propane and cresylic acid. The solution of the oil is then separated into two phases, the one containing the pure oil, the other embodying its impurities. It is a simple matter to separate the solvents and to recover the purified lubricating oil from them.

Synthetic Oils

Solvent refining has done much to advance the reliability of the modern lubricating oil. But, thanks to the ingenuity of the chemist, even this process is not without its serious competitor, for there has now appeared on the horizon the "synthetic" oil manufactured by the polymerisation (condensation) and/or hydrogen-treatment of refinery gases and waste oil-well products. Synthetic lubricating oils have not yet been fully tried out in daily civilisation. Yet their future production in large quantities is assured and the scope for their utilisation is vast.

Chemical discovery in the realm of petroleum products has not stopped at petrol and oil production. It has over-stepped its original boundaries and has proceeded to attack new domains of industrial chemistry. Already its conquests are of enormous economic importance, for just as the application of chemical research to the coal-tar industry resulted in the production of a multiplicity of chemical products ranging from dyestuffs to disinfectants and from perfumes to synthetic drugs, so, also, is the modern impact of chemical study wholly revolutionising the structure of the entire petroleum industry in consequence of the enormous extension of the range of its products which is now being created.

A decade ago one might have been justified in considering that merely petrol and its allied oils were obtainable from crude petroleum. Nowadays, however, chemical methods have been worked out for the production of alcohol, acetone, acetylene, glycerine, toluene and even artificial resins and synthetic rubber from crude petroleum materials only.

Alcohol and Anti-freezes

One of the first attacks upon the problem of extending the range of petrol products resulted in the commercial manufacture of ethylene glycol, a well-known solvent and anti-freeze agent, which, some 20 years ago, was a chemical curiosity.

Having successfully commercialised ethylene glycol, which they produced from petroleum gases, the petroleum researchers turned their attention to the obtaining of alcohols from petroleum residues.

Several methods of converting the waste petrol refinery gases into the popular ethyl alcohol are now available. Such methods also, when suitably modified, are productive of other types of alcohols, so that it is now commercially possible to derive a large range of alcohol substances from one or two types of petroleum gas.

Alcohols can, of course, be chemically converted into various other substances of high economic importance. For example, from ethyl alcohol we can obtain acetone, a most useful and indispensable solvent. By combining various alcohols with acids we obtain "esters," which comprise a class of usually pleasant-smelling substances which have valuable solvent properties besides being concerned in the production of various perfumes, flavours and other chemical articles.

Acetylene can be obtained by the heat treatment of the methane contained in petroleum gas, and from acetylene is derived an entire world of chemical materials, including certain types of artificial rubbers.

Synthetic Glycerine

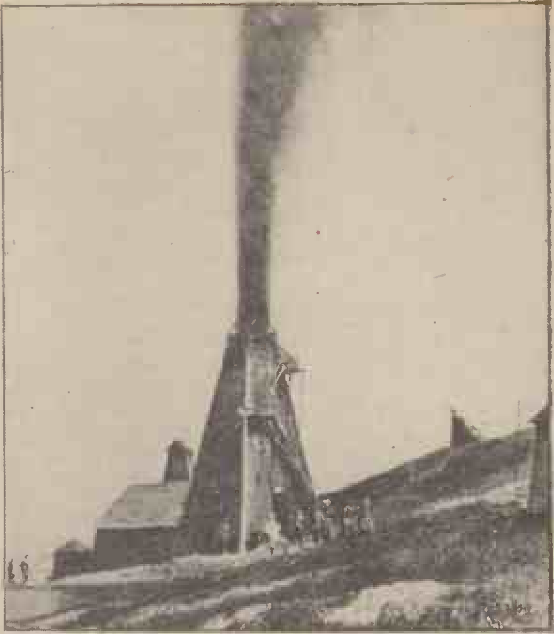
Another product of petroleum gas is propylene. This is fairly readily convertible into iso-propyl alcohol, which, by a chemical removal of a portion of its hydrogen, can be turned into acetone. But the propylene synthesis is likely to prove even more useful than this, for, by the treatment of propylene at high temperatures with chlorine gas and the subsequent treatment of the product with water, an alcohol is obtained which can be directly converted into glycerine.

The synthesis of glycerine has long been known to the chemical theorists, but up to the time of the petroleum synthesis it has never been found practicable to work the artificial glycerine method in view of the scarcity of the necessary raw materials. Consequently all the world's glycerine has had to be derived from the chemical treatment (saponification) of fats, as a residue of the soap-making industry.

The production of glycerine from petroleum gases now frees this commodity's market from the entire domination of the soap-making interests. One of the most valuable of industrial chemicals, glycerine, will, in the future, tend to become increasingly common and cheaper.

Many modern products are prepared in the form of emulsions, that is to say, in a condition of fine particles dispersed throughout a liquid medium. Milk, for example, is a natural emulsion of solid fats. Many artificially produced emulsions, however, closely follow the emulsification efficiency of milk, and in this connection it is interesting to note that one of the petroleum industry's latest developments is to be seen in the manufacture of *morpholine*, a chemical emulsifier of very high efficiency.

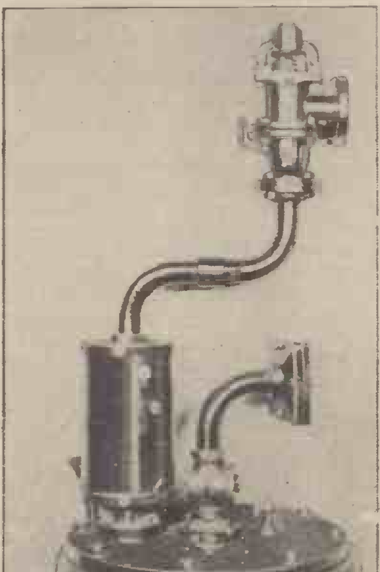
Six or seven years ago morpholine was to be classed among the rarest of chemicals. Nowadays, although its use is restricted severely under war conditions, this commodity is potentially plentiful. The chemical world will, indeed, in the future hear more of morpholine (originally so named on account of its incorrectly supposed chemical relationship to *morphia*, the drug), for this curious alkaline liquid seems to have the property of being able to dissolve a greater number of substances than any other single liquid.



A column of petrol and gas being hurled into the air from a newly-drilled oil well in Southern Russia.

Petrol Rubbers

It is not now possible for us to enter into the matter of the synthetic rubbers which are obtainable from petrol products, except to mention the fact that an American material styled "butyl rubber" has been claimed to be a 100 per cent. petroleum product which resembles raw crêpe rubber, and is stated to be more resistant to chemical attack than ordinary rubber. Butyl rubber is obtained by the chemical polymerisation of certain of the petroleum gases containing ethylene. The process is a secret one, particularly in regard to its working details.



The first carburettor for the vaporisation of petroleum fuels. It was made by Benz, in Germany, about 1886, and was used for gas engines.

Sufficient now has been said to indicate the enormous field of successful synthesis and chemical creation which awaits the trained investigator in the rapidly increasing domain of petroleum and its products. Many chemists have opined that just as the coal tar industry was the chemical field of yesterday, so the petroleum industry has provided the chemical kingdom of to-morrow.

Future Developments

It is certain that as chemical methods develop, particularly in America, the scene of industrial chemical activity will shift more and more from coal tar and its allied materials to petroleum and its gases, for, even more than the black, tarry matter of coal-distillation ever did, it would seem that the industry of motor spirit and lubricating oil production is potentially able to supply the chemist with a variety of chemical "bricks" out of which many important and as yet unknown products will, in the course of time, arise for the use and benefit of all the well-meaning nations of the world.

Johnsons' Photographic Competition Prizewinners

MESSRS. JOHNSON & SONS, Manufacturing Chemists, of Hendon, London, N.W.4, recently forwarded us the list of prizewinners in their June, 1944, Photographic Competition, which appears to have been a very popular one.

The winners of the two first prizes of £5 are: Mr. Philip Johnson, 23, Alexandra Road, Peterborough, and Rev. R. Caudwell, Westwick Rectory, Norfolk. Three second prizes of £2 each are awarded to Mr. Victor Tee, of Gosport, Hants; Mr. W. K. Chadburn, of Northfield, Birmingham; and Mrs. Dolce L. Rowan, of Ventnor, I. of W.

There were also ten third prizes of £1, twenty-four prizes of 10s., and twenty-five consolation prizes awarded to other successful competitors.

A Twin-solenoid Electro-motor

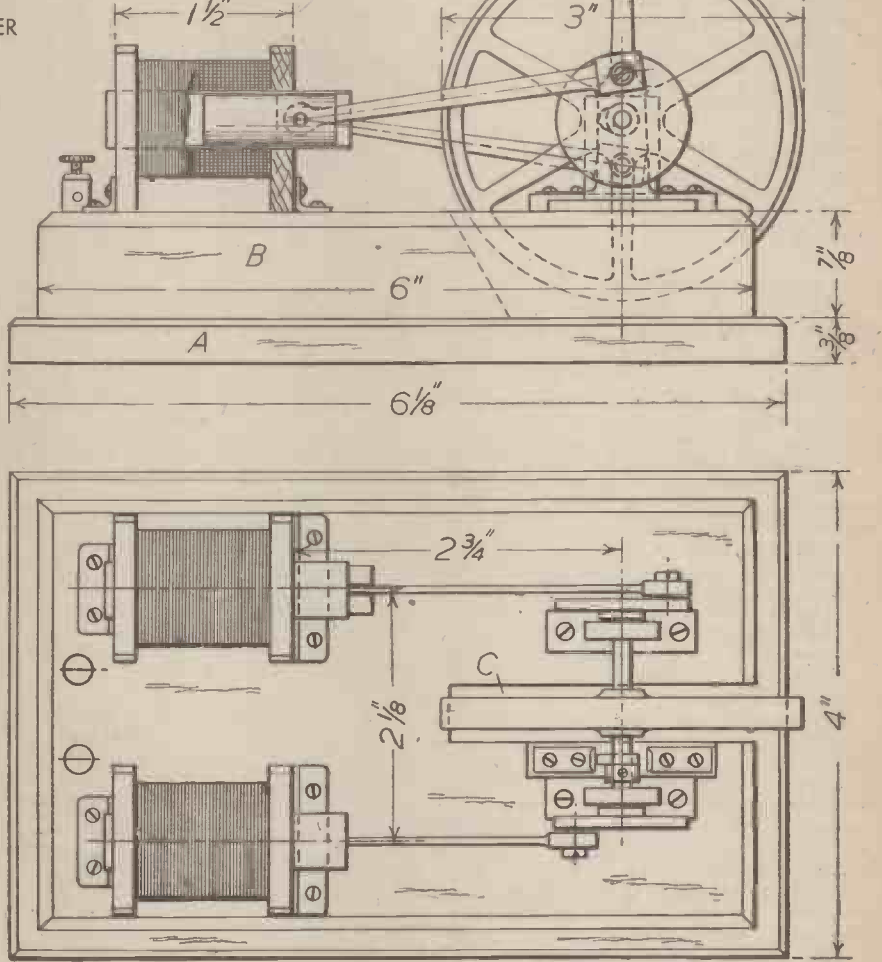
Constructional Details of a Simple-working Electric Motor of a Novel Character.

By ENGINEER

THE simple motor described in the present article does not work on the orthodox principle, i.e., an armature revolving in a magnetic field, but derives its driving force from two solenoid coils, in the hollow cores of which slide soft iron plungers.

To each plunger is pivoted one end of a connecting rod, the other end of each rod being connected to a crank-disc on the end of the flywheel shaft, as shown in Figs. 1 and 2. By means of a contact cam fitted to this shaft the current from a battery is caused to flow through each coil alternately and at the same time pulling in its plunger, thus giving an impulse to the crank and causing the flywheel to revolve.

Some of the necessary materials for making the motor can probably be requisitioned from the scrap box, while other items, such as the flywheel, brass tubing and steel rod, may have to be purchased.



Figs. 1 and 2.—Part sectional side elevation and plan of the twin-solenoid electric motor.

Baseboard and Plinth

To begin with, two pieces of wood will be required for the baseboard A and the plinth B. The baseboard A may consist of a piece of deal 6½in. long, 4in. wide and ⅜in. thick, with the top edge chamfered all round. For the plinth a piece of wood ⅞in. thick will be required measuring 6in. long by 3½in. wide. After chamfering the top edge, cut out the slot C for the flywheel and fix the plinth in position with four ¾in. countersunk screws (one near each corner) driven in from underneath the baseboard.

It would be as well at this stage to give the baseboard and plinth a coating of varnish stain and then put them on one side to dry.

Solenoid Bobbins

For the solenoid bobbins two pieces of thin brass tubing will be required, each 2in. long and ½in. outside diameter. Fitting tightly on each tube are the two wooden end-pieces (preferably of satin walnut), which can be cut to the dimensions given at D (Fig. 3). Before cutting out these end pieces, bore the ½in. holes with a brace and centre-bit. Smooth the edges of each piece of wood with fine glasspaper and, if necessary, rub round the edges of the central holes till they are a fairly tight fit on the tubes. Apply a thin film of liquid glue round the edge of the holes, and push the end pieces in position on each tube so that 1/16in. of the latter projects at one end, and 7/16in. at the other, as shown in Figs. 1 and 2. Adjust the end pieces so that the bottom edges rest flat on a level surface.

After the glue has set hard, each bobbin can be wound with 26 gauge d.c.c. wire till the coil measures 1in. outside diameter, leaving about 8in. of free wire at the starting and finishing ends for connecting-up purposes. About 3oz. of wire will be required altogether, and before commencing the wiring stick a layer of thin brown paper around each bobbin tube. After winding one coil, tie a piece of strong thread round the last two or three turns to prevent the coil from unwinding. Treat the other coil in the same way.

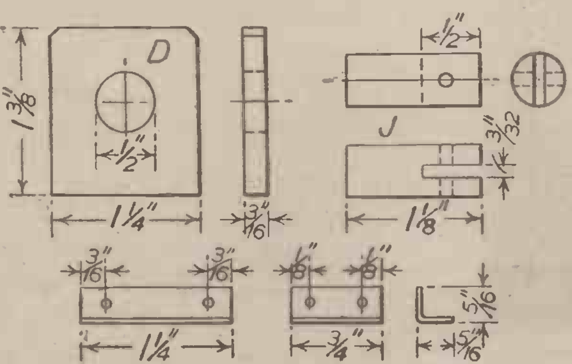


Fig. 3.—Details of bobbin ends, supporting angles and plunger.

Crankshaft and Flywheel

For the crankshaft, E, a piece of 5/32in. steel rod, 1 15/16in. long, will be required, threaded at each end to take the crank-discs, F, Fig. 5. These discs, made from sheet brass, are 1⅛in. diameter, and two holes are drilled and tapped in each to take the threaded ends of the shaft and the crank-pins. Before tapping the holes for the shaft, solder a brass washer, 1/16in. thick, to the centre of each disc, and tap the hole through in one operation. For the crank-pins two ⅛in. machine screws can be used, part of the screwed ends being cut away, as indicated in Fig. 5, to give the required length.

The flywheel is a light brass one, 3in. diameter, and it is fixed to the shaft by means of a small grub screw in the boss. A suitable wheel can be obtained from one of the model-maker's supply stores advertising in PRACTICAL MECHANICS. The contact cam, G (Fig. 5), consists of a short piece of thick brass tubing with a pear-shaped piece of 1/16in. thick sheet brass soldered on one end. The hole through the cam must be a good fit to the shaft, and a 1/16in. hole to take a small grub screw can be drilled and tapped as indicated.

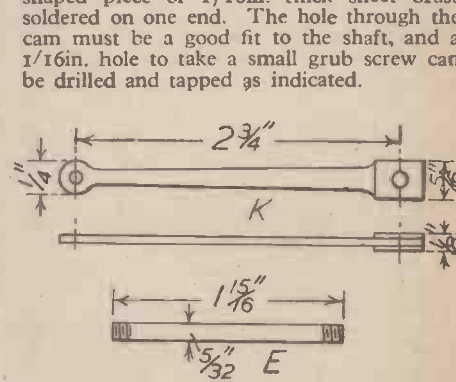


Fig. 4.—Connecting rod and crankshaft.

Bearings

Each bearing is formed of two pieces of sheet brass, the upright part, H, being 1/8in. thick, and the base 1/16in. thick. After filing the edges of each part square and parallel, drill the holes for the crankshaft and fixing screws and carefully sweat the two parts of each bearing together with soft solder. This is best done by clamping together and holding in a Bunsen flame after well tinning the surfaces which come in contact. Particular care should be taken to ensure that the parts H are square with the bases.

Plungers and Connecting Rods

Each plunger, J, consists of a piece of soft iron rod 1 1/8in. long and of a diameter which permits it to slide easily within the hollow core of the solenoid. At a distance of 5/16in. from the end of each plunger a 3/32in. hole is drilled through for the pivot pin, and a slot made, as in Fig. 3, to take the end of the connecting rod. The pivot pins are cut from 3/32in. mild steel rod.

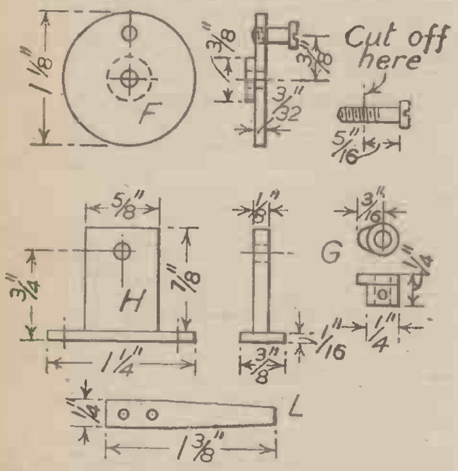


Fig. 5.—Crank-disc, bearings, contact-cam and spring.

The connecting rods, K, can be made from a piece of 1/16in. flat sheet brass, 3 1/2in. long and 1in. wide. With a sharp scriber mark out the shape of the two rods, side by side, to the dimensions given in Fig. 4. Drill the holes for the pivot and crank pins, cut the piece of brass in half with a hack-saw, and file each rod to the shape required. A side plate, cut from 1/32in. sheet brass, is sweated on to each side of the "big end" of the connecting rod, and the hole for the crank-pin drilled a correct fit.

Assembling the Parts

It will be noticed, with reference to Figs. 1 and 2, that the solenoid coils are fixed in position by pieces of light angle-brass which are screwed to the ends of each coil, and to the plinth, with round-headed brass screws. The dimensions for these angle-pieces are given in Fig. 3. Screw the angle-pieces to the coil ends first, and then mark the positions of the screw holes in the plinth, so that when the coil ends are screwed down, the centres of the solenoid coils are 2 1/8in. apart (see Fig. 2).

Now take the crankshaft with the flywheel and contact cam in place and, after slipping on the bearings, screw these down on the plinth so that the shaft is at right angles to the centres of the solenoids. Note also that the centre of the shaft should be 2 1/4in. from the front faces of the coils.

Screw on the crank-discs and adjust them so that the crank-pins are set at 180 degrees. Connect the small ends of the connecting rods to the plungers by pressing in the pivot pins, and after slipping the plungers in the solenoid cores, pass the crank-pins through the other ends of the connecting rods and screw the crank-pins into the discs.

The two contact springs, L, cut to the dimensions given in Fig. 5, from a piece of thin, springy sheet brass, are mounted on a strip of fibre or hardwood. The fixing screws pass through this into the plinth.

After screwing two terminals into the plinth, as in Fig. 2, the wiring connections can be made. The two wires from the rear ends of the coils are taken to one terminal and the other terminal is connected to the nearest bearing. The other end of the winding of one coil is taken to one contact spring, and the remaining of the winding of the other coil is connected to the other contact spring, as indicated in the diagram Fig. 6. Adjust the contact cam so that it is at right angles to the two crank-pins, and tighten up the grub screw. See that the nose of the cam rubs lightly against each contact spring in turn when the flywheel shaft is turned.

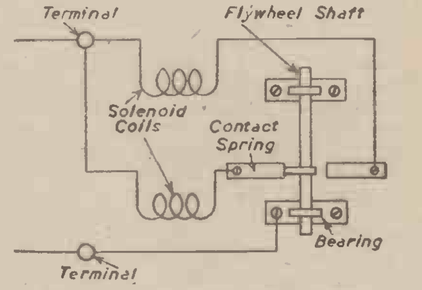


Fig. 6.—Diagram of connections.

Apply a spot of fine machine oil to the bearings, crank-pins and plungers, and give the flywheel a few turns to see if everything runs smoothly. On connecting the terminals to a 4-volt accumulator, and giving the fly-wheel a turn with the hand, the motor should run at a fair speed. It may be necessary to make a final adjustment to the contact-cam before the best position is obtained.

The Ceiling Projector

A Powerful Searchlight which Simplifies Locating Altitude of Clouds

A FIVE-MILE-HIGH beam of light that makes it a simple matter to find the altitude of clouds is helping to overcome flying hazards for airmen at home, and in battle areas.

Nearly 100,000 times as strong as that from a reading lamp, the beam is shot from a 16in. searchlight, called a ceiling projector, and literally searches out the exact location of cloud-layers, leaving a record which the field observer readily transcribes into ceiling height and passes on to the pilot approaching for a landing.

"By means of this light, the height of clouds anywhere from zero ceiling up to 28,000ft. can be measured," declared W. A. Pennow, section engineer at the Westinghouse Lighting Division, Cleveland, Ohio, where the lights are manufactured. "With this information radioed to him at frequent intervals, the pilot can determine whether it is safe to land at one airport or go on to another where ceiling conditions are better."

Beam is Rapid Calculator

Ceiling information is especially useful to a pilot flying above unfamiliar terrain since a low-lying bank of clouds may obscure a hilltop or ridge in the plane's path.

The job of calculating the height of clouds is done in a matter of seconds. The beam from the projector is shot straight up in the air and strikes against the first layer of clouds it contacts, forming a round bright spot about the size of a dinner plate.

Meanwhile on the field an observer stands ready with a sighting device that closely resembles the sextant seamen use to shoot the sun. Called an alidade, the instrument consists of a telescope-like tube about a foot long through which the observer sights the bright spot made by the beam. The tube swings on a pivot across a semi-circular strip of steel marked off in hundreds and thousands of feet.

To focus on the beam the observer adjusts his sights until the bright spot on the clouds is in the exact centre of a mirror in the lower end of the alidade. He then tightens the tube into position and a marker at the other end points to the exact altitude of the clouds.

Based on Simple Principle

The principle behind this calculation is as follows: The projector and alidade are fastened to the roofs of airport hangars on the same level and at a distance of 1,000ft. from each other. The beam is shot into the air at a perfect 90 degrees angle. When the observer "draws a bead" on the bright spot overhead, a perfect right-angled triangle is formed, with the hangar roofs as a base. Knowing one side and two angles of a right-angled triangle, it is simple to find the dimensions of the other two sides.

The ceiling projector being tested.

Rocket Propulsion

Further Notes on Its History and Development

By K. W. GATLAND

(*Continued from page 411, September issue*)

SHORTLY after the Valier liquid fuel car trials of April, 1930, the original vehicle was adapted to greater power by the provision of an improved Heylandt rocket motor. Trials of the car using the new reaction system were scheduled for May 17th.

It was while carrying out a final check of the fuel tank capacity, just prior to the initial test, however, that an accident occurred—Max Valier being instantly killed when an explosion completely wrecked the vehicle. Thus, at the age of 35, a brilliant career was brought to a most untimely end. In memorial of this great rocket engineer, David Lasser (founder of the American Interplanetary Society) dedicated his book, *The Conquest of Space*, published in 1931: "To Max Valier, the first to give his Life for the Conquest of Space."

Coupled with the success of Dr. Goddard's early work in the field of liquid propellant research, the very promising results achieved in the Valier car trials, using the Heylandt constant volume combustion chamber, undoubtedly did much to promote widespread interest in the possibilities of liquid rocket fuels.

Solid Fuels and their Control

As has been mentioned earlier, the German rocket vehicle and aircraft experiments served to emphasise the point of limited control in the employment of the solid fuel, illustrating effectively that, once ignited, it is virtually impossible to regulate the reactive effort of any single powder charge. Opel and Valier, of course, had achieved a certain though small degree of control by the simple procedure of employing a *number* of ordinary powder charges, firing them in sequence; but, as will be readily appreciated, this solution was by no means adequate for truly practical purposes.

The firing duration of this system, too, had severe limitations. As an example, it is of interest to note that a single 10lb. charge of the rocket battery employed in the 'plane in which Fritz von Opel made his memorable flight of 1929 operated for a period of only 25 seconds while developing an average thrust of 53lb.

The solid propellant is generally contained *within* the "combustion chamber" (a tube closed at one end and constricted to form a narrow orifice at the other), and upon ignition the fuel burns rapidly without exploding, the gases developed exerting considerable pressure inside the chamber before their final ejection in the form of a high-velocity efflux.

A German design evolved in 1930, developed on the lines of the liquid propellant constant volume combustion system, provided a pressure feeding arrangement in which it was intended to actually *pump* powder fuel into a combustion chamber from a separate containing tank. However, the device when tested proved unreliable in operation, mainly because of the high-feed system pressure, which invariably caused premature explosions while the fuel was being forced into the combustion chamber.

It was Dr. Goddard, however, who provided the most satisfactory solution to the problem of solid propellant control in a reloading mechanism which has since become known as the "cartridge injector." This device consisted essentially of a combustion unit, which recoiled under the action of thrust, and by means of its travel successive charges of nitro-cellulose powder were automatically fed, reloading being effected in much the same way as in a rapid-fire gun. Much of the early work concerned with the "cartridge injector" was carried out in 1918—at about the same time as Dr. Goddard's early powder researches, mention of which has already been made. Later, however, the device was improved to enable a greater number of cartridges to be fired than had hitherto been possible. This particular motor formed the basis of a design for an unmanned rocket projectile intended to penetrate to outer space and reach the moon. Its arrival on the lunar surface was to have been marked by the firing, on impact, of a flash powder charge, the rocket being directed to fall on that portion of the moon in shadow. It was considered that the combustion of merely a few pounds of flash powder would be sufficient for astronomers on earth to recognise the projectile's arrival. Dr Goddard's figures give the total initial mass for such a projectile as eight to ten tons.

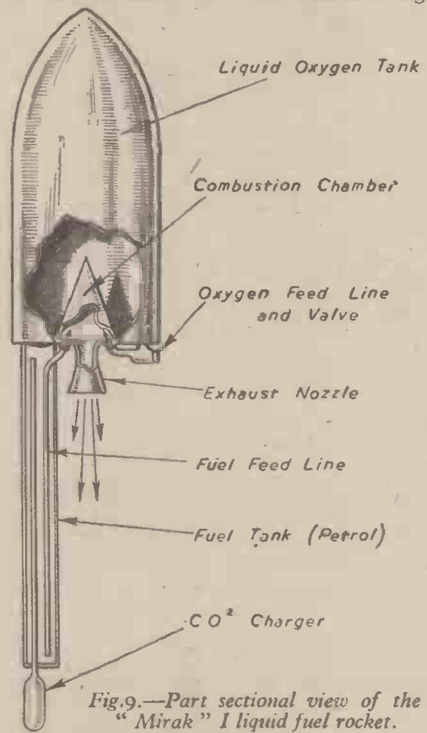


Fig.9.—Part sectional view of the "Mirak" I liquid fuel rocket.

Tiling Powder Rocket

Mention has already been made of the highly successful Schmiedle postal rockets, which employed powder as fuel; but this experimenter was by no means alone in his adherence to the solid propellant. Ing. Reinhold Tiling, for instance, carried out several highly successful powder rocket experiments during the early 1930's, and many of his rockets proved well able to rise to heights of over a mile, attaining speeds in excess of 700 m.p.h. A rather interesting feature of the Tiling projectile was that instead of providing a parachute for landing, a retractable rotor blade device was fitted, operated by means of a clockwork timer, the rocket wafting down to earth emulating the autogyro. Other Tiling projects included winged projectiles, and although not of a very great size—one particular type being 4ft. 6in. in length and nearly 7ft. span—their performances were highly creditable. Many of Tilings rockets were mail-carriers, and one of his most successful postal "shots" took place in 1931, when a projectile containing 200 items of mail was "shot" for a distance of nearly 6,000ft. Two years later, in October, 1933, while engaged on research concerning some 40lb. of powder, Ing. Reinhold Tiling, and three assistants, were killed as the result of a sudden explosion which destroyed the small building in which they were working. This tragedy provided dramatic proof of the severe instability of pre-mixed fuel, and undoubtedly did much to hasten the decline in interest amongst rocket authorities of the solid propellant. Nevertheless, Tiling was by no means the last to employ fuel powders, as it is intended to show in a subsequent article.

The Oberth Step-rocket

Meanwhile, Professor Oberth was busy developing a theoretical basis for flight in interplanetary space, his investigations being based on the *step-rocket* principle.

The space-vessel proposed by Oberth consisted of three *steps* (independent rocket units, each containing their own fuel and motors), the calculations being based on the most powerful fuel available—liquid oxygen/liquid hydrogen.

The weight disposition was calculated as follows: For the first *step* (at the head of the vessel) he proposed a total weight of 80 tons; 60 tons fuel, 10 tons structure and 10 tons payload (crew and equipment), this being the smallest of the *step* units. The second *step*, attached beneath the first, would include 480 tons of fuel and 80 tons structure, bringing the combined weight of the two to 640 tons. To this a third and final *step* was added, consisting of 3,840 tons of fuel and 640 tons structure, makiug the total initial mass weight for the complete vessel 5,120 tons.

It must be borne in mind that the initial mass of 5,120 tons would be sufficient only to gain release velocity from the earth's gravitational influence, and would not provide for return. To enable the vessel to return to earth a fourth *step* would be required, and, working to the same ratio, this would bring the total weight of the initial mass to 40,960 tons—clearly, not a truly practical solution.

Oberth conceived the operational sequence as follows: The third *step* would be employed first, the 3,840 tons of fuel contained being sufficient to impart to the complete vessel a velocity of 2½ miles per second. As soon as the fuel in this step had been consumed the empty structure would provide only dead weight to the vessel, and would therefore be detached and either destroyed by explosives or returned gently to earth by parachute in order to minimise risk to life and property.

The vessel, now consisting of two steps, is travelling at a velocity of 2½ miles per second, and weighs merely 640 tons. The second *step* would next be operated, the 380 tons of fuel contained permitting a further rise in speed of 2½ miles per second. Once more, when the fuel in this *step* is exhausted, the dead weight would be jettisoned, leaving the first and final 80 ton step with a momentum of 5 miles per second. Of this, 60 tons is fuel—sufficient to increase the velocity to 7 miles per second, and so obtain gravitational release.

From the above it can readily be appreciated that the key to economic space flight is in the jettisoning of irrelevant material as the vessel proceeds against a constantly diminishing gravitational influence. The vessel is made progressively lighter, and in consequence a considerable economy in fuel is effected. Thus an interplanetary vessel not designed on the *step* principle would be of even greater initial mass than the Oberth conception.

It should not be concluded from the above that an interplanetary space-vessel must necessarily be of such proportions as in the case given. Nor does the solution remain alone in the discovery of some as yet unknown fuel of high energy characteristic. The answer is involved in many considerations, chief amongst which are—(a) the development of rocket combustion motors of high thermo-mechanical efficiency, and (b) provision of the highest possible fuel/weight ratio.

Film "Girl in the Moon"

On behalf of the Verein für Raumschiffsfahrt E.V., Professor Oberth gave technical assistance in the production of the German Ufa film "Frau im Mond" (Girl in the Moon) adapted from the novel by the well-known German authoress, Thea von Harbon. For filming purposes a sizeable model space-ship was built, and in recognition of Oberth's part in the production, and also to gain publicity for the film, the Ufa group sponsored the building of a large liquid fuel altitude rocket. Unfortunately, for financial and other reasons, construction was never finally completed. Nevertheless, the film when finished in the early 1930's was a complete success, and undoubtedly did much in the way of publicity for the German society.

The "Mirak" Programme

The constant volume combustion chamber employing liquid fuel had shown great promise in the early tests of the type conducted by Goddard, Heyland and Valier, and this success undoubtedly influenced the Verein für Raumschiffsfahrt engineers in their decision to conduct a detailed series of experiments to determine the most efficient combustion chamber forms, and the most satisfactory methods of liquid propellant feed.

The first series of experiments (known as the "Mirak" programme) covered the development of a number of small rocket units, these being originated with the view of obtaining empirical data upon which to base the design of further rocket motors on a more exacting basis. The "Mirak" (lesser rocket) rockets were not designed with the intention of their being fired in free flight, but rather for rest on a special proving stand, a device with which it is possible to record such essential data as the thrust reaction and the exhaust velocity, the former being registered direct by means of a sprung attachment, the latter being computed from the thrust and amount of fuel consumed. This particular proving stand served a dual purpose in that, should the rocket units satisfactorily conclude their ground trials, by means of a launching attachment they could be actually shot in free flight.

"Mirak" I: Design

Work on the first liquid fuel rocket of the experimental programme, "Mirak" I (Fig. 9), was commenced early in 1930, a main feature being that a gas (pressure) system was provided for feeding the propellant.

The design incorporated a tankage space in the form of a stream-lined nosing shell, wherein the liquid oxygen was contained, a combustion chamber of conical form being situated within, its efflux nozzle protruding centrally from the tank base. Off-centre to the nozzle a single tube containing fuel petrol was situated, at the extreme end of which was fitted a small CO^2 pressure charger for feeding the fuel. Valves incorporated in the feed lines connecting the respective tanks to the combustion chamber were provided for controlling the rate of delivery.

As has already been mentioned, liquid oxygen evaporates rapidly at normal atmospheric temperatures, and good account of this peculiarity was taken in the design, it being found that the self-developed pressure would be amply sufficient to force the oxygen to the combustion chamber without additional aid. Heat from the combustion chamber served to increase the rate of evaporation, the liquid oxygen acting in reverse as a coolant for the motor.

Materials

Particular attention was required in the choice of materials. It was found, for instance, that many metals were apt to become brittle in contact with liquid oxygen, and this factor naturally set a problem in the construction of the tank. At the other end of the scale the construction of the combustion chamber, too, demanded careful attention. A material was required capable of resisting the intense heat likely to be generated, and one also that would not disrupt under high pressure.

After due consideration, it was decided to employ, in this first design, duralumin for both the oxygen and fuel tanks, and a special heavy copper alloy for the combustion chamber.

Trials

The first "Mirak" was completed well before the end of the year, and, although tests proved it a satisfactory first step, several preconceived design notions were severely shattered.

The most obvious fault was found to be in the shape of the combustion chamber, which, due to its form, severely restricted the exhaust flow. Efficiency suffered from incomplete combustion, and, in the light of initial trials, it became apparent that the combustion chamber lacked space at the top for the gases to mix adequately prior to their ejection from the nozzle.

After a series of exhaustive tests, "Mirak" I exploded. An examination of the remains showed that the explosion had been caused by the too vigorous expansion of the liquid oxygen, resulting in the development of excess pressure, which had burst the oxygen tank. It was obvious that heat transmitted from the combustion chamber had been the direct cause.

The Raketenflugplatz

While trials of the first "Mirak" were proceeding, officials of the Verein für Raumschiffsfahrt E.V. were engaged in the searching out of a suitable site for the establishment of a permanent rocket research station, where possibly dangerous experimentation could be carried out at a safe distance from habitation.

In the autumn of 1930 a stretch of land ideal for both ground and free-flight tests was finally secured at Reinickendorf, a suburb of Berlin; and there in September of that year the society established their experimental headquarters under the name Raketenflugplatz (rocket-flying field), where later buildings were erected and the rockets actually constructed.

(*To be continued*)

ITEMS OF INTEREST

20,000 Atlantic Crossings

THE twenty-thousandth transatlantic air crossing since the war began was recently made when an aircraft landed at an R.A.F. Transport Command airfield in Scotland. The flight was accomplished by an aircraft of British Overseas Airways Corporation North Atlantic return ferry, operated by B.O.A.C. to the requirements of Transport Command.

Most of these crossings have been from east to west over the Atlantic, and have been made by British, Dominion, American and Allied aircrews. The twenty-thousandth crossing emphasises the enormous increase in freight and passenger air traffic, as well as in the delivery of new aircraft, between America and the United Kingdom.

From the autumn of 1940 until Christmas Eve, 1943, the Atlantic had been flown 10,000 times. By the middle of May, 1944, the figure was 15,000, and now, less than three months later, another 5,000 flights have been achieved.

The majority of the aircraft delivered to the United Kingdom has been produced in the United States and the balance in Canada. Behind the achievement of the twenty-thousandth crossing is a story of organisation and high endeavour.

Vehicles and tanks coming ashore from a landing craft during the embarkation of British troops in Italy.

Modifying Car Dynamos and Starters—1

Selecting a Suitable Machine

By D. E. BARBER

IN these unfortunate times electrical plant is difficult to come by, so that the average amateur experimenter must seek some other source of supply if his efforts are to continue. One of the most instructive, and at the same time most economical, methods of overcoming this obstacle is to modify any existing machines which may be in his possession or which can be easily obtained. In this respect, the motor car scrap dealer or the local "junk" shop can usually supply an automobile dynamo or starter motor in reasonably good condition for a few shillings.

These machines, when suitably altered, have many interesting applications, and it is the object of this series of articles to suggest some suitable modifications and to guide the reader so that the best use can be made of the machine for the particular job in hand.

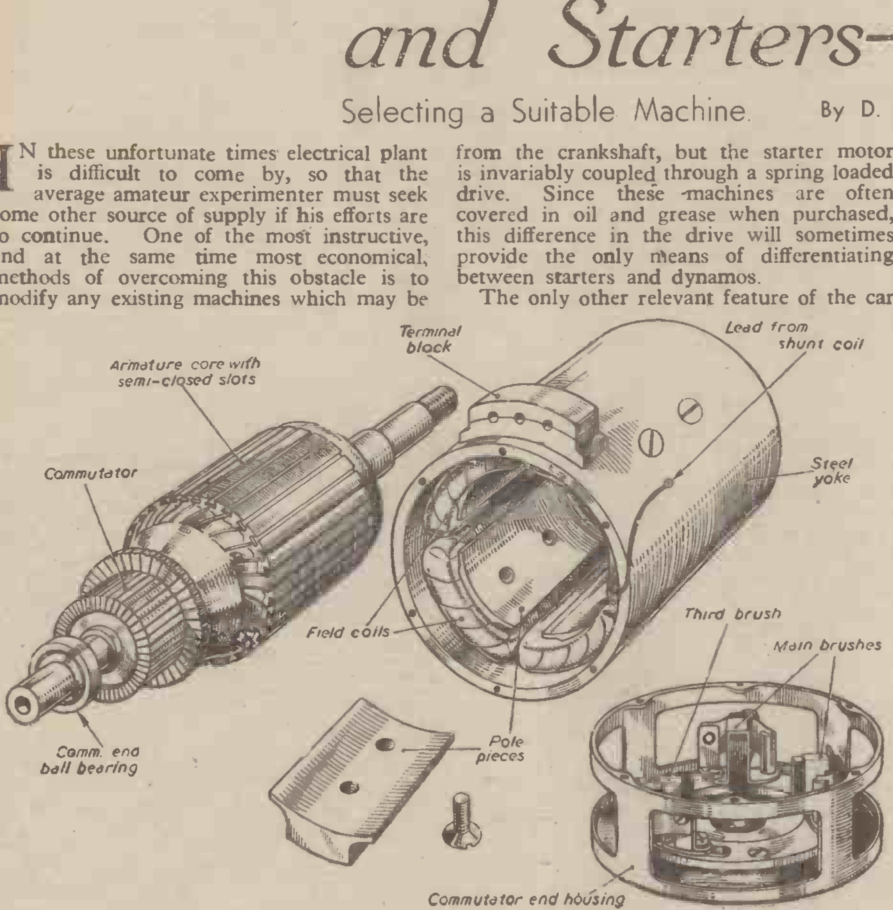


Fig. 1.—Component parts of a third-brush dynamo.

Electrical System of Cars

A word or two about the electrical system of the motor car may not be out of place since a slight knowledge of this subject is a considerable help when purchasing equipment. The usual voltage at which the system operates is 6 volts or 12 volts, although a few 24 volt circuits may be encountered on some lorries. When the engine is running at normal speed the dynamo provides the current for the various appliances which include lamps, ignition coils, petrol pumps, windscreen wipers, radio sets, and other items. In addition, the dynamo also charges the battery which serves to store energy for such time as when, due to low engine speed, the output from the generator is insufficient to meet its demands. Several regulation schemes have been devised to keep this output reasonably constant irrespective of engine speed, by far the most widely used being the third brush type of generator of which more will be said later.

The function of the starter motor is to provide, for a few seconds only, the very large torque necessary to turn the engine for it to fire. Dynamos are usually belt driven from the crankshaft, but the starter motor is invariably coupled through a spring loaded drive. Since these machines are often covered in oil and grease when purchased, this difference in the drive will sometimes provide the only means of differentiating between starters and dynamos.

The only other relevant feature of the car electrical system is the "earth return" arrangement. All that this involves is the commoning together of the negative side of all apparatus by connecting to the metal frame or body of the vehicle. This results in a considerably simplified circuit which, as the number of connections is practically halved, is also much cheaper in production.

Having briefly summarised the salient features of the electric system, the machines themselves can now be considered in detail. Fig. 1 shows the component parts of a typical dynamo of the third brush type; the detail parts, which will be referred to in the text, are designated and should be memorised. Although Fig. 1 shows a dynamo, it is also applicable to a starter motor, the only difference, outwardly, being the absence of the third brush and ball bearings.

The Dynamo

Fundamentally, and dynamo consists of an armature rotating between the poles of a magnet. The voltage which is produced in the conductors on the armature is passed on to the commutator where it is picked up by the stationary brushes. Closer examination of the armature of a car dynamo will show that it consists of a core made up of many thin steel punchings tightly clamped together and mounted on the shaft; slots, which may be either of the open or semi-closed type, serve to carry the armature coils. These coils have many turns of insulated copper wire, usually in the neighbourhood of .04in. diameter, and are connected to the commutator which is an assembly of hard-drawn copper bars each insulated from the others and from the shaft by mica. The carbon brushes, which are held in contact with the rotating commutator by means of springs, serve to carry the current from the armature to the external circuit.

The field system of the dynamo consists of an outer steel shell or yoke, the inner circumference of which carries two, four, or even six pole pieces, the number depending on the particular design and to some extent on the speed at which the generator operates. These pole pieces are bored so that the armature can rotate between them with a very small clearance, say .01 to .025in. under each pole. The field is magnetised by means of shunt coils which contain a large number of turns of insulated wire wound on the poles mentioned above. In the case of third brush dynamos, it will be found that the field coils are connected between one of the main brushes, usually the negative, and the small third brush situated between the two main brushes.

The bearings of dynamos are invariably of the ball type to suit the comparatively high running speeds.

The Starter Motor

One of the main differences between starters and generators is the size of the conductors used; since these machines take a very heavy current when starting up the engine (often up to several hundred amps), it is necessary that the wires used in the armature and field be of ample section to avoid overheating. Because of this, the slots in the armature of a starter motor are usually very narrow and relatively deep, and contain only two conductors; in addition, the number of commutator bars is much less than in the dynamo counterpart. To cope with the large currents, copper brushes are used to avoid appreciable voltage drops at the brush-commutator contact. The field coils, which carry the same current as the armature, are wound with heavy copper strap and have only a few turns.

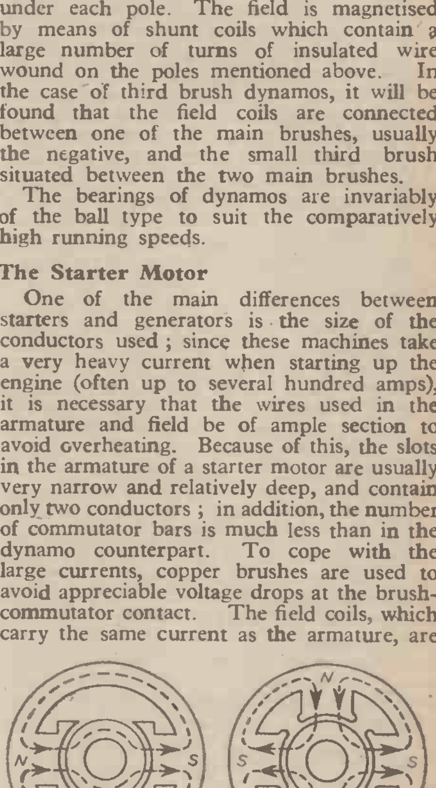


Fig. 2.—Paths of magnetic flux in two types of machine.

As the starter motor runs at only a low speed, sleeve bearings are quite satisfactory, and are thus always used. Unlike the dynamo, the number of poles does not vary much in different designs, and there will invariably be found to be four.

The Dynamotor

The dynamotor is really a combination of dynamo and starter, being used first to turn the engine for firing, and secondly, when the engine is up to speed, to operate as a normal dynamo.

The armature will be found to resemble very closely the starter armature with its narrow slots and few conductors; brushes are usually of a copper-carbon grade, with a third brush fitted for operation as a dynamo.

The field system is always multipolar, that is, with more than two poles, and, as a rule, half of the pole pieces are wound with shunt coils as in the dynamo, whilst the remaining half are wound with heavy series coils as in the starter motor. Bearings are of both types, although ball bearings are the more common. Finally, in general, as would be expected, a dynamotor is a good deal larger than either a dynamo or motor, since it has to fulfil a dual purpose.

Selecting a Machine

The main points of the machines having now been considered, the next step is to decide what type of machine to obtain, and what to look for so as not to become the victim of an unscrupulous dealer.

Unless some very special job is in hand, it will be found that dynamos are more adaptable than starters, especially where a re-wind is contemplated. There are several reasons for this; in the first place, the narrow slots of the armature and the restricted winding space of the field impose a definite limit to the number of conductors which it is possible to get into the new winding. A second reason is to be found in the few commutator bars of the normal starter motor since the sparking at the brushes on load is influenced to a degree by the "volts per com. bar" as designers put it, so that a machine having many bars can be worked at a much higher voltage than a similar machine with only a few bars. Finally, unless some form of lubricator is fitted, it will be found that the sleeve bearing is not well suited to any but the lowest speeds, the ball bearings being far superior.

Taken all round then, the dynamo will be the best type of machine to obtain for most jobs, but in any case, whether starter or dynamo, a large machine will generally be of more use than a small one. If purchasing from a breaking-up yard, the reader will probably be shown a pile of machines and told to take his pick; to the uninitiated this may be a little disconcerting, as all the machines will be covered with oil and grease. The best procedure is to select one that appears suitable externally (a dynamo will usually be fitted with a vee pulley), and after wiping off the surplus grease, and removing the commutator cover, to give it a thorough inspection, paying particular attention to the following points:

(1).—See that the comutator is in good condition and is free from burnt and blackened bars. There should also be plenty of wearing depth to allow for skimming up.

(2).—Test the bearings for excessive play or roughness.

(3).—Be certain that the end housings (particularly if of cast aluminium) are not cracked and being held together by their screws. Similarly, cracked yokes should be rejected.

(4).—Be certain that the armature has not been rubbing on the poles as this shorts the core punchings and, as will be shown in a later article, reduces the electrical efficiency of the machine.

Having made a satisfactory purchase, the machine should be dismantled and thoroughly cleaned; it can then be assembled again for a few tests to determine its probable output when modified. One important point to note when stripping for the first time is that everything should be marked plainly to ensure that it is rebuilt in *exactly* the same way. The brush gear is particularly important in this respect.

Uses

Many uses can be found for converted automobile electrical machines, some of the most common being private house lighting, machine tool driving, charging generators, in addition to several special applications. The subject of A.C. operation, being somewhat wide, is fully dealt with in a later article, so that most of the following notes refer to D. C. machines in particular. To obtain the most from the modified dynamo or motor, the converting process should be scientifically planned; this is a simple matter provided the reader becomes acquainted with the factors which limit the output of electrical machines, and with the sources of the various losses which are unavoidable.

Magnetic Saturation

Fig. 2 shows the flux path for two- and four-pole machines and it will be seen that the lines of force pass through the yoke, poles, air gap and armature core in both cases and that furthermore, with the exception of the air-gap, the magnetic circuit consists wholly of iron. The field coils serve to produce the circulation of flux and their effectiveness in this direction is measured in *ampere-turns*, a value equal to the numerical product of the turns on the coil and the current (in amps.) passing through it.

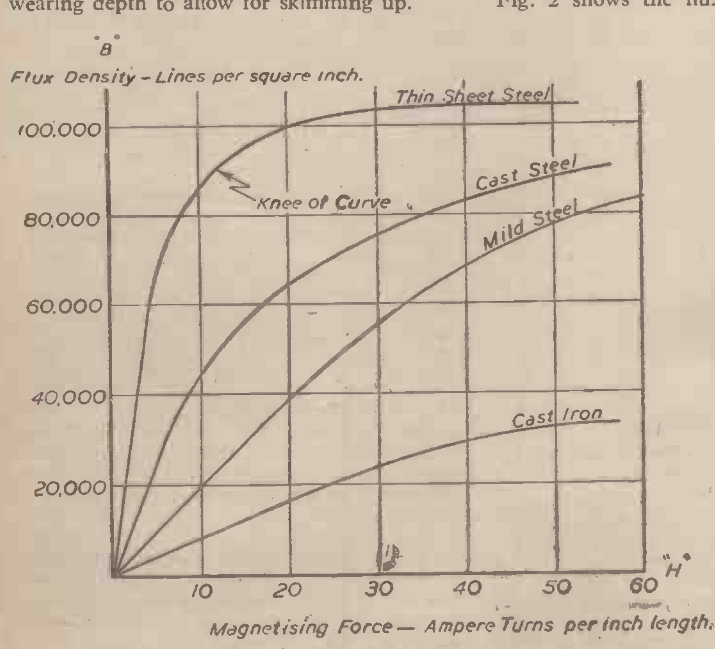


Fig. 3.—"B.H." curves for several grades of steel.

Fig. 3 shows "B. H." or magnetisation curves for several types of steel used in electrical machinery and they illustrate clearly what happens when the field ampere-turns are gradually increased. In a B.H. curve, the flux density, that is flux per unit area, is plotted vertically, whilst the magnetising force, usually expressed in ampere-turns per unit length of magnetic path, is drawn horizontally. Fig. 3 shows that as the excitation is increased, the flux also increases, but after a time the increase is barely noticeable and the iron is said to be *saturated*; in other words it refuses to carry any more flux in spite of any additional magnetising force. Thus, saturation constitutes the first output limitation of a machine by way of limiting the value of the flux passing through that machine.

It will be understood, from examination of Fig. 3, that certain grades of iron are superior in magnetic qualities to other grades as shown by the much higher flux densities at which they can be worked. Thus, in modification, the idea is to use the particular material to its best advantage.

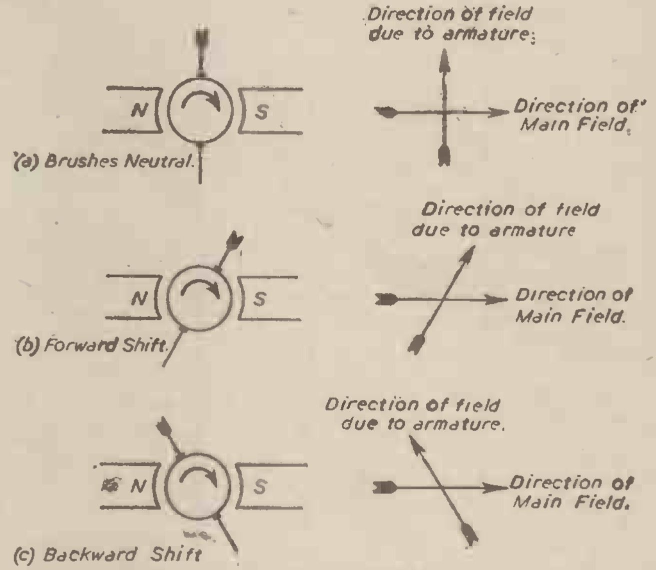


Fig. 4.—Diagrams illustrating the effect of brush shift.

The Effect of Brush Position

A D.C. machine armature, when carrying a load current, behaves as a magnet, the position of the poles relative to the main poles being dependent on the position of the brushes. If the brushes are in the so-called *neutral* position (Fig. 4a) this armature field is at right angles to the main field and no appreciable change of main flux will result; this can be seen from the vector diagram to the right of Fig. 4a.

In Fig. 4b, the brushes have been moved forward, that is in the direction of rotation of the armature, and it is clear that the axis of armature flux has also been moved forward so that it can now be said to have a definite component in the direction of the main field as shown by the second vector diagram. Whether this component assists or opposes the main field depends on whether a motor or generator is under consideration. In a dynamo, forward brush movement results in a reduced field, whilst in the case of a motor, an increased field will result. Backward shift, as shown in Fig. 4c, produces exactly the opposite effect.

There is a limit to the amount of shift which can be given to brushes since the question of "commutation" or sparking at the brushes now arises. If the brushes are moved too far from the neutral position, in either direction, bad sparking on load will be the inevitable result, although a small movement, carried out in the correct direction, may actually improve commutation. Sparking on load can be suppressed by a slight backward shift for a motor and forward shift for a generator.

Influence of Running Speed

It is fairly obvious that the output of a machine is severely curtailed by a large reduction in operating speed. Conversely, the output can be increased by running at a higher speed, and this constitutes one of the most common methods of improving the output of automobile machines, as these are, basically, comparatively slow-speed machines. Care should be taken not to push the speed up too much, however, since, as will be shown in the following paragraphs, the losses of an electrical machine increase in a manner which is more than proportional to speed. On the other hand, the cooling effects, particularly if a fan is fitted, are much more pronounced at higher speeds, so that this compensates somewhat for the increased losses.

Losses Occurring in Electrical Machines

The losses of a dynamo or motor, although inevitable to a degree, should be kept down to the minimum as they represent sheer waste of power which must be supplied externally, either electrically or mechanically. In addition, they serve only to cause undesirable heating of the machine. Briefly the chief losses are as follow:

1. Copper loss, which is the power required to overcome the resistance of the armature winding. Copper losses are proportional to the square of the current.
2. Iron losses are relatively high in small machines. They occur when the armature punchings are rotated in the magnetic field, and are much enhanced by the presence of shorted core punchings. These losses become extremely high if either the magnetic flux density or the speed be greatly increased.
3. Brush losses are due to two main causes; first, the voltage drop at the commutator-brush contact which must be overcome, and secondly, the friction loss which occurs due to the sliding action of the commutator against the brush surface. Both these losses can be reduced by selecting a suitable grade of brush.
4. Bearing friction and windage losses are, as a rule, relatively unimportant. The former, as its name suggests, is the power expended in overcoming the bearing friction, whilst the latter represents the power necessary to rotate the armature against the retarding effect of the air in which it is running.
5. One further source of heating, which is often considered separately from the first four, is the field excitation loss. It is really a copper loss due to the resistance of the field windings.

Fig. 5 shows the relative importance of copper, iron, brush contact, and friction and windage losses. Although not drawn to scale, the curves are based on actual tests made on a four-pole car generator, and are plotted on three different bases enabling the reader to see the effect of changes in speed, armature voltage and armature current individually, while other factors are kept constant.

Machines of the type under consideration are not very efficient, and seldom can more than about 60 per cent. of the power input be taken out as useful work. As an example, suppose that a certain generator was required to generate for a load of 200 watts, then an input of $200/.6=333$ watts would be required, and the equivalent mechanical power would have to be supplied by the prime mover.

Temperature Rises

The machine parts most affected by heating are the armature windings, armature core and field windings, the heat being derived from the copper loss, iron loss, and field excitation loss respectively. It has been found that certain temperatures must not be exceeded if damage is to be avoided. These maximum permissible values will vary according to the class of raw materials used in the manufacture of the machine, but for good all-round results in these experimental machines the actual temperature of the individual parts, as measured with a thermometer, should not exceed the following values:

Commutator	80 deg. C.
Armature core	80 deg. C.
Field coils	80 deg. C.
Bearings or outer yoke ..	70 deg. C.

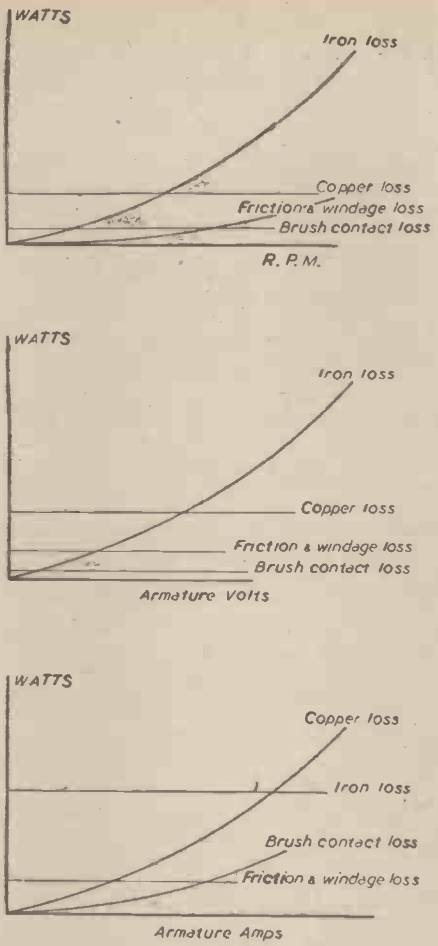


Fig. 5.—The effect of varying speed, armature volts, and armature amps. on dynamo losses.

Methods of Increasing Output

As a rule, the car dynamo is designed to generate a fairly good output at quite a low speed, so that by operating the machine at a higher speed, quite a large increase in output can be obtained. As pointed out earlier, however, the speed should not be taken too high, a good figure being about 3,000 r.p.m.

The air-gap absorbs a large percentage of the field ampere-turns, so that any reduction in air-gap length will be accompanied by a corresponding reduction in necessary ampere-turns and the excitation losses will be thus reduced. A thin sheet-iron liner or shim clamped under the back of the pole will effectively reduce the air-gap. Care should be taken that the gap is not reduced to such an extent that there is a danger of the armature fouling the poles.

As pointed out, a movement of the brushes in the correct direction will tend to strengthen the main field, so that in a dynamo a slight *backward* shift will tend to increase the voltage on load. Unfortunately, commutation may suffer and in this case, instead, a few turns of series winding wound on the poles and carrying the main load current will help to push the load voltage up if connected the right way round. If a motor is being considered, backward brush shift will cause instability if carried too far, so that in this respect experiments will have to be made.

One of the chief aims when modifying a machine is to get rid of the heat in the most efficient way. By far the best way is to fit a fan and drill holes in the end housing so that air can be drawn through the machine. Usually, however, there is insufficient room for an internal fan so that some form of surface cooling can often be resorted to with the fan bolted to the back of the pulley or coupling. Efficient surface cooling can only take place if the maximum amount of surface is presented to the passing air, and one way to achieve this is to break up the contour of the yoke surface by welding steel strips axially along the yoke.

Natural cooling may be employed if suitable ventilating holes are drilled but care should be taken not to weaken the structure or to reduce the magnetic section of the yoke in so doing. Even an apparently insignificant draught of air will keep down machine temperatures by several degrees, so that full advantage should be taken of any air movement in the vicinity of the machine. For instance, if the machine is an engine-driven generator, the radiator fan can be made to draw cool air over the generator before reaching the engine.

(To be continued.)

R.A.F. General Mobile Stores

ONE of the largest general stores ever put on wheels is operating from a field in France. Its counters are three- and six-ton lorries—and the sole customer is the R.A.F. 2nd T.A.F. The store can change location in a couple of hours and, if necessary, operate en route; it can supply anything from a pair of bootlaces to a Spitfire main plane. To operate overseas hundreds of parts are needed to keep the fighters flying, and Squadron Leader Reginald Goddard, of Plymouth, who has 17 years' R.A.F. equipment experience behind him, was given the task of forming the first mobile Air Stores Park. He now commands the first to be set up in France, having arrived on the tails of the first T.A.F. squadron to land in Normandy.

Since the unit was formed in 1942, it has been under canvas summer and winter, has experienced assault courses, fought mock battles, slogged on 20-mile route marches.

More than 3,000 demands come in weekly from squadrons. The Park supplies and carries 20,000 different pieces of equipment, and can replace any one in 24 hours. Each lorry carries rows of lockers, and each is indexed in such a way that an article can be produced within a minute of demand.

The store is housed in camouflaged lorries, parked round the hedges of a Normandy meadow. Cows graze here and chickens scurry under foot.

There are three tons of radio valves in 300 different types in stock; ranging from thimble size to 15ins. in diameter.

Propeller blades, bullet-proof wind-shields, gun buttons, or Spitfire wing-tips can also be supplied.

Here are some of the other articles that can be instantly supplied: parachutes, butchers' blocks, tents, tea spoons, cameras, nail brushes, radio sets, and pudding cloths, telephone cable or a radiator for a Spitfire.

Precision Clockmaking—4

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

By the Late GEORGE B. BOWELL

(Concluded from page 415, September issue)

Small Movements

SOME of the movements made now are of extraordinarily small dimensions, but where no need exists for begrudging a little more space there is very much to be said for the bi-polar motor, with its more favourable speed of translation, and less need for small air gaps, which would naturally be conducive to pivot wear. The motor referred to in the July issue is of the bi-polar type, and it has the whole of the faster portion of the train, together with the rotor itself, completely enclosed in a metal casing, in which, also, special provision is made for lubrication.

This motor is fitted with copper bands around a portion of each pole piece, which causes somewhat of a *rotating* field effect owing to the slight dissimilarity of magnetic response as between banded and unbanded parts. Thus it must always run in the desired direction and is self-starting. The copper bands, of course, have eddy currents induced in them, and the method is known as the "shaded pole."

The Power Factor

The action of an A.C. in many respects may seem more involved than D.C. One might, for instance, have a little transformer that would supply current for, say, two 50-watt lamps easily and without undue heating, but which would be wholly inadequate to supply, say, fifty 2-watt synchronous motor clocks, although the actual power required is 100 watts in each case.

In D.C. *volts* × *amperes* = *watts*, but with A.C., it may be that volt amperes do not represent true watts. Actually they can only do so provided that the current occurs simultaneously with the voltage, and this is a state of affairs in an A.C. circuit, which is spoken of as "unity power factor." If the circuit comprises lamps or heaters or any "non-inductive" apparatus, then it does not cause any lack of agreement in phase of amperes and volts; but if, say, a motor or any such apparatus having self-induction be included, it necessarily effects a falling-off of power factor, and it is under such conditions that the actual power in the circuit is no longer that which would be suggested by the *volt amperes*, but is that of volt amperes × the power factor. Thus it comes to light that in addition to the current actually concerned in the true watts there is some which is called "idle current," which one might broadly say is nothing to do with the power, but which nevertheless, so to speak, occupies space in the wires and thereby limits their useful current-carrying capacity.

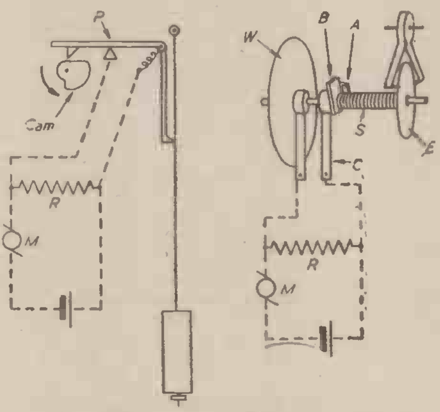
This little point concerning the "power factor" is only mentioned in this particular aspect because, overlooking it, one might rather easily come up against what might otherwise seem contradictory or perhaps perplexing results over some more or less everyday matter. But it can well be appreciated that the ramifications are very far-reaching; also that (and here perhaps the term "idle" current is not too apt) it must not for a moment be looked upon merely as a nuisance, for by its agency a wonderful working out of various other matters is provided.

A domestic supply meter measures in true watts. A few small motors would not appreciably disturb a supply system. Large induction motors as used for industrial purposes frequently have compensatory apparatus added to improve what might otherwise be a troublesome extent of "idle" current.

It is usual to speak of the size of a dynamo in terms of kilowatts (k.w.), but of an alternator of kilovolt-amperes (k.v.a.), which clearly makes allowance for a varying power factor; but the *power*, of course, is expressed in k.w., whether in A.C. or D.C.

Care of Mains Supplied Installations

As the foregoing remarks have referred largely to motors, etc., for working from a mains supply, it may as well be mentioned here that care and respect should always be shown to all parts of an installation supplied from mains. The usual voltage is quite high enough to give shocks which, under some circumstances, might be serious. All parts of an installation ought to be of good materials, properly installed, and reasonably cared for subsequently. Switch-covers or lamp-holders are better bakelite covered, otherwise in damp weather, or in damp places, there is surface leakage. Modern types of fuse fittings are also important, and no replacements should ever be made by fuse wire of larger size than intended.



Figs. 18 and 19.—Diagrams illustrating the principle of motor-driven self-contained clocks.

Old flexibles should not be tolerated. No additions to a mains supplied installation should be made without the approval of the supply authority—though a reasonable use of "plugged-in" extensions is generally permissible, but should be arranged with some forethought, and should not be allowed to get into damaged condition.

Steuart Motor-driven Clock

Of electric clocks, the motor-driven, self-contained clock is probably the least well-known scheme.

The first problem in the motor clock is that of synchronising the motor to a pendulum. There are various ways of doing this, and perhaps the simplest is by current impulses which may have their duration changed by the joint action of the pendulum with some part geared from the motor.

One arrangement is shown in Fig. 18, in which a gravity pallet, P, follows the pendulum, moving from left to right, until it meets a stop and is shortly afterwards lifted off the stop by the rotation of a cam, such as C, and the cam then holds the pallet up till after the pendulum has returned to it.

The electrical circuit is shown in dotted lines, from which it is apparent that the pallet stop also serves as the controlling contact, so an early arrival of the cam effects briefer impulses than if it arrives later, and thus if the longest impulses would give the motor enough input to rotate faster than required it should turn at the desired speed.

A resistance, R, may be added to the circuit because there is no need actually to cut off altogether. This resistance should, of course, be non-inductively wound. It may be convenient to refer to the contact or the accelerator contact, but it may be observed that with conditions suitable the cyclic fluctuation in motor speed may be so small as to be practically unnoticeable.

In Fig. 19 the accelerator contact is between A and B, A being a projection from a spring that couples an escape wheel, E, to the motor-driven wheel, W, whilst B is an insulated piece turning with W and connected by a slip-ring to brush C. Another, though uninsulated, slip-ring and brush connects to the arbor and with it to the spring S. From here the motor connections are similar to Fig. 18.

One revolution of W should occupy the same time as one revolution of E, but as E moves in little steps whilst W moves continuously the result is that normally A beats against B and initiates the impulses, thus giving control for the motor as in Fig. 18.

Continuous-motion clocks built upon either of these schemes are quite workable. The Steuart clock (1922) was on the Fig. 18 plan, and it is undoubtedly a very fine timekeeper. It also marked a most useful step forward, though various other continuous-motion clocks had been evolved in earlier years. About 1930 I made a number of clocks on the Fig. 19 plan. But it is advantageous here to regard shortcomings, and the Fig. 18 type, although simple, has the objection that unless the motor be heavily damped so as to resist any but sluggish changes of speed, it cannot be sure of keeping within its limited range of phase displacement, and directly it should for any reason get beyond that range the control process becomes inverted, thus making it run right out of step. The Steuart motor was damped by eddy current brake due to aluminium shrouding over the armature. But

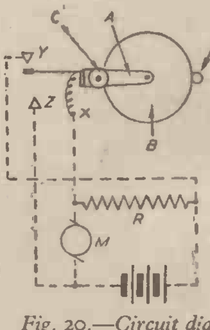


Fig. 20.—Circuit diagram and improved mechanism for an electric clock.

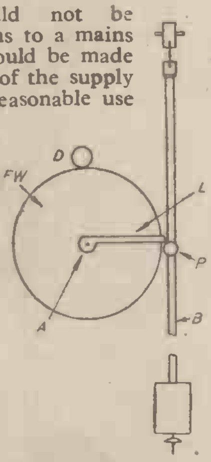


Fig. 21.—Experimental arrangement of the Meath clock.

it will be noticed that in the Fig. 19 arrangement this losing of phase cannot occur, however "lively" the motor may be, because if the motor part is behind time AB remains closed, whereas if it is in front of time AB remains open. What actually happens is that, on first starting the clock, the motor will overshoot the mark and then slow up and so on, but will soon find its proper phase and speed in agreement with the progress of the escape wheel. The difference in battery current is so very great that one might as well definitely rule out the use of a motor with eddy current damping, at any rate if the result aimed at is to be a clock free from the necessity of elaborate or costly current supply.

The defects of the Fig. 19 type were due to two points, which, of course, ought to have been foreseen. The slip-rings and brushes would in time require careful cleaning, or without it would fail to provide path for the current. The actual accelerator contact did not suffer from this disability. Apart from that there was considerable risk of the spring becoming damaged if for any reason the motor was able to run on to an unreasonable extent.

Fig. 20 shows a mechanism which effects exactly the same action as the Fig. 19 form, but obviates the defects mentioned. Here the spring is replaced by the weight of an arm, A, to which is pivoted an idler gear wheel, B, that connects between pinions C and D, of which D drives the escape wheel and C is driven by the (motor-driven) train. The arm A rides free on the arbor of pinion C, and to the arm is attached a quite slender contact spring connected to X, and this can make contact to Y or to Z. The normal rhythmic control action is therefore between X and Y. If one disregards the relatively small force required to deflect the contact spring through its normal (very small) action against Y, it will be seen that the escape wheel is driven by the weight of B (and that of A), so that, assuming the pendulum to be reasonably massive, an ordinary dead-beat escapement would go as well for time, and perhaps closer, as it should in a little turret clock.

The safeguard against abnormal excess of speed of the motor parts over the escapement is, in the Fig. 20 arrangement, provided for first by undue upward travel of B acting to close another contact X to Z, and beyond that, if need be, the wheel B rises clear of pinion D.

When contact is closed to Z, as will be seen from the diagram, a path is established across the armature, which causes it to act as a dynamic brake. It might be mentioned that of this Fig. 20 form only one has so far been constructed, but it appears to serve its purpose correctly, and it is a simple thing to make. It is very wise, if not really essential, to arrange some form of yielding connection between crutch and pallets to minimise risk of damage to escape wheel teeth.

The Meath Clock

In the autumn of 1933 the Earl of Meath, who had long been experimenting with rather unusual ways of impulsing a pendulum, became aware of the type of motor which I had been constructing for clocks, etc., and I supplied one of them to him for an experimental arrangement which was approximately as shown in Fig. 21.

When one makes a clock there are two aspects each of its own importance: one is whether the clock is a good "go-er," the other is whether it will keep good time.

In Fig. 21 the "escape wheel" consists of one tooth or "leg," L, fixed to an arbor, A, on which also is mounted a smooth friction wheel, FW, and the motor turns this by the rolling contact of D, which is an enlarged part of its arbor. The ratio of this friction gear is such that the motor carries L round one turn in just a little less than the time of a double vibration of the pendulum B, in consequence of which L will just touch on the pin P (moving with the pendulum), and this gives an impulse *and* synchronises FW, which can readily slip relatively to D. With a seconds pendulum the leg and the arbor A will therefore make 30 revolutions per minute, and from this the dial-work is appropriately geared. The unusually high mechanical advantage of FW over the dial's centre-arbor should be noted.

This simple arrangement under favourable

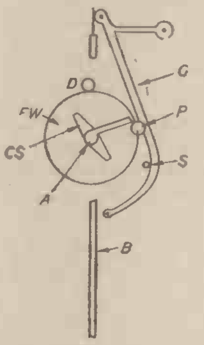


Fig. 22.—Details of a sensitive escapement.

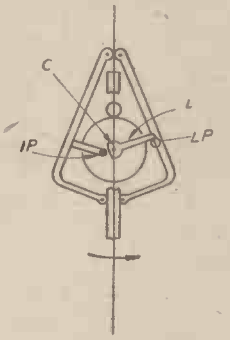
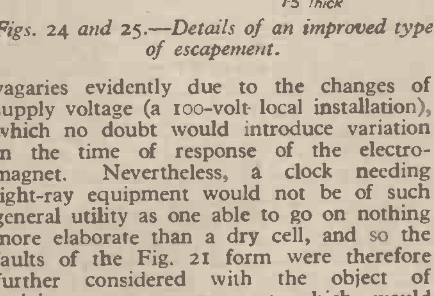


Fig. 23.—The M.B. zero escapement.

conditions can keep better time than at first would be considered possible, but apart from time-keeping it has the merit of being a good "go-er," although needing such a remarkably small electrical input; in fact, it might well be of use, even with a quite short pendulum, for mechanisms requiring a time control which need not be of such accuracy as that provided for a clock.

The Earl of Meath's next experiment employed a supplementary release for the actual impulse piece. This arrangement was added to the Fig. 21 device and combined a selenium cell and light-ray controlled electro-magnet which should have ensured particularly accurate time-keeping in view of the fact that it had a gravity impulse lever entirely free from unlocking friction. Actually, however, there were



Figs. 24 and 25.—Details of an improved type of escapement.

vagaries evidently due to the changes of supply voltage (a 100-volt local installation), which no doubt would introduce variation in the time of response of the electro-magnet. Nevertheless, a clock needing light-ray equipment would not be of such general utility as one able to go on nothing more elaborate than a dry cell, and so the faults of the Fig. 21 form were therefore further considered with the object of arriving at an escapement which would enable the pendulum to keep good time. Over this pursuit Lord Meath kindly invited my co-operation.

A certain amount of compromise usually enters into the design of mechanisms, and the little battery motor is no exception. As already pointed out in a previous paragraph, an electric motor supplied at a definite voltage and having a constant field will rotate at a constant speed irrespective of variations in load, but this presupposes the resistance of the circuit (the armature winding) to be sufficiently low to be negligible as to its absorption of some part of the whole voltage. But as both the weight of the armature and its speed must be kept within convenient limits, and the weight is chiefly in the windings, this restricts the size of wire in order to get the necessary number of turns. Hence changes in "load," which is but that of maintaining motion against the friction, must be allowed for by ample tolerance on motor speed. Decline of battery makes very little difference, because of the small current concerned.

A suitable escapement, then, must be able to act quite properly even with more speed variation than the motor would actually have. Fig. 22 shows such an escapement. Here the pallet, P, is mounted on the gravity arm, G, which meets the stop, S, in travelling with the pendulum, B, to the left. Whilst the arm is riding on the pendulum, the pallet, P, may be regarded as though it were attached to the pendulum, but the motor-driven arbor, A, is arranged to bring the leg, L, round to P at any time during its rest against S; that is to say, whilst the pendulum is detached from the escapement. In this way there is plenty of latitude for motor speed, and especially if the escaping arc is small relatively to the whole arc.

"Assisted Rise" Escapement

In this escapement it will be seen that any change in motor speed does not affect the impulse pressure at the end of leg L; nevertheless, even if the pressure which holds D against FW be constant, there must be a variation in impulse force if the coefficient of friction between D and FW varies. This has been found to be reasonably small when D is ebonite and FW is hard brass; their working surfaces being smooth to start with, they will subsequently acquire and retain a "self-polish" from use.

To prevent the slip of D continually occurring at the same place on FW, a "creep spring," CS, enables FW to move an almost imperceptible amount relatively to the arbor A each time the leg arrives at P.

For distinction this form of escapement has been called the "assisted rise," because the force of leg L is quite insufficient to raise the pallet, but on the return of the pendulum it assists its rise, thus providing an impulse.

M.B. "Zero" Escapement

Fig. 23 shows the M.B. "zero" escapement. This was described in the "Horological Journal," of July, 1938. It possesses considerable merits and does give good results. Here there are two pallets, one for giving impulse and the other for locking. The unlocking occurs correctly across zero, and the impulse is also correctly "straddled" about zero. Both these functions occur as the pendulum moves from left to right. The impulse arc is about half the whole arc, whilst the unlocking is confined to about one-sixth of the whole arc. It may be mentioned that in these M.B. clocks there is no need for a deep locking because the leg arrives at its motor-controlled speed and cannot get up a run.

In the figure it will be seen that the impulse pallet, IP, is half-way through, giving its impulse as the pendulum is passing zero, at which position the right arm has already commenced to unlock the locking pallet, LP, and the leg, L, with its cam, C, then moves forward. The cam, C, does not, however, meet the lifting pad of the impulse pallet until a little later, so that the impulse is completed and the arm remains at its stop until the pendulum arrives nearly to the end of its swing. The lifting pad will, however, then be on the "land" of the cam to await the return of the pendulum on its excursion to the left.

This escapement gives a liberal tolerance for motor speed, and, as rotation of L starts at zero, the time of $1\frac{1}{2}$ seconds, with a seconds pendulum, being the most suitable in which to make one turn, is constant irrespective of arc.

I have made several of these "zero" clocks with very good results; nevertheless, I have long been hoping for a form which, even at some sacrifice of time-keeping qualities, may have the particular charm and utility of greater simplicity.

Fig. 24 is an improvement on the Fig. 22 type, but so far only two experimental clocks have been made with this escapement, and it may be too early to commend the idea. In these clocks the periphery of the friction wheel, FW, is formed with a notch or "valley," so that when the driver, D, being unable to follow down beyond a limited distance, reaches the position shown in the sketch, the drive is completely disconnected, and this happens just before the leg, L, arrives on the pallet, P. The wheel, FW, is made very light and carries a small weight, W, which provides its motive force for the impulse and, after that is completed, to effect re-engagement of the drive. The pallet is a cornelian pin about 2 mm. diam. and the leg, L, is of hard brass. In order to facilitate a clearly defined place of engagement of the leg, L, from the pallet, L is set over 45 deg., as shown in Fig. 25. Then, to provide for equal intensity of impulse at the start and at the finish, the working face of L is shaped as an arc of a circle from centre X, which is a point that would, at half-stroke, be moving in the same direction as the pallet. The centre, X, in the second of the two experimental clocks is 3.25 mm. from the centre of the wheel, FW. The little driving weight is 6 mm. diameter by 1.5 mm. thick and lies level with the centre of the wheel at half-stroke. The impulse arc is approximately 1 deg., and the whole arc is a little under $2\frac{1}{2}$ deg., whilst the clock has a 6lb. compensated pendulum.

In order to set this escapement in beat so that impulse is given equally before and after zero, it should be such that the pendulum moves the same distance to the left of zero, to deposit the pallet arm, P, against its stop, S, as it moves to the right of zero, just far enough to allow the escape of leg L from the pallet.

Erratic Time-keeping

Not to delay longer than necessary over those things which cause the variations in rate of a clock, it may be well to epitomise the leading points about impulse, arc, and weight of bob; and then to consider needs as to workmanship and design.

First, however, needless though it may appear to be, some note should be made as to what constitutes goodness or badness in the performance of a clock. Some people seem to think that a clock, or a watch, can eventually be made to keep perfect time if only they fiddle about enough with "regulation"; with watches certainly such kindness usually leads to dire consequences, but to hold such an idea shows complete misunderstanding of the matter. Whether a clock be actually gaining or losing is quite apart from whether its actual gain or loss continues uniformly or erratically. If it be reasonably uniform it is a perfectly simple matter, first to "bring it to time" (which far various reasons is, in this connection, a preferable term to "regulating") so that its rate of gaining or losing is small. If the clock is really a good clock, capable of going to a very small variation of its rate, then obviously it can be brought very closely to time, but if it is a poor clock no amount of altering pendulum length will do the slightest good beyond a certain point. A clock having vagaries of its own, which would be due to mechanical defects either in design or workmanship or both, amounting often to, say, several minutes a month, could not possibly be brought to time to "a minute a month"; to expect that would be to expect a silk purse from the wrong material!

Actually, in checking a clock, if a graph be made on squared paper marked off for seconds vertically and days horizontally, or such other scale as might be suitable, the vagaries will be conveniently shown by joining all those points ("loci") marked in accordance with observations from a time signal or a standard clock. The line, or

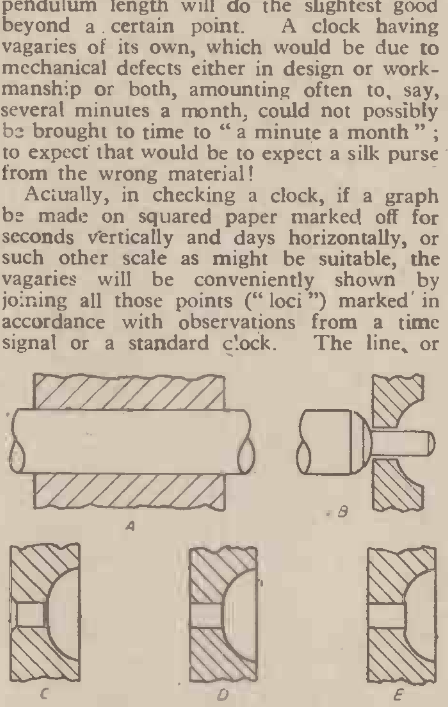


Fig. 26.—Details of a clock pivot and bearings.

"curve," so resulting might be horizontal (if the clock had been so brought to time) or might be sloping, but it is the extent of its deviation from a straight path which is the criterion of its ability to keep good time. A straight line drawn over the curve to follow the middle of the path of the "curve" will therefore conveniently indicate the extent of maximum deviations over a given period, and projecting the straight line over the as yet unused part of the sheet affords a ready means of indicating a "predicted" time.

There are quite reasonable causes for a variation sometimes to one side and sometimes to the other of a straight line (which, of course, would represent an unattainable degree of perfection), but the kind of variation which often proves very perplexing is when the deviation grows more one way than the other. This sort of thing can be expected to some extent with a new clock until it has been left going long enough to settle down in such respects as "self-polishing," but if it is persistent and cannot be traced definitely and cured, it may well be enough to justify abandoning any *new* form of escapement. On the other hand, it may be due to a failure to comply with one or more of the *needs* of a clock, which may therefore be epitomised here.

Impulse: as a disturbance detracting from that perfection of time-keeping which would be to a pendulum vibrating solely under the influence of its own "controlling force."

Unlocking friction is to be reckoned in with impulse as that force (acting in a contrary direction) required to slide the pallet over the escape wheel tooth.

Impulse equally before to after zero, for, if otherwise, a change of impulse, besides changing arc, would change the effective controlling force and then the pendulum's resultant period.

Circular "error" requires that arc change should be minimised as far as possible. It also requires that a pendulum should not swing through too large an arc, since that increases the error for a given extent of arc change.

Arc: a pendulum working at a normal arc of $2\frac{1}{2}$ deg. might be expected to lose a second a day if the arc increased to 2 deg. $37\frac{1}{2}$ min. This must not be taken to be an exact statement, but it will serve as some idea of the effect of this slight lack of perfect isochronism.

Mechanical Details

The smallness of power needed for a clock has been noted, and it is not surprising to find that a clock pivot has such little in common with the bearings of a steam engine of a sewing machine. Fig. 26 (A) shows such a bearing, extensive surface, small clearance, and intended for lubrication by mineral oil. In contrast B and C show a clock pivot and its hole. Here the surface is small and the freedom quite considerable, and lubrication is by clock oil, which is of quite a different nature to machine oil. The forces concerned at the escapement end of a clock train are, of course, very much smaller than at the slow-moving end. If the space between pivot and hole is extensive in area and lacking in enough clearance, a particular defect, colloquially described as oil drag, will be so troublesome that if over-oiled there will be little chance of uniformity of impulse and a good chance of stoppage. Thus there are three essentials to keep in mind, viz., small surface, sufficient clearance, and avoidance of superfluous oil.

The pivots at the other end of the train, having more pressure, need, accordingly, more surface and less liberal clearance. However, these things are fairly obvious and present no difficulties to anyone with experience of what is wanted, yet, unfortunately, they are sometimes at fault in modern clocks. Fig. 26 (D) and (E) show how the holes should *not* be left in the plates.

As to the pivot shoulder, its diameter should not be too great, and it can but be just slightly convex to avoid both unnecessary area of contact to the plate and anything approaching a sharp outer corner. It is, of course, important that the shoulder should be smooth and polished and free from any such defect as trace of chatter marks, which might arise in manufacture.

Pivot diameter should not be too large, but if made too small the wear will probably be less slow.

The ability to withstand wear depends largely on the extent of freedom from friction. If one could, merely for the sake of argument, imagine a pivot able to turn without any friction, there would be no wear, because no power would be absorbed really in overcoming a non-existent retarding force. However, as "μ" must always have some value, the other thing to do is to avoid unnecessary pressures which arise from two causes—(i) the dead weight of the pivoted part, also the pressure due to the mainspring or weight; and (ii) a kinetic pressure associated with stopping a part that is in motion. Wheels, therefore, should be no heavier than necessary, and if they are to be subjected to arrestment, such as an escape wheel, they should have light rims. An escape wheel which is needlessly thick will not wear so well as a lighter one, also it is much more likely to wear little ridges across the pallets in consequence of bouncing.

The application of good workmanship in such precision instruments as those under review cannot be emphasised too strongly, and in thus summarising these important considerations it is hoped that for those who pursue the subject a smoother road towards yet greater accomplishment in this realm of scientific time measurement may lie ahead.

A Heater for the Workshop

A Highly Efficient "Safety" Electric Heater

By I. P. DELASAUX

HEATING and ventilation are so closely related that the heating of a small workshop—a matter which on first thoughts would not appear to present any difficulties—forms a problem more involved than one would expect.

The workshop of the average amateur is not usually spacious; every inch of room is nearly always utilised to the full, thus restricting the choice of heating systems, which for some unknown reason do not receive the consideration they should during the building of the workshop. Those who are fortunate enough to be able to use a room in their house for their activities are, of course, freed from the problems encountered by those who have to use an outbuilding, as most rooms normally have a fireplace and possess adequate ventilation. There is, however, the possibility that the room available to the amateur craftsman is only vacant because it is unsuitable for domestic use owing to dampness, etc., and in such instances the heater described below will prove most useful, as the writer has already proved by actual experience.

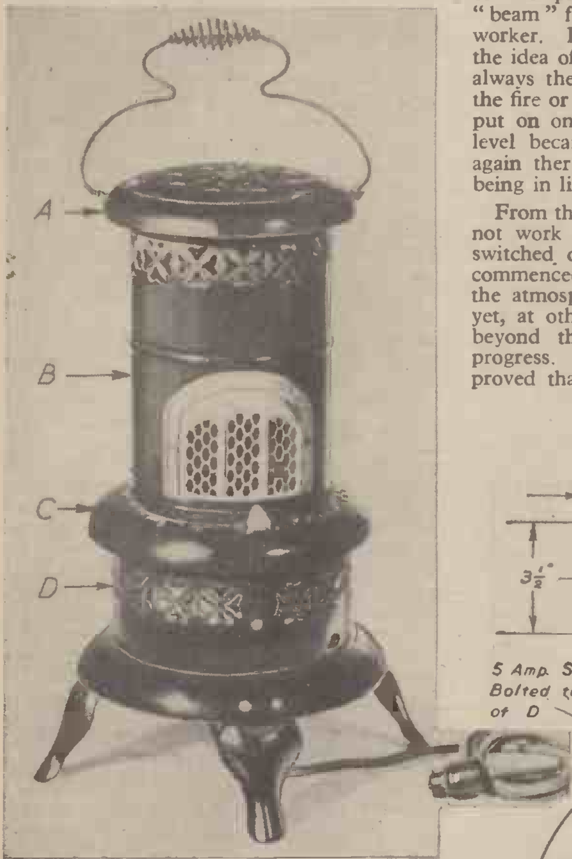


Fig. 1.—The converted oil stove, showing how heating elements are completely enclosed.

When the workshop is in the form of an outbuilding, all factors, speaking for the majority of instances, seem to be against efficient economical heating. The structure is so often built from timber; four sides, plus roof, usually exposed to the weather; double walls are more often than not the exception rather than the rule, while the distance between the worker's head and the inside of the roof makes the question of ventilation—especially during black-out periods — somewhat complicated if draughts are to be avoided.

In one of the cases with which the writer had to contend, the workshop was built away from the house, and the interior wall area was fully occupied by windows, shelves, benches and a lathe. Electricity was available, but not gas, therefore it was thought that a good electric fire of the bowl reflector type would be ideal, as it could be switched on and off at will and thus be economical. Actual tests, however, proved otherwise. It was found that the radiated heat was too concentrated and directional, and considerable care had to be devoted to the placing of the fire to prevent its "beam" from playing on objects and/or the worker. If it was placed on the floor, with the idea of keeping the feet warm, there was always the danger of scorched trousers, and the fire or wire getting in the way. If it was put on one of the benches, the air at floor level became too cold to be pleasant, and again there was the possibility of the beam being in line with other objects.


Fig. 2.—Sections C and D, showing location of both heaters.

From the point of view of economy, it did not work out as anticipated. It had to be switched on an hour or two before work commenced (in the winter months) to get the atmosphere at a reasonable temperature, yet, at other times, the heat produced was beyond that required when work was in progress. Tests over a reasonable period proved that the usual types of electric fire, and in particular the bowl type, possess several undesirable features, and make it difficult to maintain a reasonably constant working temperature, when they are considered with respect to the heating of a small workshop or room. Apart from the items already mentioned, the writer did not like the idea of elements at mains voltage being exposed to wire, swarf and metals in general which have the knack of getting into most unexpected parts when least expected; therefore it seemed that the ideal heater must be of the enclosed type and capable of being switched to, say, warm and hot.

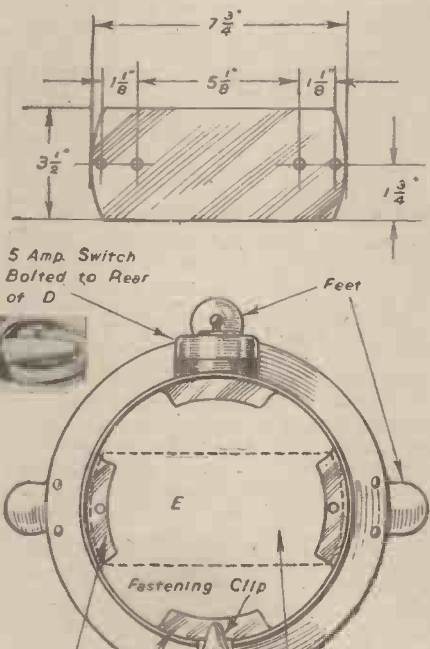


Fig. 3.—Plan view of D and the platform for the lower heater.

Air Conduction

To overcome the effects of direct radiation of heat it was decided to use the air conduction method which allows, to all intents and purposes, the source of heat to be totally enclosed, thus eliminating the danger of damage or fire being caused by direct or reflected beams of heat. Provided a reasonable surface area of metal is heated quite a large volume of air surrounding it will have its temperature raised several degrees, the actual figures depending on the power of the heating element. the area of metal heated and the general design of the assembly. A good example of this system is the modern type of vertical tubular oil stove, and it was when considering one of these that the writer saw the opportunity of saving himself a lot of work, making an efficient "safety" heater and, at the same time, dispensing with the inconveniences so often associated with paraffin lamps. After a little diligent searching of shops dealing in second-hand goods, a somewhat dilapidated, but not battered, oil stove of well-known make was secured for a few shillings. The oil container was removed, the body was taken to pieces and after a good cleaning given a coat of black stove enamel.

The Conversion

With the lamp in question, two long thin bolts hold the parts A B and C (Fig. 1) together, the nuts being located under the upper surface of C, which is hinged on D and held in its closed position by a spring fastener. There is no need to remove C from D.

Two heating elements are required, each being of the circular moulded fire-clay type having channels in which the spiral wound resistance element rests. The diameter of the moulding is approximately 5⅝ins., and the wattage rating of each element is given as 750 watts. They can be purchased from one of the popular stores or most electrical shops. (See Fig. 2.)

A piece of 18-gauge or heavier tinplate or sheet iron is cut to the size and shape shown in Fig. 3, its purpose being to form a platform across the bottom of D—as shown by the dotted lines in the same diagram. Drill the holes indicated to clear, say, 4 BA stubbing or bolts, two 1in. in length, and two ½in. long, the former being for securing the heater moulding and the latter for fastening the platform to the brackets which form part of the stove original assembly. Bolt the heater element to the tinplate, taking care to see that its connecting terminals are to the side, i.e., well clear of the metal, and that excessive tightening of the holding bolts is avoided to prevent chipping or fracturing of the fire-clay moulding. Do not fasten the platform in the stove at this stage.

The second heating element is bolted to the upper surface of C, Fig. 4, but as it is advisable to keep the centre hole in C clear, the element must be fixed so that it is approximately 1in. above the rim. This can be arranged by using two 3½in. lengths of 2 BA. stubbing, which can be secured to the part C by nuts, and the heater moulding locked in position at the free ends of the stubbing by nuts on each side. To prevent any possibility of any of these fixings becoming loose, the writer used additional nuts as locking nuts. Owing to the slightly dished shape of C, the supporting rods will point inwards, but it was found that the metal used in the construction of this part allowed them to be eased into a vertical position; in fact, the slight tension thus produced is an advantage, as it forces the rods into the "U"-shaped openings in the moulding provided for fixing purposes.

Wiring

The wiring can be carried out with, say, 20 S.W.G. copper wire, or fairly heavy (workshop) flex which has had *all covering* removed. Owing to the heat to which the wiring will be subjected, normal insulating coverings cannot be used, therefore all the connecting wires in the stove assembly must be insulated by means of the small heat-resisting insulating beads or thimbles which can be obtained from most electrical shops. After the various wires have been fastened at one end and cut to the right lengths, the beads are slipped over the wires until they are covered, when their free ends can be fastened to their respective points.

The theoretical circuit of the wiring is shown by Fig. 5, in which R.1 and R.2 represent the two heater elements, the 5-amp. tumbler switch being probably one having a china or porcelain base. It will be seen that the two heaters are connected in series and that the switch is connected across one of them (the lower one in the stove), so that it can be short circuited. This is the arrangement used by the writer, the idea being to secure half heat when the switch is open, i.e., both elements in series, or full heat when only one heater is across the mains (switch closed). This system can, of course, be modified to suit individual requirements; for example, if a greater heat is required on the two ranges, both elements could be connected in parallel across the mains, and the switch connected in series with one of them, so that it can be cut out of circuit when half heat is required. It must be remembered, however, that if this system is used, the total wattage for full heat will be 750 × 2 or 1,500 watts, whereas in the original arrangement the wattage consumption is approximately 370 watts for half heat and 750 watts for full.

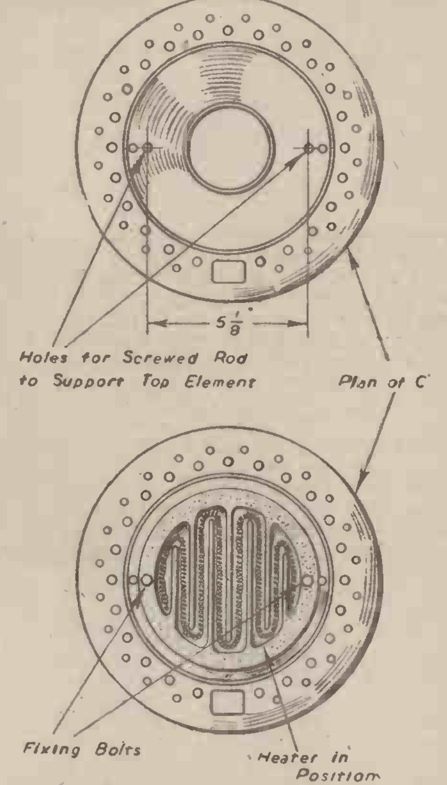


Fig. 4.—The section C to which the upper heater is fixed, as shown by the lower plan view.

A mains or on/off switch was not fitted, the writer preferring to un-plug the mains lead, thus making *quite* sure that the stove is off and not left on half heat by mistake.

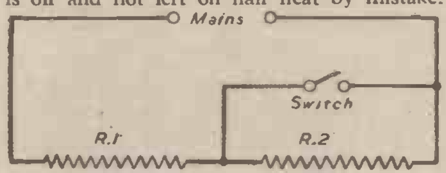


Fig. 5.—The theoretical circuit, R.1 and R.2 representing the two heater elements.

It would be quite a simple matter to add the additional switch in series with one side of the mains, in which case it would be advisable to bolt it to the vertical wall of D in front of the stove, while the range or shorting switch is fitted to the rear.

It is not advisable to take the mains leads direct to the heater terminals, as the heat will soon destroy the insulation and perish the wire, therefore some form of anchoring should be provided, and the writer used a moulded bracket which originally was designed for carrying two terminals for wireless work. A neat strip of fibre carrying two soldering tags bolted to it would be quite satisfactory, and if it is fixed (bolted) to one of the two vacant supporting brackets in the bottom of D, it will be well out of harm's way, yet located nicely for all connections.

If a three-point socket is available on the supply side, as it should be, the third wire, i.e., the earthing wire, can be connected direct to the metalwork of the stove, after cleaning away enamel, etc., until the bright metal is visible.

Point-to-point Wiring

One side of the mains to one side of *top* element. The other side of this element to one side of shorting switch, and to one side of the *bottom* element. The other side of the switch to the remaining terminal on the *bottom* element and to the other side of the mains. Earthing wire to metal body of stove. If a separate switch is required for on/off purposes, simply connect it in series with one of the mains leads before they go to the heaters.

Heating Capacity

It is rather difficult to give exact figures as so much depends on the construction of the workshop and/or the ventilation, but on actual test the stove has been found highly satisfactory for a room or shed having a capacity of 1,000 cubic feet. This is when using full heat and consuming 750 watts.

Once the room or shed has become warm the half-heat range will be found very handy for maintaining a steady temperature. During wet weather, or if a room is damp, if the heater is left on during the day at half heat, there will be little risk of tools, equipment or furnishings being damaged by the otherwise moist atmosphere. Apart from its original purpose the stove has proved its worth over and over again, as it can be used under conditions where it would not be so convenient or safe to use an ordinary electric fire of the exposed element type.

The New Gyro Gun Sight—Mark IID

THE introduction of the gyro gun sight reveals another of Great Britain's great scientific achievements. It was conceived and developed at the M.A.P. experimental establishments by a team of whom Professor Sir Melville Jones, Group Captain Ford, Mr. A. A. Hall, Mr. B. Sikes, and Mr. Hancock took the leading parts, and is notable for its simplicity in use, despite the complexity of its internal construction. The sight consists of numerous electrical units supplying information to a sighting head which is immediately in front of the pilot. On the sighting head there is a glass screen 4¾in. by 2½in. known as the reflector, on which the pilot sees the graticule, and through which he sees the enemy aircraft. The pilot has only two adjustments to make to the sight as he goes into attack. Firstly, by turning a lever he "informs" the sight of the type of aircraft he is attacking. He also "informs" the sight, by turning a twist grip, which is incorporated in the throttle at his left hand, the range at which he is attacking. These seemingly simple procedures automatically feed the correct electric currents into the sight. Whereas in previous sights the aiming graticule or ring was fixed, the graticule on the new sight, which consists of six diamonds arranged in a circle around the centre spot, moves on the reflector as a result of his or the enemy's manœuvres, and the graticule also expands or contracts according to the adjustment of the twist grip. On going into attack the pilot adjusts the diameter of the moving graticule, so as to contain exactly the wing span of the enemy aircraft. With his hand on the throttle as he shortens his range he drops his wrist to open the graticule, at the same time keeping the central aiming dot on a vital part of his opponent. In doing this the pilot knows that the sight is correctly making all the necessary deflection allowances required to register hits.

THE WORLD OF MODELS

By "MOTILUS"

A Variety of Exhibition Models and a Fine Amateur Full-rigged Ship Made During the War

Miniatures of landing craft which are on view at the Combined Operations exhibition held at Harrods which represents five years of Naval Warfare.

"DEEP down in the nature of most of us there is an artistic creative complex. We may not be gifted with pen or pencil to draw or be able to produce sounds from instruments, but the urge is there to create, and it manifests itself in various ways.

"Sometimes we say all our fingers are thumbs, but do not let us forget that it was the power of the thumb that brought us from arborial monkey to 'homo sapiens.' Pretentious words. From hanging from a branch of a tree to strap-hanging! Without the power to write, for instance, what little pooled knowledge there would be in the world.

"Modern civilisation is pushing us slowly away from craftsmanship. The machine does everything, and we poor mortals are used only when a process wants a machine that is too complicated to design, or too expensive to produce to supplant us.

"A toast, therefore, to a society like this, that brings us back to earth and allows us to express ourselves in the way we want, in whatever sphere we want, and let everyone and everything else leave us alone to enjoy our bit of creative leisure."

The quotation heading this article is from the speech by Lord Brabazon of Tara at the opening of the annual exhibition of the Kodak Society of Experimental Engineers and Craftsmen this summer. This exhibition has now been held for six years, and although the number of exhibits was down on last year's effort the quality appeared to be of a higher standard, and the society certainly kept up their reputation for a good show. The challenge cup winners were: Class 1. Locomotive (steam), Mr. L. H. Cheeseman, S.M.E.E., G.W.R. "King John"; Class 2. Marine, Mr. E. V. Messenger, Period replica "Sovereign of the Seas"; Class 4. General Mechanical Models, Mr. K. W. Harris, K.S.E.E.C., ¾in. scale reversible horizontal Mill Engine; Class 11. Aero Models, Mr. E. V. Pullen, 1-24th scale Fairey "Flycatcher."

Model of Nahalal—a Jewish agricultural settlement in the Valley of Esdraelon —1/800th actual size. From the illustration one would hardly credit that there are over 7,000 orange bushes on the model.

Among the novelties of the exhibition were a demonstration of the art of glass-blowing by Mr. F. H. Hill, and an exhibition of lace-making by Mr. A. K. Soper; also a special display of petrol-powered racing cars, which attain speeds up to 50 m.p.h., tethered from a central point. A club to promote this new sport is to be formed.

Combined Operations

An interesting exhibition arranged by Combined Operations was held in August at the ground-floor central hall of Messrs. Harrods in London, and represented five years of Naval Warfare in both full-size and model form. Among the full-size exhibits were a naval torpedo as used in the Fleet Air Arm, magnetic and ordinary sea mines, and various types of naval shells and other projectiles, together with a large number of most striking photographs. Models also played their part in this exhibition. Bassett-Lowke, Ltd., had loaned an exquisitely modelled set of landing craft that have recently been taken off the secret list. The models were of the waterline type, and included an LSI (landing ship infantry), a cross-Channel steamer converted to carry assault troops, an LST (landing ship tank), and a variety of LCIs (landing craft infantry) and LCTs (landing craft tanks), which were specially built for amphibious operations, and supporting vessels such as flak ships, gun ships, and auxiliary support craft for taking stores, etc., ashore.

Lord Brabazon of Tara operating a Trix train layout during a visit to the works where they are made. Lord Brabazon is widely known as a keen and expert model man, and is also president of the Roadfarers' Club.

A view of Mr. E. R. Coomer's model railway on show at a National Fire Service fête at Christchurch, Hants, last year.

Other model exhibits were a Barracuda torpedo bomber model, a minesweeper, and a set of small models of naval craft made by a serving officer, and altogether the exhibition, although small, was very attractive, and was visited by a large number of people, especially those in this arm of the Service.

A Palestine Model

There are models which do not show at a first glance the amount of detailed work which has gone to their making, and this model of a Jewish agricultural settlement is perhaps one of these. The model is 1-800th actual size, giving a 3ft. 10in. circle for the settlement. It took approximately 550 hours to build, and contains over 1,000 trees of various types, chiefly cedar and eucalyptus, 500 buildings in the settlement, and over 7,000 orange bushes. The model represents the agricultural settlement of Nahalal, in the Valley of Esdraelon—a settlement of family holdings organised on a co-operative basis. Built on land which was formerly malaria-infested swamp, the colony now produces wheat, oats, maize, citrus fruits and fodder. Mixed farming has also been developed, and cattle and poultry are raised and vegetable gardens and orchards cultivated. Already 69 of these settlements where individual farmers lease the land from the Jewish National Fund on hereditary lease have been formed. The model is to be on permanent exhibition at the British Association of the National Jewish Home in Palestine headquarters at 18, Manchester Square, London, where it can be seen by making a prior appointment, as the exhibition is not open to the public.

Amateur Model-makers Busy

The month of October heralds the return of indoor hobbies and pastimes. In peacetime model enthusiasts would be getting ready for exhibitions and competitions and generally devoting themselves to plans in the workshop for the long winter evenings.

This autumn, despite the difficulties of materials, tools, and the lack of commercial model accessories, amateur model work continues, and I would like to take this opportunity of mentioning one or two interesting items of work that have come to my notice recently.

I had news the other day of Mr. E. R. Coomer, who before the war had a very fine model railway at the Tarrazona Hotel, Boscombe, Bournemouth. He says that since the war he has done very little in the model railway world, but in August, 1943, he took a section of his layout to a National Fire Service fête at Christchurch and raised nearly £70 for the local hospital. This year they are hoping to have a similar show, going a step farther and running a passenger-carrying railway in conjunction with Mr. Coomer's gauge "0" layout, which is to be operated in a 40ft. x 20ft. marquee.

Owners of model railways lying more or less dormant for the duration of the war can give valuable aid in raising funds for war purposes in this way.

Model of the *Joseph Conrad*

For the last six years Mr. Frank Gaskell, of Praa Sands, Cornwall, has been working steadily on a model of the full-rigged ship *Joseph Conrad*. The picture shows her on the beach at the foot of the cliffs, and it will be seen she has now reached the sails stage.

She is 5ft. in length from the tip of her jib boom to the end of her spanker boom, and her main dimensions are: length between perpendiculars, 43½in.; length, waterline, 38in.; beam, 9¾in.; depth, 7½in. Her keel is of teak, with timbers of steamed American elm. Her stem, stem post, floors, inwales and deckbeams are of mahogany, and her planking of yellow pine. Teak is also used for fife rails and main rails, and also for her false, or, as the builder prefers to call it, her sailing keel, which also is fitted at present with 10lb. of lead. Three ¼in. steel rods go up through tubes to her main deck. All her spars are of silver spruce.

With the exception of two wells, made to facilitate swabbing out her bilge, she is crammed full of ping-pong balls right up to her deck and holds just a gross.

Mr. Gaskell is making a fine job of her and is working on the sails now. When we learn he is 70 years of age, the feat of building this splendid model is all the more creditable.

Trade News

I was interested to learn that the whole of the existing stock of Stuart Turner's boiler fittings have been purchased by Messrs. Bassett-Lowke, Ltd., who have them on sale at almost pre-war prices. I do not know whether any will be left by the time this article is in print, but it might be worth while trying for any special fitting you may be needing. Write to head office, Northampton, or call at London or Manchester branches.

I generally like to take a stroll in this firm's London branch, and always find their limited wartime staff anxious to do what they can to help those who are persevering with their favourite hobby of model-making. They still have a good selection of books on model-making and also quite a selection of castings and engine parts. They have also managed to reprint their booklet, *The Construction of a 2½in. Gauge ½in. Scale 4.6.2. L.N.E.R. "Flying Scotsman,"* price 1s., postage 2d., and *How to Build a Traction Engine*, by F. J. Camm, price 6d.,

The full-rigged ship "Joseph Conrad"—5ft. in length—the work of 70-years-old Mr. Frank Gaskell, of Praa Sands, Cornwall.

700-mile Flight on One Engine

A 700-MILE flight over Japanese-held territory on only one engine, and with barely enough petrol to get them home, was the recent unenviable experience of a Canadian pilot and an English navigator of an R.C.A.F. photo-reconnaissance Mosquito squadron.

F.O. Jack Winship, 28, of Winnipeg, and F.O. Peter Haines, 20, R.A.F., of Leytonstone, E.11, London ex-tram and trolley-bus driver and ex-clerk respectively, were over Indo-China almost 800 miles from base when their port-engine cooling system failed and two petrol pumps went out of action. With speed down to 170 m.p.h., they flew more than four hours over dense jungle and almost all the time over Jap-held country. They were forced to jettison 100 gallons of precious fuel.

When a leak developed in the cooling system, Winship dived to try to cool the overheated engine, but had lost only 3,000 feet when the whole system went unserviceable. While he prepared for single-engine flying, they lost another 3,000 feet, but at 15,000 had no difficulty in maintaining altitude on the one remaining engine. "I knew we'd make it if the petrol lasted," Winship said later, "but we'd had to jettison from our wing tanks."

The two men said they were more worried about the petrol situation and the type of country they were over than above the possibility of meeting enemy fighters. Haines, besides being busy with his navigation work, was kept occupied sending radio reports of the crippled aircraft's progress. Both men have an affectionate regard for the one serviceable engine that got them home. "It's our favourite engine," they declared later.

Winship trained at High River, Alta., and Dauphin, Man., while Haines trained in England and at Port Albert, Ont., and Charlottetown, Prince Edward Island.

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.

Rubberising Canvas

CAN you please tell me an economical but effective method of rubberising a piece of canvas to be used in canoe construction?

If this is impracticable, please suggest an effective substitute.—H. P. Stillman (Belper).

YOU will find it very difficult to rubberise the canvas. However, you may attempt the job by brushing into the dry canvas a solution of rubber in naphtha. This solution can be made by finely shredding rubber and macerating it in warm solvent naphtha, but it is not easy to get a good solution of the naphtha without special machinery, and hence we think you might do better if you approached some local rubber works and requested to be allowed to purchase a small quantity of rubber solution.

Fabric which has been rubberised in the above manner is apt to remain permanently tacky, but in some instances, of course, this character is of no detriment.

You can also rubberise a fabric by immersing it in rubber latex such as is obtainable from Revertex Sales Co., Ltd., Upper Thames Street, London, E.C.4. Here again, however, it is difficult for an unskilled worker to obtain a satisfactory result and, added to this is the fact that rubber latex is rather an expensive article.

You can, of course, waterproof the canvas without the use of rubber. You may, for instance, brush on to it a hot solution of hard bitumen (such as "Gilsonite") in solvent naphtha. This will make the canvas somewhat inflexible, but it will be perfectly waterproof. Other and softer grades of bitumen may be used, but with very soft bitumen the canvas will be tacky.

A still further alternative is to brush on to your fabric a solution of aluminium stearate in solvent naphtha. The aluminium stearate can be obtained, price about 1s. 6d. lb., from Messrs. A. Boake, Roberts and Co., Ltd., Stratford, London, E.15. It must be dissolved in the naphtha in the cold, for if the naphtha is heated, a jelly will result. A 20 per cent. stearate solution is the best to use.

Again, you may employ the following waterproofing mixture: aluminium stearate, 2 parts; paraffin wax, 7 parts; linseed oil varnish, 100 parts.

In our opinion, you would obtain the best waterproof results by applying a stearate treatment to your canvas and by following this up with impregnation by a solution of bitumen in naphtha.

Making Aluminium Powder

I AM interested in making aluminium powder from foil or metal. What is the best way to deal with quantities up to ¼ ton? The powder is to be used either for painting or local firework displays. —L. Bettencourt (Funchal, Madiera).

THE manufacture of aluminium powder has for many years been retained a close secret by manufacturers, and even to-day the process is more or less a secret one in its practical details. Here, however, is an outline of the process, so far as is known at the present time:

Clean scrap aluminium, either in the form of thin sheet or foil, is cut up mechanically into pieces about 1in. square. The material is then placed in a stamping mill wherein it is subjected to heavy mechanical hammering for several hours until the metal is reduced to powder. In order to prevent the metal particles from sticking to one another, a lubricant consisting of 70 per cent. of stearic acid and 30 per cent. of tallow is added to the stamping mill at the rate of 12 ozs. of lubricant to every 100 lbs. of metal treated. After stamping, the powdered metal is sieved.

Usually, the metal so prepared has not a brilliant lustre. In order to acquire this characteristic, which makes it suitable for paint manufacture, the metal powder is subjected to a process of polishing. This polishing process may consist of subjecting the metal powder to the action of two or three paddle wheels or vanes revolving in an iron cylinder, or, alternatively, to the action of a pair of stiff-bristled brushes revolving within a cylinder, the bristles of the brushes making contact with the inner walls of the cylinder. The paddle wheels or the brushes must revolve at 100 revs. per minute.

The aluminium powder is subjected to this polishing process for about 30 hours, after which it is again sieved and packed for use.

It is nowadays impossible for you to procure machinery in England for this process, but you may, of course, be in a position to procure such for yourself.

The stamping mill necessary for the reduction of the 1in. squares aluminium foil or sheet to powder may be of any design, provided that they are able to give the metal continuous and heavy hammering. In this connection, therefore, it will be necessary for you to experiment for yourself.

Making a Hard Tennis Court

I WISH to lay down a hard tennis court, and would like to know the best material to make it with, consistent with low cost. Of what materials are ordinary red courts made?

Would screened ashes be satisfactory? The large ones as the base and finer for the top dressing?—R. M. Bowers (Leicester).

UNDOUBTEDLY the best and most enduring materials for making a hard tennis court is coloured asphalt, which may be obtained in red, green or grey shades. Unfortunately, however, asphalt (particularly green asphalt) is expensive, and its satisfactory laying necessitates skill and experience.

Many red tennis courts are laid in red asphalt, which is the cheapest of the coloured asphalts.

As an alternative to red asphalt, you may use red shale mixed with sufficient Portland cement and fine sand to bind it together.

Coloured concrete courts have sometimes been laid, but players usually find these too hard and unyielding to the feet. However, you may obtain particulars of such coloured concretes from the Cement Manufacturers Association, Tothill Street, London, S.W.1.

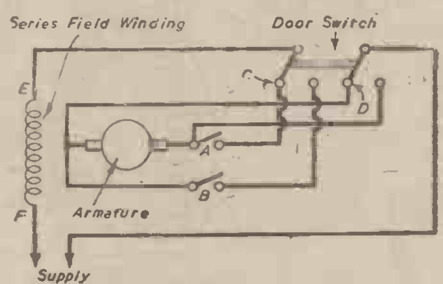
Your suggested procedure of laying fine ashes on top of coarser ones would hardly suffice, since the top dressing of ashes would speedily be removed or, at least, seriously disturbed, by the movements of the players' feet. For a satisfactory hard tennis court, you must have the top surface suitably "bound" down so that it is not readily disturbed. As we have already remarked, coloured asphalt is the best material for this purpose, and, after this, any other suitable material may be used provided that it can be made into a "mix" with Portland cement, laid down in the moist state and then left to set and harden.

Automatic Operation of Curtains

CAN you please give me details, including a circuit diagram (but without the relay system) and types of switches used, of how the curtains at a cinema opens and closes by electricity?

I require this knowledge with a view to constructing a similar job at home for ordinary room curtains (at a window about six feet wide) and which will open and close at the opening and closing of the door.—R. E. Blackwell (London, W.C.2).

WE suggest that you use a small universal (series commutator) motor for operation on either A.C. or D.C. To control this motor you could use a double-pole two-way switch operated by the opening



Switching arrangement for controlling motor for operating curtains.

or closing of the door. Assuming the curtains are to be closed when the door is opened, arrange the two-way switch so that it is on the contacts C and D (as shown) when the door is open. The contacts A represent a small limit switch which is opened by the curtain when this reaches the end of its travel and is fully closed. In a similar way the contacts B represent a small limit switch which is opened when the curtain is fully open. With the door switch on the contacts shown (C and D) the motor will therefore run to close the curtain until it is stopped by the opening of the contacts A. If the motor should run in the wrong direction the connections E and F to the ends of the field windings should be reversed.

Transformer Windings

WOULD you please inform me how one arrives at the number of turns and gauge of wire required for the primary on a mains transformer with laminations of say one square inch for 230 volts, also how one knows how many turns to wind on top of this for secondary high tension 250 volts?

A friend of mine has an A.C. radio, 220 volts mains, and wishes to use same for his own private electricity supply of 110 volts D.C. Could you let me know what is required to enable him to do so? I understand that D.C. mains cannot be stepped up via a transformer.—W. H. Eakins (Dromore).

A TRANSFORMER having a core of one square inch cross sectional area used on a 50 cycle supply, could give an output of about 50 volt amps. For 20 volt amps. we would suggest a core size of 0.5 sq. in.; 1.75 sq. in. for 150 volt amps.; 2.5 sq. in. for 300 volt amps., and so on. The volts per turn of either the primary or the secondary windings can be found from the formula—

$$\text{volts per turn} = \frac{4.44 \times \text{frequency} \times 65{,}000 \times A}{100{,}000{,}000}$$

where A is the cross sectional area of the core in square inches. If the area is 1 sq. in. on a 50 cycle supply this works out at 0.144 volts per turn, or approximately 7 turns per volt. The number of turns needed for the primary will be $7 \times 250 = 1{,}750$ for a 250 volt primary. The number of secondary turns can be found by multiplying the required secondary voltage by 7, and adding 5 per cent. to allow for voltage drop. Dividing the volt amp. output by the secondary voltage gives the secondary circuit in amps. (in a single phase transformer); whilst the volt amp. output divided by the primary voltage gives the approximate primary current. The size of conductors for both primary and secondary can then be worked out, using a current density of about 1,500 amps. per square inch cross section of the copper conductors.

In order to operate the 220 volt A.C. radio set from the 110 volt D.C. supply it would be necessary to use a 110 volt D.C. motor driving a 220 volt A.C. generator or alternator. It would be cheaper and much more satisfactory to replace or modify the set to operate direct from the 110 volt D.C. supply.

Calculating H.P. of Water Wheel

I HAVE started to repair an old overshot wheel which used to drive millers' stones some 50 years ago. It is 13ft. 2in. in diameter and is 3ft. 6in. wide. It has 42 buckets, each of which holds rather more than 2 cubic ft. of water. The weight of water in a bucket is 9 stones.)

The head of water is about 1ft. above the wheel, and there is about 6in. clearance between wheel and tail water. During spring, autumn and winter the water supply will be more than ample.

Could you please tell me (1) what h.p. such a wheel would generate; (2) how many r.p.m. the wheel would revolve under load?—J. R. Wilson (Morpeth).

THE weight of water in a full bucket is 126 lbs. In one rev. of the wheel the weight of water lowered is 42×126 lbs. $= 5{,}292$ lbs. The theoretical work done per revolution is equal to the product of the water lowered and the distance, and is equal to $14 \times 5{,}292 = 74{,}000$ foot pounds. Since 1 h.p. is equivalent to 33,000 foot pounds of work per minute, the calculated horse-power of the wheel should be equal to $\frac{74 \times \text{r.p.m.}}{33}$. The actual work obtained would be less than the calculated value owing to the fact that the buckets may not be quite full, some water may be spilled, and the friction of the wheel shaft will absorb some of the power. The actual horse-power obtained may, therefore, be about equal to the r.p.m. It is difficult to say what the speed of the wheel will be when loaded, as this will depend on the load driven and the rate at which the water is fed to it.

THE P.M. LIST OF BLUEPRINTS

The "PRACTICAL MECHANICS" £20 CAR (Designed by F. J. CAMM), 10s. 6d. per set of four sheets.

"PRACTICAL MECHANICS" MASTER BATTERY CLOCK* Blueprints (2 sheets), 2s.

The "PRACTICAL MECHANICS" OUT-BOARD SPEEDBOAT 7s. 6d. per set of three sheets.

A MODEL AUTOGIRO* Full-size blueprint, 1s.

SUPER-DURATION BIPLANE* Full-size blueprint, 1s.

The P.M. "PETREL" MODEL MONOPLANE Complete set, 5s.

The 1-c.c. TWO-STROKE PETROL ENGINE* Complete set, 5s.

STREAMLINED WAKEFIELD* MONOPLANE—2s.

LIGHTWEIGHT DURATION MODEL Full-size blueprint, 2s.

P.M. TRAILER CARAVAN* Complete set, 10s. 6d.

The above blueprints are obtainable, post free, from Messrs. G. Newnes, Ltd., Tower House, Strand, W.C.2.

*An * denotes that constructional details are available, free, with the blueprint.*

ELECTRADIX

INSTRUMENT CASES, metal with hinged lid, 8¼in. x 4¾in. x 5¼in., well finished, ex-W.D., 10/-. Base covers, light ventilated metal, arched, contains 6¼in. x 5in. with terminal extension, 3/6. Leather cases for galvos., etc., various sizes, 2/9.

POWER TRANSFORMERS. 150 watt Foster, 400 cycles, 230 volts to 15 volts C.T., 10 amps., £3. 500 watt Foster, 440 volts, 50 cycles to 110 volts, 5 amps., £4/15/-. 1 kW. Powquip, 250 volts 50 cycles to 50 volts, 20 amps., £9. 3 kW Metvick, 400 volts 50 cycles to 600 volts, oil, £9/10/-. 4.3 kW Foster, 400 volts 50 cycles to 60 volts to 72 amps., £12.

TEST TRANSFORMERS, 5 watt 110/220/1,000 volts, 10/-. Deaf Aid ten guinea sets S.H., for reconditioning, Ardente and other first class makes, less battery and plug cord. Lapel Mike and earpiece, etc., in pocket case, 45/-. Marconi Otophone 2-valve voice amplifier, S.H., with valves; list £25, less batteries, £5.

FUME EXTRACTOR AIR PURIFIERS, 25 cub. ft. approx., with large filter chamber, all steel, 15¼in. x 20¾in. x 14in., with intake down shaft. Geared hand drive or 1/6th h.p. motor. Suit laboratory or works.

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AUTO SWITCHES, magnetic trip thermal delay, 10 amps., double or triple pole, 25/-. 250 amps., £4. Battery auto cut-outs, 8 amps, 6 volts or 12 volts, Lucas, 10/6. Contactors and other autos quoted for.

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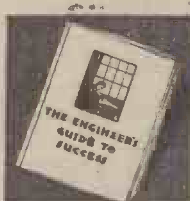

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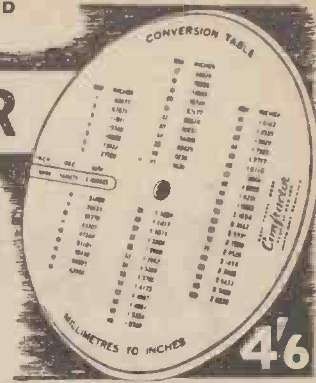

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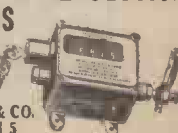

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THE Cyclist
Editor: F. J. CAMM
VOL. XIII OCTOBER, 1944 No. 272

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

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

Memorandum to M.O.T. on Massed Start

The following is the text of the memorandum delivered to the Ministry of Transport by a deputation appointed by the B.L.R.C.

THIS deputation has been appointed by the British League of Racing Cyclists, the governing body for Massed Start racing, to place before the Ministry of War Transport and the Home Office their case in favour of Massed Start racing in this country, and to reply to the joint announcement of the Home Office and the Ministry of War Transport to the effect that Massed Start racing is "undesirable."

We have asked the M.O.T. to receive this deputation so that the M.O.T. and the Home Office can have made known to them facts concerning Massed Start racing not in their possession. It is noted that the Home Office and the M.O.T. did not invite the B.L.R.C. to submit their side of the case before the Home Office issued the aforesaid joint announcement.

It is our hope that upon reconsideration of the matter this joint statement may be withdrawn or modified to remove the impression that further Massed Start races will result in prosecution, irrespective of whether participating riders break the law or not.

[*Since this memorandum was submitted races have been successfully held without police interference.*—ED.]

We would draw attention to the fact that such races of the Massed Start type which have been held in this country have been run without accident or incident, with police co-operation and without complaint from the public. It is all the more surprising, therefore, that the joint statement should have been issued.

It is our belief that the National Cyclists' Union is the chief opponent of Massed Start racing in this country, and it is necessary, therefore, to inform you of the facts.

The National Cyclists' Union, up to 1888, was the body which governed road racing in this country, and it also homologated road records.

Owing to the attitude of the police in those early days of cycling (before the invention of the pneumatic tyre) and to the opposition of the horse-drawn vehicle interests, the National Cyclists' Union, in 1888, at its annual general meeting tabled and passed the following resolution:

"The National Cyclists' Union as a public body desires to discourage road racing, and calls upon the clubs to assist it by refusing to hold races on the roads, and it prohibits any of its officials from officiating or assisting at any road races, and refuses to recognise any records made on the road, and that this be added to the rules."

The National Cyclists' Union from this point has been concerned only with racing on closed circuits and tracks. As a result, the Road Records Association was formed shortly after (in April, 1888) to homologate attempts at record on the road, and that body is still in existence.

Racing on the roads continued, and this was controlled by a number of bodies until, a few years before the war, the Road Time Trials Council was formed to control time trials, that is to say, trials in which the riders are started at minute intervals, and race against the watch.

[*Note that both the R.T.T.C. and the R.R.A. were formed as a result of breakaway movements; yet these two bodies oppose the B.L.R.C. who have done the same thing.*—ED.]

In spite of this method of starting, it is obvious that close finishes must result, where a number of riders will sprint to the finish. Even so, there have not been any accidents.

There are a number of other associations, such as the Women's Road Records Association, the Bicycle Polo Association, the Tricycle Association, and the Cyclists' Touring Club, which is not concerned with racing.

The main opposition to Massed Start racing seems to be raised by the N.C.U., which actually controls (or did in 1939) less than 500 licensed riders. To-day, of course, the number is far less. Massed Start racing on the other hand, has become extremely popular on the continent, and there has been a large demand among cyclists in this country for a similar form of racing over here. On the continent, such races are front page news, and provide riders with opportunities for improving their physique, and attaining the skill necessary to represent their countries in other international sports meetings such as the Olympic games. Our riders have always shown up poorly in these games, because of lack of opportunity for training.

The international body governing cycling sport is the Union Cycliste Internationale, and the N.C.U. is affiliated to this body. The U.C.I. promotes Massed Start races abroad, and the N.C.U. issues licences to British riders to take part in those races. It is difficult, therefore, to understand why the N.C.U. should be opposed to Massed Start racing over here, where the roads are no worse, and in many cases much better, than those, for example, used in the Tour de France. It would seem that the main opposition of the N.C.U. is to a new body handling a form of sport which has become more popular than track racing.

Massed Start races have been held abroad for a large number of years without accident, either to the riders or to the members of the public. Apart from being a healthy pastime, such races are of considerable public interest, and additionally they act as a fillip to industry, including the cycle industry. It is important to remember that there has not been a general meeting of the N.C.U. or the R.T.T.C. since the war, the Union now being governed by an emergency committee, which merely expresses personal opinions.

Police supervision of Massed Start racing is not necessary, any more than it is for time trials. The B.L.R.C. is itself a disciplinary body, and would take drastic action against any rider who transgressed the rules, which are so framed as to insist upon the law being obeyed. However, the promoters of these Massed Start races were most anxious to demonstrate to the police that they were law abiding citizens, who, in wishing to indulge in this particular form of cycle sport, had no intention of allowing its members to do so by running foul of the law, or by inconveniencing members of the public. As a fact, to date, the B.L.R.C. has not received any complaints from the police, or from the members of the public. We ask: Has the Home Office received any complaints from the police or members of the public, and, if so, from whom, and in what circumstances? Is it not a fact that the only real opposition has emanated from the N.C.U. which, having dissociated itself from road sport, in 1888, and thereby caused a number of other controlling bodies to be formed, now sees in Massed Start racing a dangerous competitor? After the start of a Massed Start race, the riders soon thin out, and the start is comparatively slow. The courses are well marshalled, and the conduct of the riders subject to continuous and careful scrutiny.

[*It was admitted that the only opposition had come from the R.T.T.C., the N.C.U., and one member of the C.T.C., who acted without instructions from the club.*—ED.]

If the Home Secretary intends to ban Massed Start racing (we note that he merely says that it is undesirable) does he intend to ban time trials?

The B.L.R.C. is prepared to continue Massed Trials without police co-operation, for the police have no power to stop Massed Start racing, providing it is run in accord with the law, and the B.L.R.C., as in the past, will insist upon this in any future races. It is prepared so to plan its programmes that it will not run more than two races in any year in any one area, and it will, of course, as hitherto, select those courses most appropriate for the running of such races, without inconvenience to other traffic, other road users, or members of the public.

We seek an assurance that the police will not, as in 1880, trump up cases against those partaking in Massed Start trials which are properly organised, and run in accord with the law, as a result of the Home Secretary's statement.

We would remind the M.O.T. and the Home Secretary that the Motor Cycling Club organises many famous motor trials on the roads of this country, and has done so for many years prior to the war. The police co-operated in the running of these races, which have been free from accident or incident. It is true that these races are run as time trials, but riders in these races can bunch together as in any other form of race, for short periods.

All of those associated with the B.L.R.C. are experienced men of mature years, who hold cycle sport in too great an esteem to do anything to injure it.

Paragrams

Stratford St. Mary, Suffolk.

A Third Hendry

ANDREW HENDRY, 16-year-old brother of the two well-known time trialists, has started track riding, and has already won several races.

Kendal Youth Hostel

A LARGE part of Kendal youth hostel has been requisitioned by the Government, and only 40 beds are now available. There are no cooking facilities for the time being.

A. C. Elliss Missing

A. C. ELLISS, Southgate C.C., a pilot in the Fleet Air Arm, is reported "missing, believed killed." He was one of the club's promising string of short distance riders.

Killed in Burma

J. DILLEY, Leicester Section of the Clarion C.C., has been killed in action in Burma. He was 29.

Southward Bound

DAN QUINN, Douglas C.C., has completed his 30th tour in England in 40 years of cycling. A seasoned veteran, he recalls the days when two "fifties" comprised the year's time trial activities in Scotland.

Hampshire Road Club News

STEWART McNEILLE, Hampshire Road Club, is reported missing. He was with an Army Reconnaissance Unit. Well known in Hampshire road circles as an enthusiastic clubman, he was also a photographer of outstanding merit.

News from Norwich

L./CPL. TONY W. FRESCHINI, well-known Norwich rider, has been killed on active service. Jack Fitt, of the same city, has escaped from captivity in Northern Italy, as has Maurice Voisey, of the Norwich Amateur B.C. Former club champion J. Nudds, who served in Italy, is now in France.

An Innovation

THIRTY Chinese seamen accepted an invitation by Frank Sleman for a day's cycling in Cheshire. The innovation was enjoyed, and a request has been made for more.

Carter Commissioned

W. J. CARTER, Southgate C.C., and noted short distance exponent of a decade ago, has been commissioned in the R.N.V.R. He spent over two years in Icelandic wastes.

Harding's Dual Win

A. C. HARDING, Middlesex Road Club, winner of the 50-mile road championship of England, has also won the 100-mile championship with an excellent ride of 4.28.12.

Strange Bedfellows!

A. WRIGHT, Zenith Wheelers, and S. Hudson, Barnsbury C.C., met in a Midland hospital. Both were wounded in an attack in France.

A Good Reason!

BELIEVED to be London's oldest taxi-driver, W. J. Thomas, of Clapham, has been driving a cab for 29 years, during which period he has not had an accident. In his "spare" time he is a cyclist. He is 74.

A New Role

THE Hon. Treasurer of the Goldberry C.C., Andrew Aird, has been directed to take up work in a mine.

His New Club

SGT. STAN MILES, member of the Century Road Club, is now a member of the Manchester Wheelers, under a special wartime invitation scheme.

J. W. Raybould Dead

STATED to be the "oldest cyclist," J. W. Raybould has died. He was 96, and commenced cycling in 1868. At the age of 71 he covered no fewer than 200 miles in 24 hours.

The Vicar's Centenary

PREBENDARY R. J. E. BOGGIS, Vicar of St. John's, Torquay, who has retired at the age of 81, is stated to cycle over 100 miles weekly.

Hendry's Fast "25"

ALEX HENDRY, Glasgow Wheelers, joins the select few who have covered 25 miles out and home inside the hour. He clocked 59.58 to win the Charles Star "25."

Killed in Normandy

ALFRED SCOTT, prominent Lancashire wheeler, has been killed in action in Normandy.

Cyclist Casualty

AMONG the casualties in Normandy was L./Cpl. John Mobley, Walsall Road Club, who subsequently spent some time in hospital in Yorkshire.

Wembley Wheelers' Loss

BY the death on active service in France of John Barrett, the Wembley Wheelers have lost another prominent member as the result of the war.

After Two Years

JUST over two years ago Quartermaster Sergeant James Cluff, former secretary and champion of Hitchin Nomads C.C., was reported missing in the Far East. He is now known to be safe and well in Japanese hands.

Another Forces Club

THE Abourkir C.C. is the lastest Forces C.C. Membership is drawn from men in the Middle East, and the secretary is F./Sergeant T. Reading.

Harry Ryan Dead

HARRY RYAN, genial official of the Dunlop Rubber Company for the past 37 years, has died. He was a well-known figure at cycling fixtures.

Death of Rev. C. A. E. Pollock

AN Alderman of the Borough of Cambridge, Rev. C. A. E. Pollock has died. He was 86, and a well-known Cambridge cyclist and contemporary of Keith-Falconer. He rode for Cambridge against Oxford in 1879-80-81.

The Tempsford Wheelers

SERVICEMEN in the Tempsford area have formed the Tempsford Wheelers.

Lamp Battery Priority

BY an agreement between the Welfare Department of Morris Motors, Ltd. and a local firm, a priority supply of at least 1,000 cycle lamp batteries a month during the coming winter is assured.

Red Cross Effort

UXBRIDGE Bicycle Polo Club have, as the result of a successful sports meeting, donated £100 to the British Red Cross and £20 to a local Comforts Fund.

Barnsbury Loss

JOHN GAUL, Barnsbury C.C., has been killed in action in France.

Resuscitation

AN attempt is being made to resuscitate the Northern Unity C.C., which, unfortunately, became defunct after the outbreak of the war.

De Laune's Century!

WITH the calling up for military service of Walter Fraser, the number of members of the De Laune C.C serving reached 100. Each receives monthly the magazine and a donation from the Comforts Fund.

Woman Champion

SUSIE RIMMINGTON, Chesterfield Spire C.C., won the R.T.T.C. women's national 25-mile championship with a ride of 1.7.46.

Hostel Ships?

ACCORDING to "The Handlebar," a cycling periodical published in America, plans have been initiated which may lead to the conversion of troopships into floating hostels after the war.

N.C.U. Appeal

THE surface at Herne Hill has now been laid and received its initial rollings. It does, however, require as much traffic as possible before the final coat is applied, and the N.C.U. invite clubfolk who can spare the time to ride on the track and to put in as many hours training as possible.

The appeal is addressed to both sexes, and those who are going along should bear in mind that it will be an advantage if they ride, as far as possible, all over the surface and not just at the lowest points of the banking.

Unfortunately, owing to circumstances beyond the Union's control, there are no facilities for bathing, changing, etc. N.C.U. membership cards must be produced, as only members are invited.

Matter of Taste

WE were interested to note recently the remark of a writer on cycling topicsthat, having once cycled through the Mersey Tunnel, he never wished to do so again. Everyone to his taste, of course. To my way of thinking, the traverse of the tunnel is a joy. At first the noise is rather terrifying, but one gets used to this, and one has time to appreciate something of the wonder of a magnificent under-water link between two counties. We are prepared at any time to spend a nimble tanner (with whatever increase the rising cost of raw materials has added to the toll) for the pleasure of doing the double trip below the Mersey merely as a detour.

Lanercost Abbey, Cumberland. Founded in the 12th century, it is now a National Trust property.

Around the Wheelworld

By ICARUS

Harry Ryan Passes On

I GREATLY regret to record that my old friend, H. F. Ryan, Fellow of the Roadfarers' Club and a member of the Centenary Cycling Club, recently died at the age of 64. He had been with the Dunlop Rubber Company for more than 30 years. In July, 1924, he went to Fort Dunlop as sales manager for cycle and motor cycle tyres, and latterly he was particularly interested in their sale to the actual makers of cycles and motor cycles. His familiar figure will be missed at cycle races and cycle events which he regularly attended. It is in the nature of things that many of those famous from the earliest days of cycling will vanish from our ken within the next few years. We have had a crop of jubilees, and it is inevitable and regrettable that those jubilees must also see the passing of those who made them possible.

Cycling President's Post

ANOTHER Fellow of the Roadfarers' Club who is also attached to the Dunlop organisation is Mr. E. Mitchell, who, I hear, is leaving the South for the Midlands after having been Dunlops' London manager for the last seven years. He goes to Birmingham as their regional manager for the Midlands, in succession to Mr. Charles Sinclair, who is giving all his time to the tyre division of the New Dunlop Training Scheme. Mr. Mitchell is president of the Charlotteville Cycling Club.

Any Post-war Plans?

NOW that the war is nearing its close the question of the secretaryships of national bodies becomes topical. The present secretary of the N.C.U. took over the duties of secretary when Crowe joined up. It is not known whether Crowe will remain in the Services or return to civilian life and, if the latter, whether he will join the organisation for which he did so much.

The present secretary, Mr. Chamberlin, has worked hard in the interests of the Union, and has seen his efforts rewarded by an increase in membership. I have not always seen eye to eye with Mr. Chamberlin, nor with the N.C.U., and I shall continue to dispute with them on what I sincerely believe to be their mistaken policy in relation to mass-start racing.

I think it was unwise of the N.C.U. to have written a letter regarding the undesirability of mass-start racing to the authorities, and thereby to have aggravated a matter which could have been amicably settled round the table, until the attitude of the N.C.U. made that course quite impossible. But that does not mean that my appreciation of their work in certain directions in connection with track racing and the resuscitation of the Herne Hill track is any the less. I also think they are mistaken in endeavouring to exercise a control over races on the road, which are quite outside their articles of association. I think they are mistaken in associating with the Road Time Trials Council, because their policy is against road races, and the R.T.T.C. exists to promote them.

When the war is over and cyclists return to their clubs some hot words are going to be spoken on these matters, and there may be a revulsion of feeling and a turning of the tables.

The present secretary of the C.T.C. will presumably retire some time next year, and the question of the secretaryship will also arise? When the new appointment is made, will advantage be taken of that opportunity to remodel the whole constitution of the Cyclists' Touring Club? Will it become a really democratic organisation devoted only to cycle touring, or will it continue to be purely a political organisation dragooning the members to support a policy which they have had no hand in framing? Will it act upon resolutions passed at annual general meetings instead of going through the motions and promptly pigeon-holing any resolution which it thinks awkward? Everyone else has framed post-war policy, and until the C.T.C. and N.C.U. announce theirs I fear that their membership is unlikely to grow. Cyclists require a policy in keeping with 1944, not 1884. Perhaps some younger blood could be introduced and they do not wish to be hamstrung to an effete policy.

Mr. E. Mitchell.

Road Accidents—July, 1944

THE number of children killed on the roads in July was the highest ever recorded in this month, with the exception of July, 1941. Fatal accidents to child pedestrians numbered 106. In addition, 30 child cyclists were killed.

Reports on accidents to child cyclists indicate that two of the main causes were collisions at cross-roads and swerving or turning without giving hand signals. To guard against such accidents, all children using cycles should be made familiar with the rules of the road contained in the Highway Code. Drivers can help by keeping a sharp look-out for these young riders and giving them plenty of room.

These accidents to children formed more than a quarter of the total road deaths for the month. Casualties to children and adults together totalled 511 killed and 10,302 injured. In July last year the figures were 384 killed and 9,502 injured.

The following table shows the numbers of fatalities analysed under the type of vehicle primarily involved:

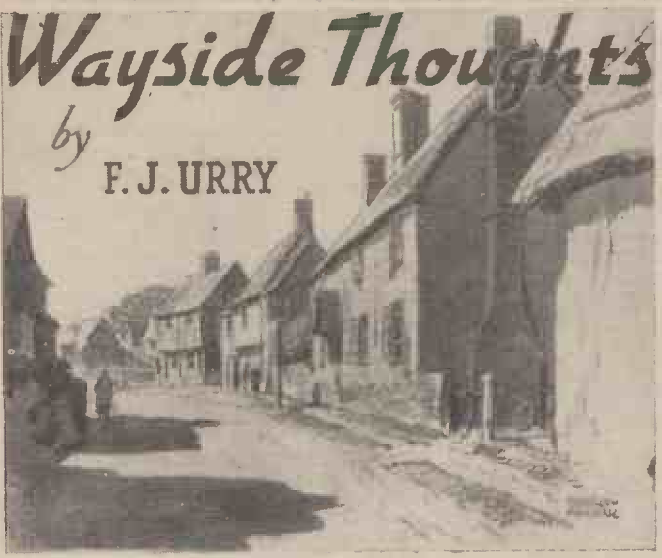
Type of Vehicle.	*Number of Persons Killed.*
Service (British, Dominion, and Allied of the three Services)	165
Civil Defence and N.F.S.	8
Public Service and Hackney	77
Goods	112
Private Cars	26
Motor Cycles	19
Pedal Cycles	92
Others	12
Total	511

(The term "Vehicle primarily involved" means (1) where only one vehicle was concerned, that vehicle; and (2) where more than one vehicle was concerned, the vehicle to which the accident appears to be primarily attributable. *In either case it does not imply that the driver of the vehicle was culpable.*)

SOUTHERN GRAND PRIX—THREE DAYS' CYCLE RACE, August, 1944. L. Plume, of Manchester (right), being congratulated by L. Hook, of West London (runner-up) after winning the Southern Grand Prix held in the region of Farnborough, Kent. Plume covered 276 miles in three days' riding.

Wayside Thoughts

by F. J. URRY



East Hagbourne, Berkshire.

A Good Way To Go

THAT Welsh tour occupying ten days referred to in my last contribution duly came off and was a most enjoyable trip for the three elderly participants, whose total years counted up to 190. It was good going, for only one day was tempered with real rain, and the other nine had plenty of windy sunshine that filled the countryside with colour and the riders with health. I will not parade our itinerary through these pages beyond saying our area was mainly in mid-Wales, our route included numerous passes ridden and walked in easy fashion, and our accommodation being pre-booked was excellent, and the food satisfactory. We went equipped with primus stove, a minimum of cooking utensils, some food from the home stores, picked up more—and often unexpectedly—on the way, which enabled us to have all our lunches and teas by the way, and in our own selected spots. True it was that our bicycles were heavily laden, but then we were not out to achieve distances, and were well content with our quiet 400 miles of glorious roaming.

"Drumming-up" Tour

IT is many years since I went on a "drumming-up" tour—cooking roadside meals—and the return to the days of my youth was quite a novelty, particularly as it was shared with a couple of merry companions who entered into the spirit of the nomadic picnicking with boyish delight, and swore the lamb chops and tomatoes tasted better for being impregnated with the mountain air. And I think that is true; but equally true is the joy of choosing your own dining site and time, of lingering over the meal and looking at the glory of a countryside where observation will always treat your sense of beauty to a new delight. On our rainy day we used barns, with straw for our couch, and a great vision of the rill-streaming hills for our outlook. There is nothing, I think, quite so good as this freedom of touring.

Two Rocky Passes

THAT our machines were weighty with luggage was a fact, but the modern bicycle will easily stand that strain, even when it is taken over the rough mountain roads of the Welsh passes. Our only hold-up was a front-tyre puncture, and one gear control adjustment. Our only accident a badly torn cape which the storm wind of our wet day ripped up from hem to neck, so that its owner in order to gain all available protection had an apron tied on his back, and tucked himself among the remnants in front with considerable success. Generally speaking, the Welsh roads are good, and most of the well-known pass routes have been remarkably cared for, including Bwlch-y-Groes. But the road leading from the summit of the Bwlch down to Lake Vyrnwy is in a dreadful condition, almost unrideable.

Cwn Eunant

THIS pass of Cwn Eunant has been closed for four years and apparently no attempt has been made to keep it in reasonable condition, even mountain-track condition, with the result that the winter storms have cut the ravines across its surface, some of them a foot or more deep, and for some miles the way is no better than a torrent bed. The Hirnant Pass on the Vyrnwy side is also in a deplorable state. It never was very good; but to-day, what with four years closure and neglect, plus lumbering operations, it is difficult to walk in places, let alone ride. On the Bala side it is remarkably good, every yard rideable once you are over the summit; so the best way of tackling the Hirnant is certainly from the Vyrnwy side, for it gives you a fine run down after a rocky walk up. If you approach from the Bala side you have to walk part of the rise over good surfaces, and then foot it on the rocky descent to Vyrnwy. Personally, I've no objection to idly walking up or down a pass when time is not pressing; it adds variety to the journey.

The Snob in the Bar

IN due time our younger partner of this tour arrived home to tell his golfing friends of his experiences and their enjoyment. One of these acquaintances introduced my friend to his wife as "the congenital idiot who has just completed a 400 miles cycle tour." Because ladies were present the personal description was treated as a joke, but I hope I shall be there when this comrade of mine—a member of the cycle trade by the way—meets that traducer on the wide and lonely spaces of the links. The fireworks will then go up! In a way I do not regret that incident, because it has opened the eyes of one member of the industry to the deplorable derision in which cyclists are held by a certain type of individual. Here was a man, fit, bronzed and happy—a lad of 61—referred to as a congenital idiot because he preferred mobile activity to the slumped attitude of a bar lounge, waiting for "time." This incident was possibly intended as a joke, as a measure of distance existing between the type of man who said it and the type to whom it was addressed; but it affords a good example of the attitude of mind some folk harbour towards cycling. I wonder who will more resemble the congenital idiot at the end of the story; the man whose pasty face, puffed eye sockets, convex waistline and stiff gait, or the cyclist whose summer bronze and bright eyes still retains, and sees in memory, some of the loveliness that went to the decorating of those 400 miles of travel? But the point I want to make is that this kind of superior nonsense, still rampant among certain types of lazy snobs, wants crushing out, and you and I can only help to eliminate it if we have the backing of the members of the industry whose livelihood depends on better cycling, better riders, better bicycles, and the growing wisdom of the people in all these things: and the best pastime man has yet invented for his joy.

Some Folk Learn

IT is a revealing thing to drop across people whose interest in travel was confined to the motor-car until war necessities put an end to that method, and perforce they had to ride a bicycle, take a bus or tram, or walk. I know of numerous such cases, and sometimes one of these individuals stops me for a chatter on things cycling, and is surprisingly frank in his reactions to the pastime. A case in point is a young lady in a bank who knows my signature, but who only knows me, as I her, through the intermediary of the works secretary. This lady rode a bicycle during her school days, then the car captured her appetite for roaming, and now she cycles on a wartime model whenever the chance occurs, and spends all her holidays touring. If the visit to the bank has been a long one, then the reason is that my kindly representative had to listen to the latest adventure, told with an enthusiasm overwhelming my own. And, I am informed, the result of that enthusiasm is sparkling health speaking its mind on a matter of mutual interest. This is by no means the only case I know where the reactions of a returnee to the pastime have been of a new-found and healthy activity in a new world of simple values and perfect scenic delight. That, of course, is cycling: it was never less than that, and so long as we riders retain our freedom to use the road wherever it runs, it never will be.

Worth Remembering

FOR a number of years now I have advised the users of light tyres to treat a fracture or bad cut with my method of repair—the needle and carpet thread, plus thin rubber patch outside and canvas inside. I sew the edges of the cut or fracture neatly and then patch, and if the job is carefully done, guarantee that repair will out-last the tyre. People have laughed at my domestic outfit with its needle and thread, but some of them have seen fit to praise when the operation has saved them a bulge on the cover, and often the cost of a new one. At the moment I have three Sprites which have been so treated, all running on front wheels, and as far as I can see they will outlast the harder worn rear covers. Naturally, they are given the front position because of the wounding, but are doing duty at a time when open-sided tyres are difficult to obtain, and are well worthy of the slight trouble of preservation. Some time ago a Manchester correspondent asked me to give him this form of treatment for fractured tyre walls. Here is part of his letter written at the end of June after six months' experience of such repairs: "I have applied your repair to three pre-war covers, one a Sprite: and it is excellent. I have worn one tyre out yet the repair is still intact. Previously I have always had them vulcanised, but this method invariably leaves a lump on the tyre which can be felt when riding. Vulcanisation is actually a source of weakness as the tyre wears most in the repaired spot. But your method is not disfiguring and is certainly better." I wonder if anyone else will believe in the needle and thread repair which keeps good tyres on the road which would otherwise be discarded?

Coming Nearer

WITH the war situation moving from success to success, there seems every reason to think the position in the cycle trade will immensely improve for 1945. That I think is not just idle wishful thinking, but a judgment of the present state of things both in the national field of vision, and the more limited one that concerns cyclists. That we shall not be enabled to obtain all we desire in the way of bicycles and equipment next year goes without saying; but I think we can confidently look forward to a better type of machine, and the return of at least some of the extras, like speed gears, that have been so long unobtainable. We may have to wait awhile for the return of good tyres to the market, but it is to be fervently hoped this improvement will not long be delayed, for it is impossible to pay the present war-grade cycle tyre a greater compliment than to say it fills a need. I know the industry is getting ready to show the new-comers to the pastime what sort of high-class product it can make, and how much more easily and comfortably we can ride it. I wonder if we can hope for a national cycle show at the latter end of 1945? It would serve as a great re-introduction, as it were, to the sport and pastime, and I imagine, open the eyes of many people to the part the bicycle has played in the war, and more importantly, the part it can and should play in the joy and health of a freedom-loving and athletic nation. For I believe this pastime of ours, this happy game of cycling, has not reached its full stature by a very long way, and that it will be the greatest of the outdoor athletic movements of Gt. Britain, and indeed of the world.

The old bridge, Jedburgh, Roxburghshire, Scotland.

★ In other days this might have been a club run—to-day it's a tougher proposition. But now, as then, Firestone tyres are proved more than equal to the occasion.

they use **Firestone** tyres

★ Your help to meet this great demand is vital. Not one ounce of rubber, synthetic or natural, must be wasted. Keep all tyres properly inflated.

Synthetic Rubber Inner Tubes

ARE NOW BEING MANUFACTURED

"S"

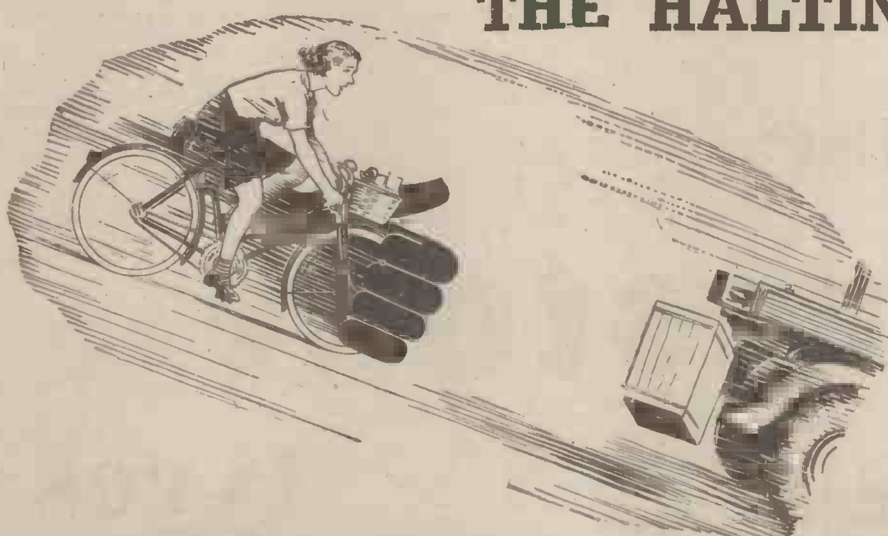
You will recognise an inner tube made of synthetic rubber by the letter 'S' stamped on it, at least half-an-inch high.

and demand special care in repair if the best results are to be obtained. Cycle tyre patches of existing makes may be used, but it is important to prepare the place to be repaired with an abrasive material, such as sulphur remover or sandpaper, before proceeding. In every case solution must be used to secure good adhesion to the tube.

DUNLOP

4H/305

THE HALTING HAND!



Rain or shine you can cycle in safety if you fit

FERODO All-Weather BRAKE BLOCKS

REGD. TRADE MARK FERODO

CYCLORAMA

By H. W. ELEY

Frensham Church, Surrey. The fine tower dates from the early 14th century, and contains some interesting windows.

Americans Studying English Rural Life

I AM happy to live in an area where there are large numbers of Americans billeted, and glad I am that I have such good opportunities of mixing with our cousins and learning a little about their great country. And so many are keen on seeing just the places in England they ought to see! I know two, one from New York and the other from Texas, who are making quite a study of English rural life and English villages by-means of short cycle tours. And in leafy Warwickshire they have ample chance of getting a true picture and taking away with them some glorious memories of ancient towns and grey old churches and cosy inns . . . !

"Old Time" Cycles

MANY months ago I wrote in these columns about the names of cycles which seem to have disappeared, and I recall that some "old-timers" were interested, because such names as "Monopole" and "Premier" and "Royal Ruby" brought back good memories; well, a veteran rider mentioned another bike to me the other day, and I had never heard the name for years . . . it was the "Campion," made, I believe, in Nottingham and once quite famous. I dare say that there are "Campions" in many an old shed, and maybe some being ridden to-day.

Post-war Fellowship

TALK to a Home Guard enthusiast, or to a keen N.F.S. man, and sooner or later you will probably hear a lament that all the good-fellowship, all the friendliness of the contacts made by membership of these wartime organisations, will probably melt away when the "job is done" and the need for the organisations no longer exists. It is a sorry thought . . . but *need* all the friendships disappear? It occurs to me that in cycling we may have the solution of the problem . . . If only all the cyclists belonging to H.G. units and N.F.S. units could be held together by the bond of cycling, what a fine thing it would be!

Pre-war Catalogues

TURNING over some old papers and books the other day I came across some catalogues issued by cycle makers before the war . . . and I had rather a shock when I realised that such richly illustrated, beautiful booklets used to be issued freely and gratis in the piping days of peace! It was good to browse through these catalogues and note the alluring descriptions of the various models; to note, too, the attractive prices! And I imagine that catalogue printers are longing for the day when they will again get orders for such lavish productions . . . the war must have hit the catalogue printer very hard!

Roadfarers' Club

ATTENDED another "Roadfarers' Club" lunch the other day, and heard an inspiring talk by that pioneer of matters aeronautical, Sir Frederick Handley-Page. What an enthusiast he is for the air! He had many sly digs at cyclists (and there were many in his audience), and referred to all road-users as being "earthbound." Well—I do not mind being earthbound as long as I possess a bike! The Roadfarers' Club is a truly live organisation, and is doing a big work in breaking down the barriers which have existed all too long between the various road interests.

"Time Cycles On"

SOME people read advertisements almost unconsciously, others read them deliberately. I belong to the latter class, and find Press advertisements full of interest. Just recently the Hercules Company has broken new advertising ground with a series of really interesting "talks" by its chairman, Sir Edmund Crane. "Time Cycles On" is the title of the series, and in advertisement No. : there was a wealth of wisdom. Sir Edmund has a nice appreciation of the vital part which the bicycle has played in our national life, and particularly during these war years.

American Soldier Cyclists

I HAVE referred previously to the enthusiasm of some of our American soldier visitors for the bike. I talked with an American "buddy" the other day in a little inn not far from the Staffordshire border and he was eloquent about the English countryside, and eager for information about our roads, our inns, our wayside curiosities, and our village churches. And as I chatted with him, in a very old inn, I mused on the romance of it all . . . a gentleman from Texas sipping ale in a Staffordshire wayside tavern! And I believe that gentleman will go back to the States with a genuine love for England and things English: he will have good memories of herds of English cattle moving slowly over green meadows; memories of grey old churches, nestling amid great elms, with ancient yew trees flanking the worn path to the church porch; memories of low-ceilinged tap-rooms, smoke-laden, ringing to the laughter of English farm hands . . . all good memories to take back home, and maybe memories which will be the cement binding our races together during the coming years.

Bank Holiday Traffic

AUGUST Bank Holiday and thronged roads are not a phenomena of the war . . . and despite the convoys and the almost incredible number of "jeeps," the roads were not unduly crowded when compared with pre-war days: those days when our by-pass roads were thick with cars and the journey home was an irritating crawl. But there was quite enough traffic to make one extra careful in riding . . . those giant American vehicles in the long convoys are not things to have arguments with!

Standard of Riding

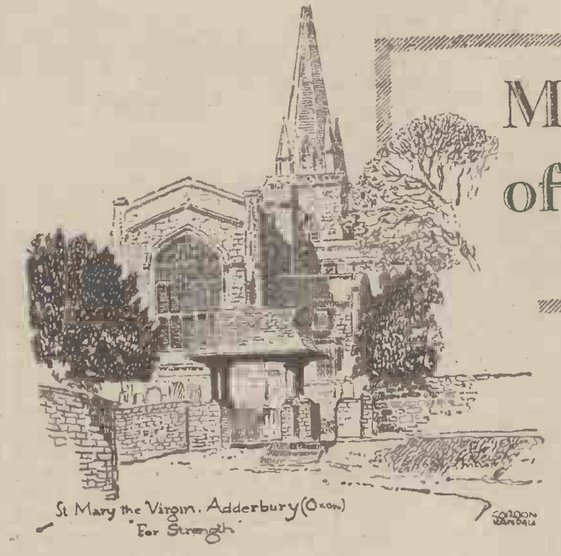
IS it better or worse than in pre-war days? I certainly saw some inexpert and reckless riding during my hours on the roads on Bank Holiday, but comparisons are always odious, and I suppose that—as ever—there are good and bad riders. But what a gulf there is 'twixt the expert rider and the novice! How differently the expert handles his machine . . . and how much more he gets out of it!

Retailers' Windows

ONE knows and appreciates that the lot of the "window dresser" is a hard one these wartime days, and that there is a great scarcity of all those colourful materials which used to go to the making of tasteful displays in the days of peace. But . . . there seems to be a strange lack of window display *ideas*; one imagines that even without the lavish supplies of display material which used to be issued by the cycle, tyre and accessory manufacturers, dealers could do a little more to make their windows attractive. After all, the window is the "silent salesman," and, despite the shortage of many supplies, the dealer might try to attract the eyes of potential customers more than he does to-day. What about staging a little show of old-time bikes in the window? In many a town there are old-time cyclists who would be willing to loan old machines, and with descriptive tickets, indicating the years of manufacture, and various salient points about design, a very attractive window display could be built up.

My Point of View

BY "WAYFARER"



Without Meaning

A NEWSPAPER correspondent who participated in a recent advance in France said that, owing to the difficulties, the pace was that of a cyclist. Meaning, of course, anything between three and 60 miles an hour! Reminds me of a novelist who endows one of his characters with a face "the colour of paper." Meaning, no doubt, wall-paper!

Asking For It

A FRIEND of mine, paying a visit to some people in a small country town near which he lives, left his bicycle leaning on the kerb. When the time came for him to depart and to start for home—at 1.30 a.m.—there was no bicycle leaning on the kerb, nor anywhere within sight. It was not to be wondered at: an enterprising thief had accepted the obvious invitation!

The Only Way

I OBSERVED in my newspaper recently an announcement relative to an investigation where is to be made, under influential auspices, concerning the future of the tourist and holiday industry in Scotland, the idea to put the Land o' Cakes more firmly on the map as a playground. I would suggest to the Committee of investigation which has been formed to deal with the matter that early attention should be given to the possibility of doing something to destroy the plague of cannibal midges which infest Scotland.

Too Much Difference

AN old inhabitant of the road has greatly rejoiced on many occasions this year and last to see the hordes of cyclists who are using the King's Highway. It has been "a sight for sore eyes" (as the saying goes) to watch boys and girls pass by in droves, and to linger at a vantage-point and note the variegated procession—some of the young folk being wisely clad: others being apparelled most unsuitably. But when last year's autumn fell on the scene, where were those boys and girls? And when the autumn of this year is in full blast, whither should one seek the vast majority of the great army of cyclists who cluttered up the roads during summer week-ends? The departure of the cycling "season" is bound to make a difference, but, to my way of thinking, far too much difference is revealed.

Again, the penultimate Sunday of the August just passed struck one as hardly coming in the category of the better days. However, I went forth as usual, taking no short cuts, but riding a full 30 miles in my cape to reach the customary destination for lunch, 17 miles from home. The roads were empty: the lunch-place was an aching void. That afternoon I rode about 15 miles to a tea-place, which a friend and I had to ourselves. The rain had ceased and the sun had emerged, and was gallantly "doing its stuff." In the evening I "made a ride of it" to get back home, and achieved another 23 miles, totalling 68 for the day. The conditions were admirable, despite a marked fall in the temperature. All day long I did not see half a dozen other cyclists. I realise that a wet day is not everybody's "cup of tea," and that it is bound to make a difference. But it should not make so much difference. Actually, the morning's rain was not heavy, nor was riding through it unpleasant, and one was cheered by the prospect, ultimately realised, of fine weather intervening.

Time Lost is Saved

MY established policy of passing behind cross traffic, rather than in front of it, has already been mentioned in these notes. The practised eye of an observant cyclist will generally tell him what he can safely do, and in my case the system of waiting for the stuff to roll by has become automatic. Momentarily, no doubt, time is lost, but in the long run opportunities for cycling are preserved. The motto is to "play safe" on all occasions.

Newspaper folk have this wise rhyming phrase: "When in doubt, leave out." We cyclists would do well to apply something like that advice to our comings and goings, even if we can't make it rhyme. When in doubt—WAIT.

Infuriated

THE other day I was infuriated by the action of another cyclist—or of a man on a bicycle—in signalling me on at a crossing protected by a "Halt" sign, his object being to encourage me to ride over the cross-roads, as he had done, without a pause. My retort to him was much more forcible than polite—very much more so!

Catering and Accommodation

ALL travellers—and many non-travellers—are nowadays interested in catering and accommodation matters, and it may be helpful if I briefly summarise the experiences in connection with a recent 10-day Welsh tour of 641 miles. I stayed at four different addresses, and at only one of these was the question raised as to whether I had brought towel and soap. I had not done so: I have no intention of ever doing so, for home touring.

Eggs were scarce everywhere, and I was never able to obtain more than three or four in a day. In some places sugar and jam were doled out in small quantities: in other places, where it looked as though the war was over, supplies were as adequate as in the good old days. All the same, I am bound to say that sugar is a problem, and on any further war-time tours I shall feel inclined to take some saccharin tablets just to help out on those occasions when porridge is on the breakfast menu—as it was on five out of the 10 days referred to.

I don't believe that I was supplied with margarine anywhere. Meal prices jumped to and fro, and it is worth noting that two of the best teas I had cost me, respectively, 1s. and 1s. 3d. Not bad in these war-days! Always, when on tour, I keep a careful note of my expenditure, thus going to the opposite extreme from my normal practice for the rest of the year, when I neither know nor care where my money goes. For years, until the war, 10s. a day was my normal touring figure. The holiday now being spoken of cost me 11s. 6d. a day, which is not bad, "considering." I had a bedroom to myself every night. I had four good meals a day, and did not stint myself. In fact, I lacked nothing—except hot baths!

I must again be at pains to point out that 11s. 6d. a day does not represent the actual cost of the tour.

Notes of a Highwayman

By LEONARD ELLIS

Woodman Spare that Tree

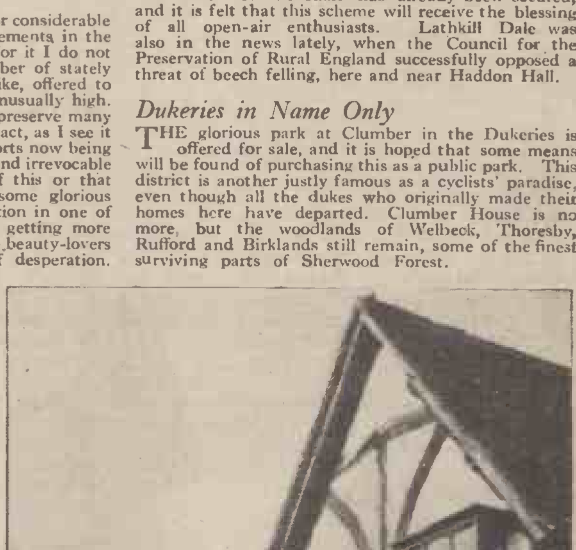
THERE is food for thought and cause for considerable pleasure in certain recent announcements in the Press. Whether the war is responsible for it I do not know, but it has seemed that the number of stately properties, parks, monuments and the like, offered to the nation or sought by the nation is unusually high. It seems that there is a definite drive to preserve many of the old beauty spots for posterity; in fact, as I see it there is the strength of despair in the efforts now being made to save these things from complete and irrevocable destruction. Day after day we read of this or that body opposing the wanton felling of some glorious beeches, or the erection of a power station in one of Scotland's scenic gems. Either we are getting more beauty conscious or, as I have hinted, the beauty-lovers are now moving with the strength of desperation. Three places come to my mind, places well beloved of cyclists, and all three have figured in the Press during recent weeks. Lacock, in Wiltshire, is generally acknowledged to rank very high in the list of England's most beautiful villages. Perhaps its dignity would be hurt by this description, but to call it a town seems to spoil the effect. Here is a place of charming cottages, with old and twisted gables and beams, quaint old inns and everything that goes to make a real old English village. There is an old cross and a medieval abbey. Lacock Abbey has a romantic story, and to-day is a beautiful mellowed building. It was with great pleasure that cyclists heard the news that it is now the property of the nation. As no two hobbies are more harmoniously combined than cycling and photography it is even more interesting to remember that the recent residents are descended from the family of Fox Talbot, who was the pioneer of photography in England. It is said that the first photographic negative ever made in this country was from one of the oriel windows in the Abbey.

A National Park

MANY cyclists will have read with much interest the little booklet entitled "The Peak District a National Park." Herein is outlined a plan for the provision of a national park somewhat on the American lines, comprising a large tract of beautiful country retained in its natural state with a minimum of disturbing and anachronistic details. There is no need to stress the desirability or suitability of this area as the Peak District is well known and eagerly sought by tourists. The land suggested is roughly 40 miles by 30, excluding a tongue stretching down from the north-west embracing Buxton. This means that most of the dales would be included, the Peak itself, so long denied to beauty lovers, and also that lesser known but very fine piece of ground including the Dane Valley, Ludchurch Gorge and Three Shire Head. It will be remembered that much of Dovedale has already been secured, and it is felt that this scheme will receive the blessing of all open-air enthusiasts. Lathkill Dale was also in the news lately, when the Council for the Preservation of Rural England successfully opposed a threat of beech felling, here and near Haddon Hall.

Dukeries in Name Only

THE glorious park at Clumber in the Dukeries is offered for sale, and it is hoped that some means will be found of purchasing this as a public park. This district is another justly famous as a cyclists' paradise, even though all the dukes who originally made their homes here have departed. Clumber House is no more, but the woodlands of Welbeck, Thoresby, Rufford and Birklands still remain, some of the finest surviving parts of Sherwood Forest.



A bit of old Lacock.

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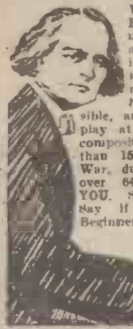

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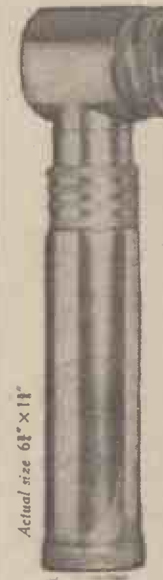

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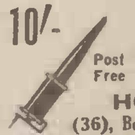

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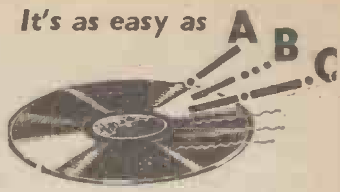

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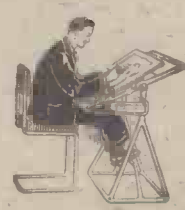

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