THE CONSTRUCTION OF BATTLESHIPS

NEWNES

PRACTICAL MECHANICS

SEPTEMBER 1940

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PRACTICAL MECHANICS

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Editor: F. J. CAMM

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FAIR COMMENT

By the Editor

The World Toy Markets

THE bulk of the world's toys were originally made in Germany, although in latter years the Japanese have become serious competitors to the German toy-makers. During the last war there were practically no imports of toys from abroad, and, of course, none from Germany. Between 1914 and 1918 post-war plans were laid by many British manufacturers to capture the German toy trade, and firms that were during the war engaged upon munitions decided that the manufacture of toys would keep employed the machines which, when peace was signed, would otherwise be idle.

In order to protect British interests, an *ad valorem* duty was imposed on toy imports to enable British manufacturers, who paid higher wages than were earned by the sweated workers of Germany and Japan, favourably to compete with them. Alas, as Mr. Churchill has said, we were glutted with victory and, but for a few isolated and outstanding examples, we let the opportunity slip by. I well remember the drive to capture the German toy trade. Firms set out to manufacture dolls, clockwork trains, draughts and dominoes, beads, mechanical and constructional toys. The effort waned, and Germany regained her position as the chief manufacturer of toys. During the last war Japan was permitted to send to this country a large number of Japanese to be trained in English manufacturing methods. Although I protested about this at the time, taking a somewhat longer view of the problem than the authorities evidently did, I was compelled to teach British engineering principles to a Japanese, who had free run of the works in which I was engaged, and privilege to ask questions of the designers, the executives and the workshop personnel. Time has indicated the wisdom of my objection. We taught the Japanese our methods, and now they compete with us.

I hope that when the war is over, the present effort will not fail!

History Repeats Itself

THE export council of the Board of Trade are making an intensive drive to capture the export market which Germany has lost. Before the present war Germany flooded world markets with toys to raise foreign exchange with which to finance Nazi fifth-column activities, notably in South America and the United States. It is worthy of record that since the present war commenced, the British toy industry has increased its exports by more than fifty per cent. and some firms by as much as seventy-five per cent. The British Navy has stopped the dumping of German goods, and our export trade is growing every week. We are capturing markets from which Germany is cut off. When we have gained those markets, we must see that we hold them and do not permit the Germans to regain them. Before the war some of the British firms had established export departments, salesmen, and selling agents abroad. Now, through the export groups, these facilities are being co-ordinated and placed at the service of small and large firms alike. The present demand abroad is for model Hurricane fighters, Blenheim and Wellington bombers, anti-aircraft guns, tanks, searchlights, military transport vehicles, made faithfully to scale and with realistic camouflage finish. British manufacturers are also concentrating on model ships, soldiers, constructional, kindergarten (nasty German word!) and wheeled toys, as well as unbreakable dolls.

Chance for Amateurs

THERE is a chance here for amateurs to develop a successful business. It is unlikely that supplies of material will be granted for the manufacture of toys for home consumption, but there will be no difficulty, I understand, in obtaining supplies of materials to be manufactured for export. Readers of this journal are perhaps better equipped than most to enter this market, because they know the principles of toy construction and they know what is wanted. It is of little use to wait until the war is over. Plans must be laid now. The Board of Trade is anxious to assist British manufacturers to gain export markets.

New Technical Books Catalogue

AT the present time, when technical books on all subjects are in great demand, readers may care to have a copy of a handy pocket size list of the technical books published from the offices of this journal. These books appeal to engineers, motor mechanics, aero engineers, electricians, radio mechanics and technical students. Recent titles include "Diesel Vehicles: Operation, Maintenance and Repair," 5s., by post 5s. 6d.; "Watches, Adjustment and Repair" 6s., by post 6s. 6d.; "Motor Car Principles and Practice," 3s. 6d., by post 4s.; "The Radio Engineer's Vest Pocket Book," 3s. 6d., by post 3s. 9d.; "The Superhet Manual," 5s., by post 5s. 6d.; and Newnes' "Short-Wave Manual," 5s., by post 5s. 6d. Copies of the catalogue will be sent free to any reader addressing a post card to The Publisher, Book Department, George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2.

Indexes for Volume 7

INDEXES for Volume 7 are now ready, price 9d. each. Once again I would remind readers that even if they do not have their copies bound, they should keep these annual indexes by them so that they can survey the contents of past issues without having to wade through a large number of them. Postal orders should be sent to the Publisher, George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2.

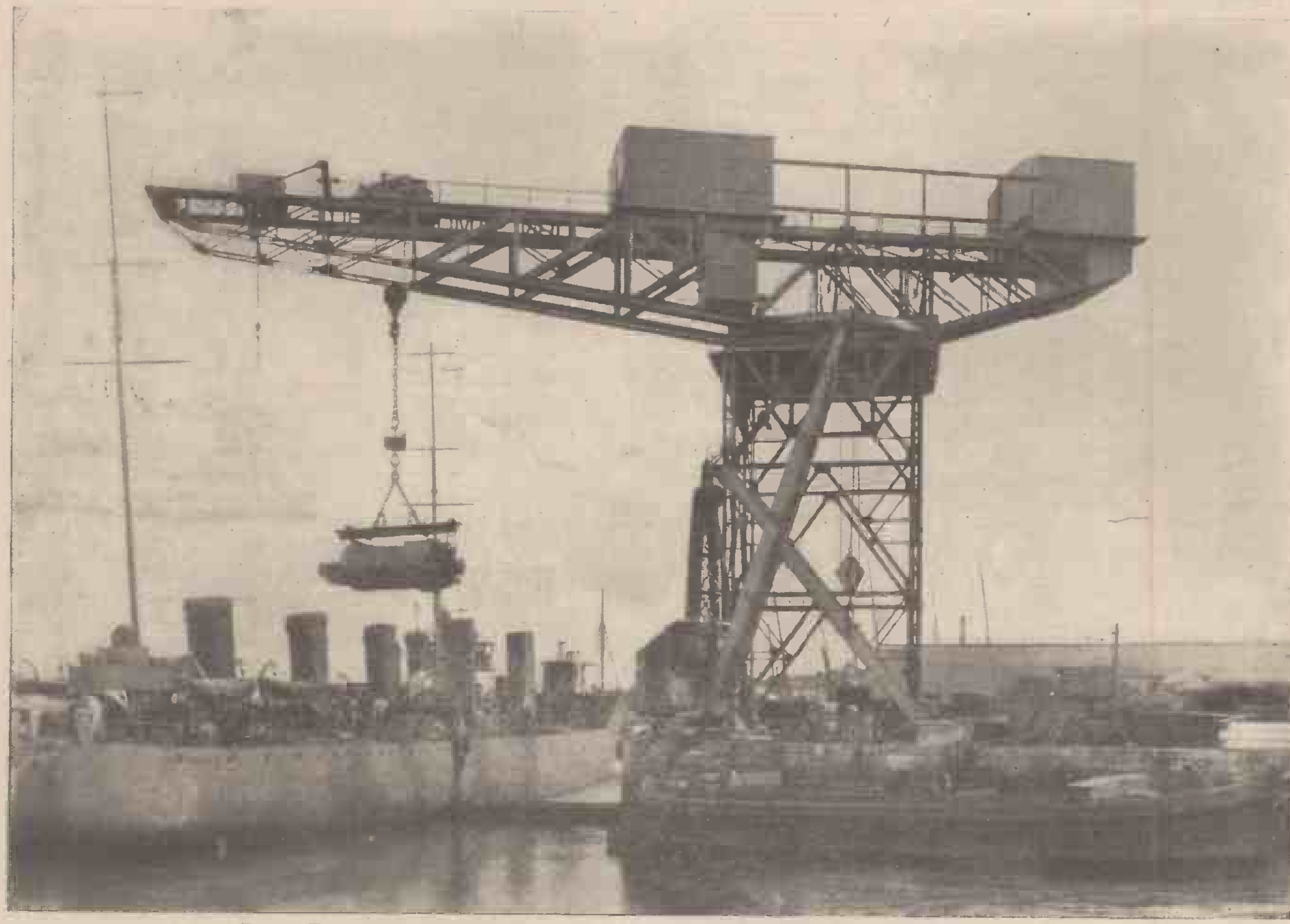


Fig. 1.—The cantilever crane is chiefly used in a shipyard, where it is found alongside the fitting-out basin.

Crane Construction

The Three Main Types—Overhead, Cantilever, and Jib Cranes are Dealt with in this Article

ENGINEERS, on coming across a new machine, frequently express their admiration for the original conception or the assembly, or, it may be, of the finish, but even they seldom visualise the thought, the labour, and the many and varied processes involved in producing the completed article.

The design of a crane germinates in the drawing office, where the requirements in duty, strength, and speed are carefully sifted and the limitations set down. It may be left to one man to carry out this task, and instances are known where skill and experience have resulted in a first rapidly made drawing which did not vary by more than fractions of an inch from the final design prepared after all calculations had been made.

On receipt of the order, the contract section of the drawing office takes charge. Details are prepared and drawings and orders issued to the workshops concerned.

Rough Castings

The first step towards manufacture is one of dispersal. For castings, patterns are made, passed to the foundry, and the rough castings are finally transferred to the machine shop. For structures, the templet maker first of all takes charge and sets out the frames on the floor. When the templets are completed, they are sent through to the structural shop, to which by this time the ordered steel sections are probably being delivered. Bars are marked off to the templets, cut and drilled with rivet holes, and sent to the construction floor. Here the units are built up bar by bar and connected together by service bolts, which are ultimately replaced by rivets. Some structural units may be suitable for welded construction without the use of rivets, or on certain parts there may be a combination of both systems of building up. Small frames are probably transferred to the machine shops, where they can be prepared for the reception of the machinery. Forgings from the smithy, rolled bars for shafting, and parts made in metal alloys by specialist firms, also find their way to the machine shop, where they join the products of the foundry and structural shop and are put through one or more of the processes of turning, boring, milling, planing, slotting, nibbling, or gear cutting.

With this the steps of dispersal cease and those of collection begin.

Assembly

When they have been under the careful scrutiny of the machine shop inspector and passed by him, the parts are transferred to the assembly shop, where by now specialised finished products, such as electrical equipment, are arriving, and so the piecing together of the machine may begin.

During a visit to the works of Messrs. Babcock & Wilcox, and to the crane department in particular, the careful planning and preparation of material necessary before the actual assembly of cranes were realised. This department deals with the manufacture of electric cranes of all types, and also allied machines such as electric transporters, telphers, hoists, charging machines, winches, capstans, and wagon tippers.

The general process of machinery assembly is much the same in all cases. Bearings are carefully lined up and bedded on the machinery frames. The individual shafts have their wheels, brakes, or barrels fitted, and here the advantage is evident of the accurate system of gauges employed in the machine shop. Next the shafts are transferred to the machinery frames and fitted into the bearings. Lever gear, motors, switches, and wiring complete the assembly of the unit. Several such units may be required on certain jobs.

Types of Crane

There is a surprising number of types of crane in use, but they may be classified roughly under three main types—overhead, cantilever, and jib cranes.

The overhead type is the crane of the workshop and storage yard. The hoisting and cross traversing mechanism are carried on the moving crab, and the structural bridge bears the longitudinal travelling gear. Fig. 4 shows a characteristic type of the Babcock & Wilcox overhead crane. It is one with the crab gearing totally enclosed. This pattern was evolved about ten years ago, in the desire to find something more suitable for foundry service than the usual type with open gears. It was tried out in the workshops at Renfrew and the results more than justified the foresight which led to its development. Not only were the gears protected against the abrasive action of dust, unavoidable in a foundry, but the overall efficiency was found to be greater by about 15 per-cent. than with the customary design. After years of working, the wear on the gears was scarcely discernible. When the Factories Act of 1937 was introduced, making the encasing of gears imperative, the firm had the advantage of years of experience behind them and were able to offer machines in full compliance without the need of rushing into hasty revision of designs. In the standard sizes, the main gears are run in oil-tight cast iron boxes, but in the large sizes oil boxes of fabricated construction may be used.

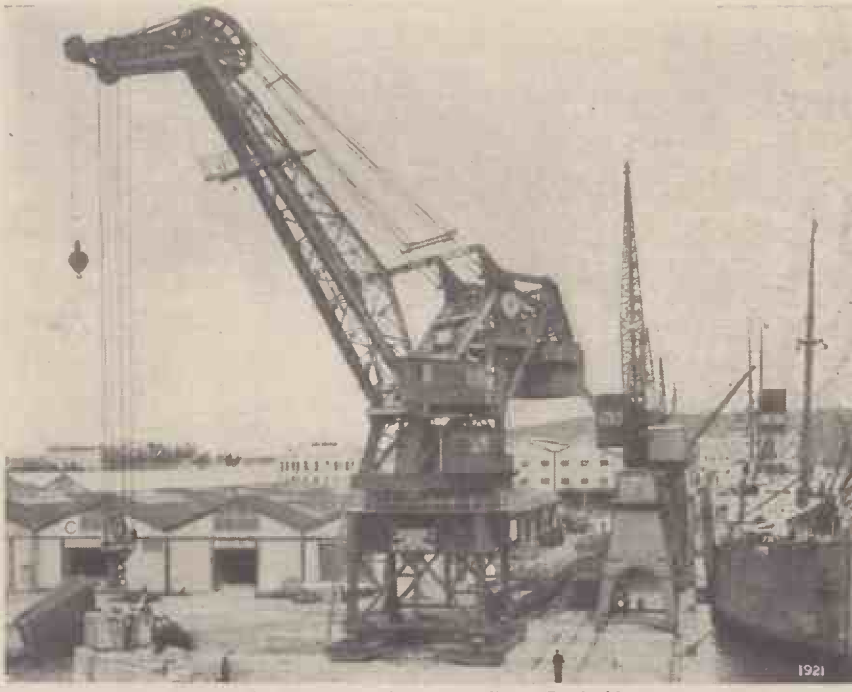


Fig. 3.—An 80-ton Babcock crane installed in South Africa.

The Cantilever Crane

The cantilever crane is more for use in a shipyard, where it is found alongside the fitting-out basin. This type is illustrated in Fig. 1. Owing to its weight, it is bedded down on solid foundations, but because of the large radius it can cover a considerable part of a ship.

It has three motions, hoisting, racking of the trolley from which the hoisting block is suspended, and turning or slewing. On the very large cranes, a whip hoist is carried on a small trolley running on the underside of the cantilever, and thus light loads can be dealt with expeditiously, as the main movements of the crane are necessarily slow.

The Jib Crane

The jib crane may be met with engaged in many different duties, but by far its most common sphere is the dockside, where it unloads or loads vessels. Here speed and flexibility are essential, and in the development of the up-to-date type of wharf crane Messrs. Babcock & Wilcox have played a very prominent part. Of the designs now in common use, theirs was the first to be introduced, and its efficiency is unique. Fig. 5 shows an example of the wharf type of jib crane. The folding lever on the jib head is characteristic of the Babcock design. By means of it the movement of the jib inwards and outwards can be attained without lifting and lowering the load. Thus the load maintains a horizontal path, hence the name given to this type—the level luffing jib crane. It is in contrast to the derricking type, in which work is done against the force of gravity by bringing in the jib, as the load is unavoidably lifted. The power saving on the luffing movement is difficult to believe, as the luffing motor is only about 5 per-cent. of that which would be required for derricking at the same speed. In the design illustrated, this advantage is achieved without introducing multiple sheaves and ropes, and with the folding lever a swinging load is more readily controlled because the length of rope dependent from the jib is shorter than it can be with a straight jib. The weight of the jib itself is balanced in all positions and the imposition of a load on the hook or grab in no way affects this balance. This is a contributory factor to the high efficiency. A roomy machinery house and good natural lighting enable the machinery to be freely examined.

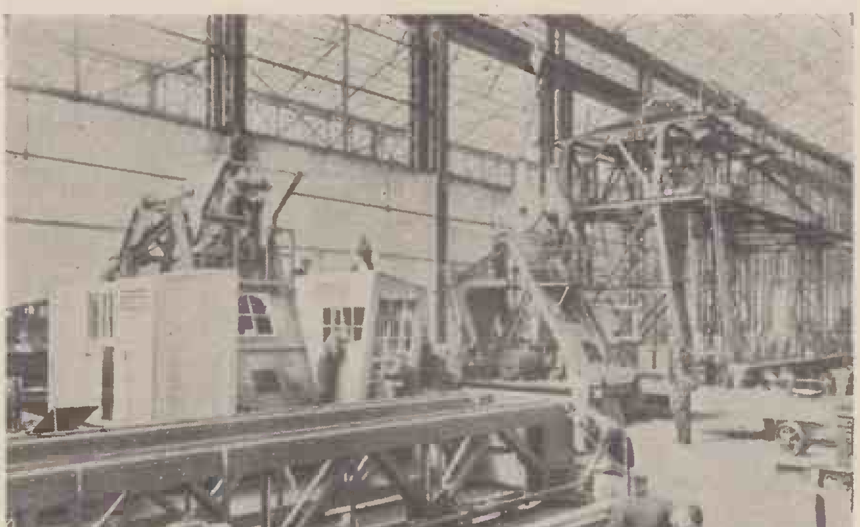


Fig. 2.—Inside a crane assembly shop.

A Travelling Crane

Hundreds of these cranes are at work throughout the world and at Renfrew they have been built with a radius as great as 135 ft. and with loads as high as 80 tons. Fig. 3 shows one installed in South Africa. In addition to the main hoist of 80 tons capacity, an independent auxiliary hoist, driven by separate motor and gearing, is arranged for loads up to 20 tons. Owing to its size, this crane was designed for fixing down on a solid foundation and construction proceeded accordingly, but before the actual completion the engineers of the purchasing company realised that the utility of the crane would be enhanced and the general traffic of the wharf less interrupted if the crane could be made to travel; so they approached the makers with a request to investigate this possibility. The problems of the actual design of travelling gear for moving so great a weight, of the matching up of the travelling gear with the already designed structure, and, lastly, of the arrangement of the track rails in such a way as to avoid interference with the traffic rails along the wharf, were all faced in turn and overcome. So the project was proceeded with, and the crane was finally arranged for travelling up to the wharf side when heavy loads have to be lifted to or from ships.

Their Uses

It will be understood that the cranes to which reference has already been made are merely characteristic of the main general types. The uses to which cranes are put are, however, so diverse that radical changes in design are required to suit special purposes and duties. Those intended to handle material by means of grabs are made particularly heavy, due to the full working load being picked up in practically every cycle of operation, and to the necessity of maintaining rapid and continuous output. Great strength is also imperative in the case of steelworks cranes, where the most severe working conditions are encountered.

Although many of the steelworks cranes are of the overhead type, some are of such special application that instead of being referred to as cranes, they are called charging machines. These are employed for charging melting and reheating furnaces. Occasionally, charging machines are arranged for running on rail tracks on the charging floor, but in modern practice the overhead type of charging machine is preferred, as then the charging floor is left clear for the movement of the men.

Apart from charging machines, overhead cranes of a now universally recognised design—ladle cranes—are used in steel works for the handling of molten metal, and others for charging ingots into the soaking pits and for withdrawing them when white hot.

Fig 5.—An example of the wharf type of jib crane. By means of the folding lever on the jib head, the movement of the jib inwards and outwards can be attained without lifting and lowering the load. Thus the load maintains a horizontal path, hence the name given to this type—the level luffing jib crane.

An Underhung Jib Crane

An extremely useful combination of overhead and jib crane in what is usually called an underhung jib type, can be made to serve not only the workshop bay in which it runs, but also the sides of adjacent bays.

The chief variants of the cantilever crane are the Titan type, with a low portal travelling carriage and suitable for block setting in harbour construction, and the light and graceful tower crane, for operating between the berths in shipbuilding yards.

Then for jib cranes there are many types adapted for specific situations or purposes. The wall type is commonly employed for the handling of merchandise to and from warehouses which border on a river. By providing top and bottom rail tracks, a crane somewhat similar to the wall crane may be traversed down the side or centre of a workshop. When engaged on routine work small cranes of this type can considerably relieve the overhead cranes.

Testing Cranes

Before being taken over for actual service by the purchasers, each crane must be tested. This may be carried out at the maker's works or at the site after the final erection. Part of the test must be the operation of all movements with an overload on the lifting hook or grab, and, in general, the amount added to the working load for this purpose is 25 per-cent. Some engineers consider this a sufficient test in itself, but it is more satisfactory for all concerned if a more extensive trial is carried through. It should include the running of each movement under working load, during which speeds may be checked and, with overhead cranes, the deflection of the main girders taken. The speeds are easily found by the aid of a stop watch, and the deflection is not difficult to obtain. For the latter, readings are taken with the grab loaded and unloaded, either by measuring between the top of the crane girders and a roof-couple, or by recording the change of height of a small weight suspended from the girders and brought near to floor level. During the various runs an ammeter may usefully be inserted in the main electrical circuit to register the current taken by each motor, so that comparison may be made with the amperage anticipated. If the crane has a definite duty cycle to perform, the opportunity of having the working load in position should now be taken to make certain the duty is fully realised. After the safety devices have been tried out, the overload test should be made and, again, in overhead cranes, a further deflection reading makes an interesting comparison with the figures obtained earlier. Further, there may be insulation tests and a check made to ensure that specialities, peculiar to the machine under trial, are entirely up to specification.

At the termination of the trials, examination is made of the whole crane to make sure that all parts have successfully withstood the tests and then a certificate is issued by a competent representative of the maker. *Reproduced by courtesy of The Edgar Allen News.*

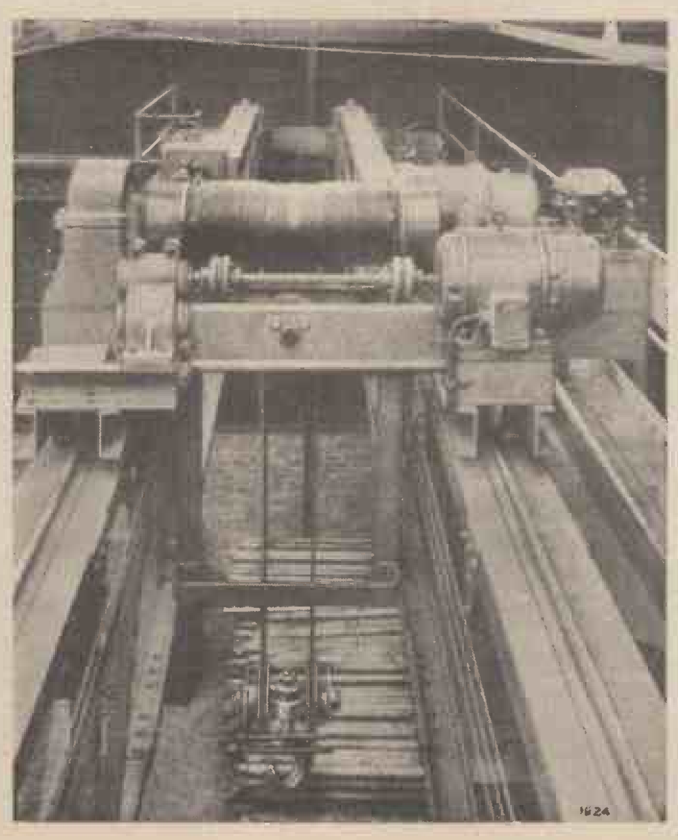
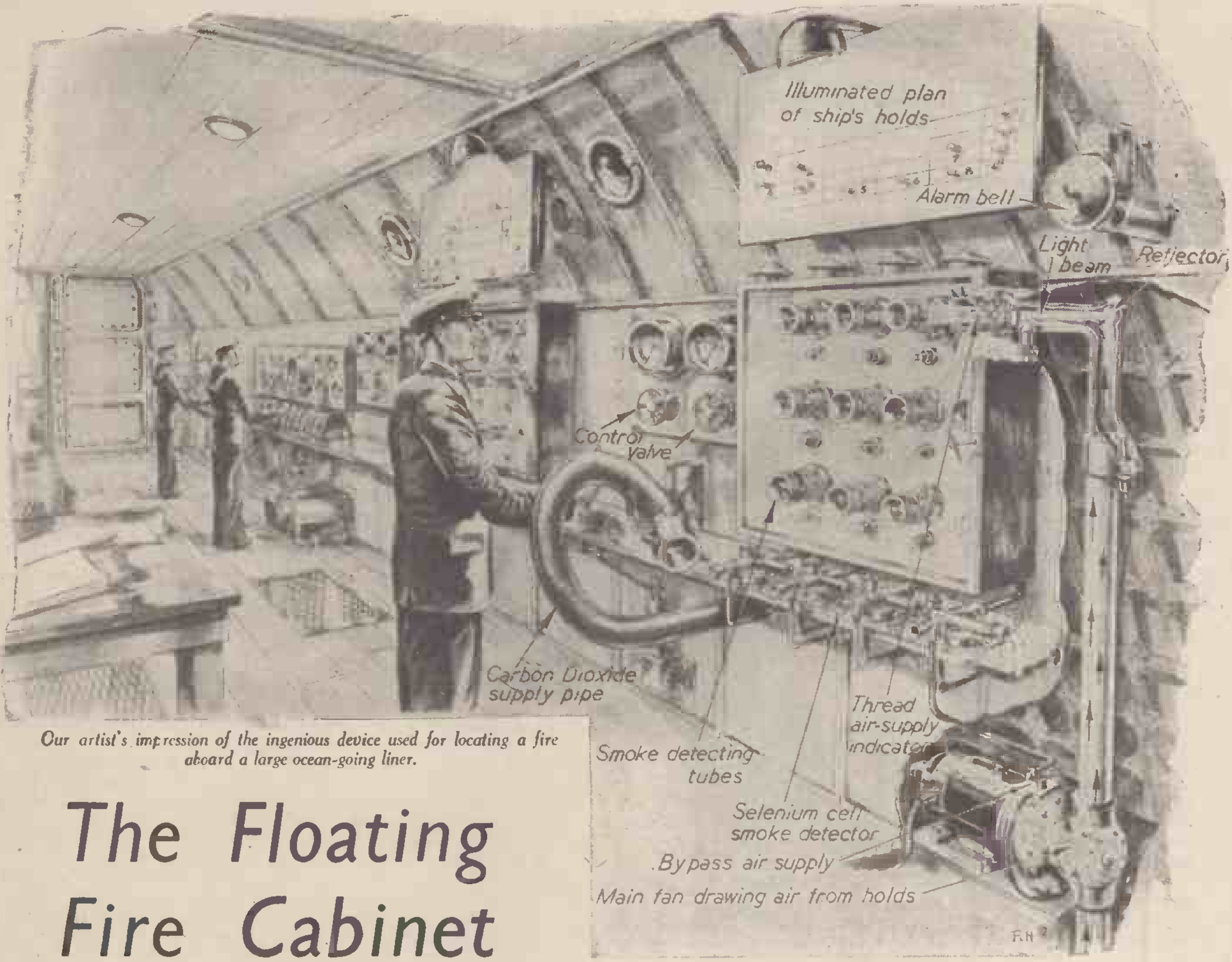


Fig. 4.—A characteristic type of overhead crane. This pattern was evolved about ten years ago, in the desire to find something more suitable for foundry service than the usual type with open gears. When tried out it more than justified the foresight which led to its development.



Our artist's impression of the ingenious device used for locating a fire aboard a large ocean-going liner.

The Floating Fire Cabinet

A Device for Locating Fires Aboard Large Ocean-going Liners

TO know the exact location of an outbreak of fire, should this occur, aboard a vast ocean-going liner, within a few moments of its occurrence is of paramount importance to the ship's firemen. Not only must passengers not be alarmed but the first flickering tongues of flame must be subdued before there is any danger of the outbreak spreading. The two firemen who are always on duty in the fire station aboard the 85,000 tons *Queen Elizabeth*, new floating palace of the Cunard White Star Company, are at the nerve centre of an infallible system of fire-control and fire "spying" which perhaps may one day be improved upon but which, at the moment, is as mechanically perfect as it is ingenious.

Fire Alarms

Signals of an outbreak can be conveyed to the fire station by means of manual alarm, by thermostatic alarm, or by smoke detector. The automatic sprinkler system is a precaution which had proved its great value ashore but is something of an innovation afloat. There are, of course, coiled hoses and water connections at various strategic points about the decks, fire buckets, hand extinguishers and the usual shore-going appliances. And asbestos-covered fireproof doors at frequent intervals below decks can be closed to shut out the draughts on which flames feed. But these latter are commonplace beside the installations in the ship's fire station.

Most ingenious of these is the glass-fronted cabinet which can suck the first wisp of smoke from any of the less frequented and unpatrolled spaces of the tremendous floating town. Even the smoke from a stowaway's cigarette can be flicked from any one of the cargo, storage or mail holds and from the garage spaces, and in a second or two be delivered before the eyes of the men on watch in the fire station. Instantly, either of those alert watchers can release a fire-choking supply of carbon dioxide into the space whence the tell-tale wisp of smoke was automatically drawn. No fire can continue to exist in such conditions. It expires as promptly as the silent alarm is given.

In that glass-fronted cabinet are pipes whose lower ends terminate in open mouths in the holds and other unpatrolled spaces. The upper ends, inside the cabinet, are perpetually delivering air which is drawn from the holds, etc., by means of fans and driven upwards. Now you see the ingenuity of this device. If there is smoke in any of the spaces served by any of the pipes and fans it will be delivered into the cabinet along with the air. So that even the thinnest smoke shall not go unnoticed by the watchers, each pipe throws up a light-ray from a mirror set in a bend in the pipe. Against that light-ray the faintest suspicion of smoke can plainly be seen.

Automatic Alarm

The fireman who spots it immediately releases down the same pipe carbon dioxide from cylinders ranged in one corner of the station—and the job of fire-fighting is in instant operation. There is, of course, the possibility that a fan might for some reason stop working, and if that happened an alarm would automatically be sounded as a signal for the watchers to set a duplicate fan in operation. A further possibility was foreseen, that a pipe in the cabinet might become choked and the outlet of air be interrupted. To give warning of that, in the upper mouth of each pipe is inserted a thread. When the pipes are working properly those threads waver in the air-stream. Should one thread "collapse" the fireman who observes it takes immediate steps to have the pipe passage cleared.

Those responsible for designing this robot alarm saw even further: the human element is not infallible, and the watchers might have their attention distracted at the critical moment from the metal mouths on which so much depends. To bring back that wandering attention in a split second, a rising wisp of smoke is accompanied by the ringing of an alarm and a red light shows. This is the result of the utilisation of selenium cells. At four-second intervals another ingenious device draws an air-sample from each pipe-mouth and this is passed between a strong light and a selenium cell. The latter is affected by the obscuring of the light, and the warning bell rings and the red lights up.

In order that there shall be no confusion in the watchers' minds as to where the smoke originates, each air-delivery pipe is numbered, the number corresponding with a hold or other space. Each of those four-second samples is similarly numbered. The carbon dioxide delivered down the "guilty" pipe does its work far more swiftly than streams of water could do, and without the mess that hose-work inevitably results in.

Deck Plans

All the deck plans of the liner are constantly before the watchers' eyes. Set out one above the other in the fire station, these are studded with small electric bulbs, one to each section of the vessel. If one of the manual alarms which are distributed about the decks is broken and operated, one or more of the bulbs will be set glowing, indicating the situation of the outbreak. Others, differently coloured, will light up if a thermostatic detector in any one of the public rooms comes into operation.

In either case, the firemen know without shadow of doubt to which part of the ship one of the waiting fire squads should be directed. These men are in readiness day and night, equipped with asbestos suits, smoke helmets and other necessities which long experience of fire afloat has brought into common use. The working of the thermostatic detectors, previously mentioned, is entirely automatic. They are set in action by an abnormal rise in temperature in any of the public quarters of the ship.

The automatic sprinkler system causes a fire to put itself out without the intervention of any human hand. Extinguishers come into action when any one of the numerous small quartzide bulbs, with which the ceilings of all the accommodation spaces are studded, is affected by hot air rising from an outburst, or threatened outburst. The heat need be only a little in excess of that given off by an ordinary hot-water radiator, but the quartzide bulb feels it. The liquid it contains expands rapidly, so that the bulb bursts. This releases a small piece of tough glass normally kept in position by the bulb and acting as a plug in the end of a bronze nozzle.

Downpour of Water

With the shattering of the bulb and the release of the glass plug, water emerges as a heavy and widespread downpour. This continues until the fire is extinguished and the flow of water is stopped by re-plugging. Notification of the coming into action of this sprinkler system is conveyed to the watchers in the fire station by the ringing of an alarm bell and the lighting-up of a red lamp at the top of the glass-fronted cabinet, another lamp glowing at the appropriate spot on the deck-plan concerned. The fire squad who hasten to the outbreak (in response to orders from the bridge, where the alarm is conveyed from the fire station by telephone) probably find the fire extinguished by the time they arrive on the scene and have but to clean up the mess and replug the bronze nozzle and fix another quartzide bulb.

The bursting temperature of the bulb can be varied as circumstances require. This point is fixed in accordance with the natural temperature of the region through which the vessel is passing. To distinguish bulbs of different "strength" the fluid contents are tinted in various colours. Both fluid and bulb remain efficient indefinitely, or until an outbreak shatters the one and disperses the other.

The water supply is maintained at high pressure automatically in the thousands of yards of piping in which the nozzles are fixed, and as water is "lost" it is replenished through the action of special pumps which begin to operate immediately the downpour starts. The discharge is in the nature of a heavy rain, the jet which emerges from the nozzle being broken by a star-shaped bearing forming part of the bulb-holder. Thus the discharge is effective over a much wider area than could be covered by a solid, unbroken stream. No combustible surface under the control of this system is out of range of the spray.

Ever-Present Risk of Fire

By these means, a fire might be extinguished in one part of the big liner and not more than two or three passengers be aware that anything out of the ordinary had occurred to break the even tenor of the ship's ways. In such days and nights as we are living through now, with peril afloat increased beyond any previous threat, human and mechanical vigilance cannot be maintained at too high a standard. Without some such mechanical aids as we have described, the ever-present fire risk is appalling. With unlimited water around it the vessel whose interior is insufficiently safeguarded is in parlous straits. For water by itself won't put out fire. The floating fire-cabinet is, so far, the last word in man's determination to gain and retain ascendency over the peril that lies in every puff of uncontrolled smoke and every pencil of flame or shooting spark on the big ships that use the world's waterways—in peace or war.

A Radio Compass for Small Vessels

The radio compass unit made by Western Electric.

MARINE radio-telephone equipment is finding wide use in pleasure craft of various types. Although it is employed primarily for ordinary communication with shore, it has great potential value for summoning assistance in emergencies. Previously, only the larger vessels equipped with radio telegraph and manned by a commercial operator had such facilities. To increase the usefulness of Western Electric marine telephone equipment, the Bell Laboratories recently developed the 50A radio-compass unit. When associated with the telephone equipment, this unit will permit radio bearings to be taken to determine the ship's position.

The Compass

The compass unit consists of a small metal box carrying tuning and volume controls on the front, and the loop aerial on the top. Power is obtained from the radio-telephone unit, and the loudspeaker of this unit is also employed. A jack is provided on the compass unit, however, to permit a headset to be used instead of the loudspeaker if desired. A switch on the telephone set switches these circuits to the regular aerial or to the compass as desired.

The 50A compass unit covers the frequency band from 230 to 350 k.c., which includes all of the marine radio beacons maintained by the United States lighthouse service at strategic points on the Atlantic, Pacific, Gulf Coasts, and on the Great Lakes. By taking bearings on two of such stations, a ship's position may be determined regardless of fog or darkness. Also included in the band from 230 to 350 k.c. are numerous aircraft beacon stations operated by the Civil Aeronautics Authority.

Operation is Simple

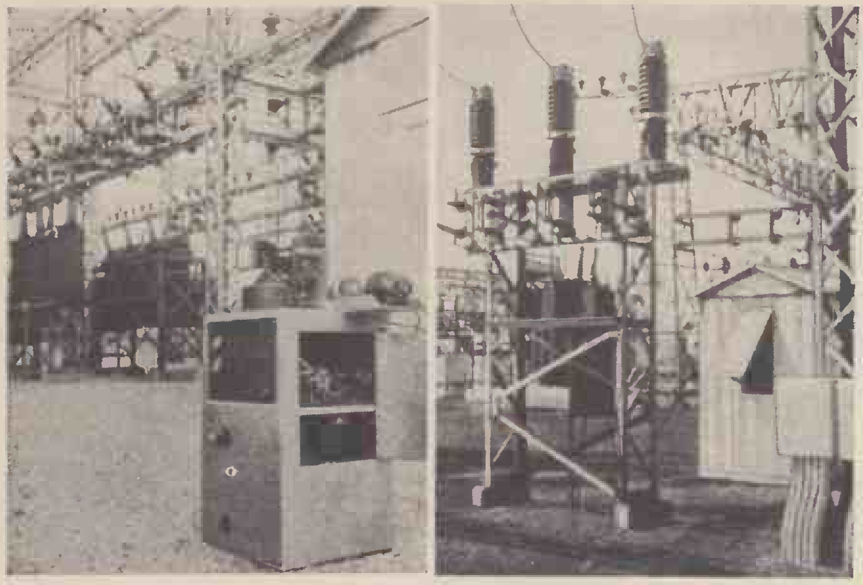
On installation, the compass box is permanently fastened in position, and the bearing scale on the base of the loop, which is adjustable in position, is set so that the zero gives a direction in line with the keel of the vessel. After a signal has been tuned in, the loop is turned to the position of minimum signal. The reading of the scale then gives the bearing in degrees with respect to the ship's keel. The true bearing of the station may then be determined by the application of the ship's course as obtained from the magnetic compass.

The 50A compass was designed particularly for use with the 227B radio telephone equipment—a small radio-telephone set operating on either 6 or 12 volts D.C. and designed primarily for small vessels. Only minor modifications are required, however, to permit it to be used with either the 224 or the 226 types of radio-telephone equipments.

(Bell Laboratories)

An Automatic Cathode-Ray Oscillograph

Studying Transient Currents in Power Systems



Figs. 1 and 2.—The oscillograph, and on the right the capacitance potentiometer and protective equipment installed between the power lines and the oscillograph.

IN studying transient currents in telephone circuits and power systems, apparatus is required which will operate instantly and move quickly enough to record the initial part of the pulse. Oscillographs have been found suitable for this purpose. Usually they have been unattended and operated automatically by the disturbance to be recorded.

Until recently galvanometer-type instruments have been used. They were capable of recording only up to 3,000 cycles and depended on film movements for wave-shape resolution. With instruments of this type a lamp must be lighted and the film started before recording begins. This takes at least a hundredth of a second, during which interval transients of importance may occur on the power system. Frequencies above 3,000 cycles may also be involved. These deficiencies led to the search for a recorder capable of faster starting and of a greater frequency range.

Record High Frequencies

An oscillograph with automatic features was chosen because it can record very high frequencies and requires only a few microseconds to release the beam. As developed by the Bell Laboratories in America, this oscillograph has, in addition to the cathode-ray tube, circuits which make the disturbance start the sweep action and the film movement. It also has power supplies and a photographic mechanism, including a lens system to project the trace from the screen of the cathode-ray tube to 35-mm. motion picture film. The initial part of the record is made by sweeping the cathode-ray beam, and during this interval the film starts to continue the recording. A complete record includes an automatic calibration and a clock picture to indicate the time the disturbance occurred. A schematic diagram of this oscillograph is given in Fig. 3, with an outline of the circuits and a view of the photographic operating mechanism.

Three-phase Power System

This apparatus was used in an investigation of overvoltages on a three-phase power system, conducted by the Joint Subcommittee on Development and Research of the Edison Electric Institute and the Bell system. Three recording elements were required, one for each phase, and this led to the choice of the Western Electric 330C cathode-ray tube, which is a development of the Bell Laboratories. This tube has three complete units enclosed in a single glass envelope, thus making unnecessary three separate tubes with the attendant complication of the photographic system and increase in bulk. Each unit has a hot cathode, a modulator to control the magnitude of the beam current, a focusing electrode, and an accelerating electrode. The accelerating electrode imparts energy to the electrons and forms the beam, which strikes the screen where part of the energy is radiated as light. Two mutually perpendicular pairs of plates are provided for each unit. When a field is established between either pair of plates, the beam deflects toward the more positive one and the deflection is proportional to the amount of the applied voltage.

The line-to-ground voltages of a three-phase system are applied to the deflecting plates through networks which provide a balanced input, because a well-focused beam is maintained only when the pair of plates is balanced with respect to the potential of the accelerating electrode. The other pair of plates in each group is connected to the sweep circuit to resolve the wave shape on the fluorescent screen.

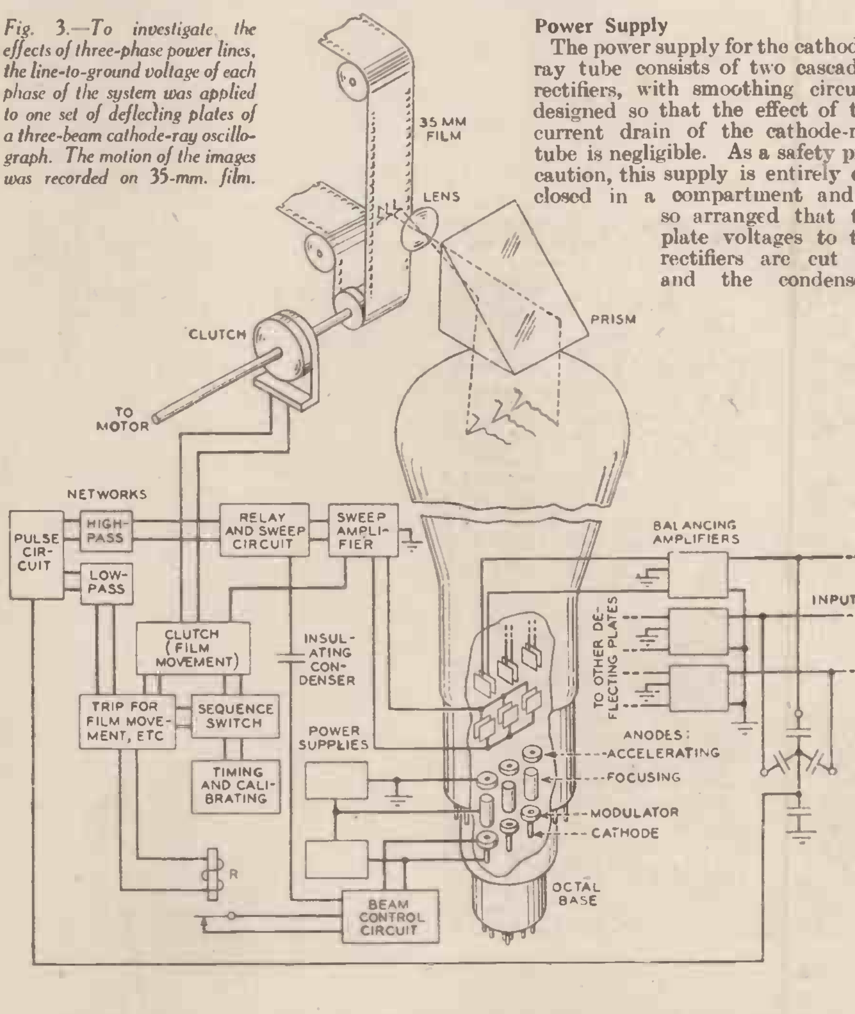


Fig. 3.—To investigate the effects of three-phase power lines, the line-to-ground voltage of each phase of the system was applied to one set of deflecting plates of a three-beam cathode-ray oscillograph. The motion of the images was recorded on 35-mm. film.

Power Supply

The power supply for the cathode-ray tube consists of two cascaded rectifiers, with smoothing circuits designed so that the effect of the current drain of the cathode-ray tube is negligible. As a safety precaution, this supply is entirely enclosed in a compartment and is so arranged that the plate voltages to the rectifiers are cut off and the condensers shorted if the door of the compartment is opened.

Voltage to trip the oscillograph is obtained from the drop across a condenser between ground and the neutral formed by three Y-connected condensers as illustrated at the right in Fig. 3. The other terminal of each of these condensers is connected to one phase of the three-phase circuit under observation. When unbalance occurs on the power circuit, voltage appears across the condenser in the neutral. This voltage is fed to a rectifying circuit which converts it into undirectional pulses, thus assuring that the succeeding trip circuits will operate on incoming waves of any polarity. The pulses are fed through discriminating networks to two trip circuits, one of which is high speed and the other slower and sensitive only to low frequencies.

The Relay

The relay which trips the high-speed circuit consists of two electrically interlocked vacuum tubes. A pulse of any frequency above 1,000 cycles per second, of sufficient magnitude to operate this relay, excites the beam and sweeps it always at the same rate across the screen. By adjusting this high-speed relay and the sweep circuit the sweep speed may be varied in discreet steps in the ration of approximately $\sqrt{2}:1$, from about 1/2,000th to 1/6,000th of a second. This range of speeds was considered adequate because the transients of interest in this study were those which arise within the power system itself

Fig. 4.—The photographic mechanism of the oscillograph with the film magazine and clock on top. The oscillograph tube is mounted in a metal cylinder, shown just below the clock, to protect it from stray magnetic fields.

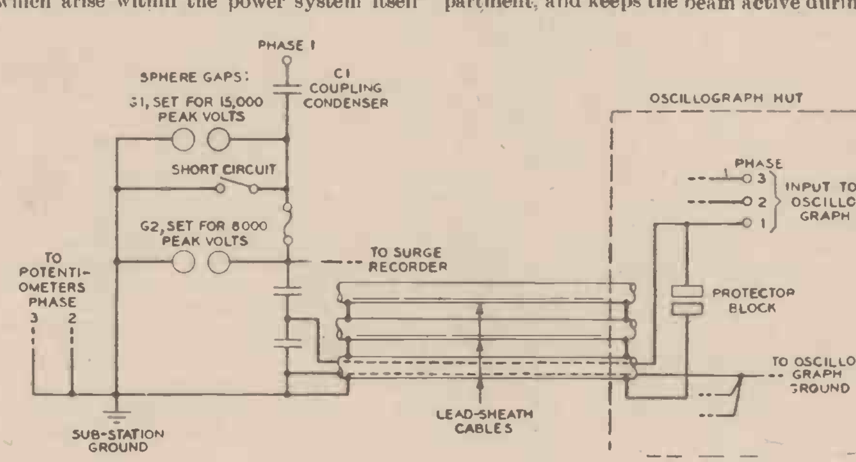


Fig. 5.—Schematic diagram of the potentiometer, including protective equipment, by which the oscillograph is connected to the power line.

due to the faulting of a conductor rather than those impressed on the system of lightning. The output of the sweep circuit is fed to an amplifier which delivers a balanced output to the deflecting plates. A portion of this voltage is used to energise the clutch circuit by means of a cold-cathode tube and relay. This clutch-energising circuit is self-resetting and, if the transient is short-lived, the clutch remains closed only long enough to give a film advance of about six inches so as to provide an unexposed piece of film for recording the next transient.

Power Overvoltage

When the surge which trips the high-speed relay contains, or is followed by, power overvoltage, a more extensive record is made. It includes the initial resolution by the sweep, about three seconds resolution by film movement, a calibration and a clock picture. To obtain this additional record at the proper time, there was added a low-speed trip circuit, sensitive to 60 cycles and its lower harmonics. It consists of a cold-cathode tube and associated relays, which take control of the clutch and beam circuits and energise the sequence switch. The beam circuit is controlled by the insulated relay R (Fig. 3), which actuates mechanically a contact, located in the high-voltage compartment, and keeps the beam active during the resolution of the record by film movement. The film movement initiated by the low-frequency trip circuit is terminated after a predetermined time by the sequence switch, which records on the film the calibration and a clock picture to show the time of operation. This film movement also resets the tripping circuit.

Trip the Relay

Since the initiating transient of most power-system disturbances, as well as those due to lightning, contains higher frequency components, any disturbance will trip the relay and release the beams for the initial sweep, but a complete record will be made only when power system overvoltage of fundamental frequency, or its lower harmonics, is present. Otherwise, the film only moves forward sufficiently to provide an unexposed section for a succeeding record.

The photographic system for recording the screen image is shown pictorially in Fig. 3. The images on the screen are recorded on 35 m.m. motion-picture film. The cathode-ray tube and the optical system are oriented so that the beam's path across the screen will be recorded with the time axis longitudinally along the film. A clock picture can be made at the end of a record to indicate the time of the disturbance.

The Oscillograph

Fig. 4 shows a picture of the oscillograph. The photographic mechanism is on the top with the film magazine near the rear left-hand corner and a clock projecting in front of it. The clock has two faces, one visible so that the operator can check the time, and the other enclosed for photographing. At the right of the film magazine are the clutch and the motor which drives the film. The panel at the front of the instrument carries the meters and the trip sensitivity controls. The projection under the panel is the motor, which operates the ventilating fan. All the control apparatus and the power supply equipment are contained within the case.

This oscillograph has been used to record phase-to-ground voltages on a 44-kilovolt transmission line. Capacity potentiometers, one for each phase, reduced this voltage to a value suitable for the oscillograph. The schematic diagram of the potentiometer and its associated protective equipment is shown in Fig. 5. The protection equipment is designed so that gap G2 will break down if condenser C1 fails. The resultant current will open the fuse and gap G1 will ground the system until it is cleared by circuit breakers. Additional protection is furnished by protector blocks at the terminals and by grounding the oscillograph case.

Records Obtained

The records obtained with the original sweep speed, which was fairly high, did not disclose any very high frequencies in the initial part of the disturbance on the power system under observation. Consequently, the circuits were arranged so that the resolution due to the sweep gradually merges with that from the film movement, thereby producing a continuous record. An example of the results obtained by this method is shown in Fig. 6. Comparison with records of faults obtained with a string oscillograph has effectively closed the gap of approximately one cycle required to start the string oscillograph.

In addition to the extensive data on overvoltages which have been obtained in this investigation, much experience has been gathered on problems met in adapting oscillographs for continuous automatic operation under routine field conditions.

Bell Laboratories Record.

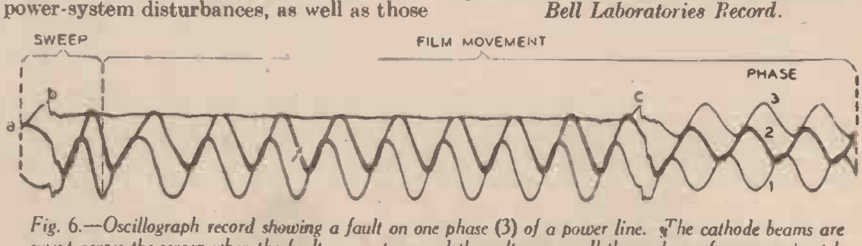


Fig. 6.—Oscillograph record showing a fault on one phase (3) of a power line. The cathode beams are swept across the screen when the fault occurs to record the voltages on all three phases for approximately the first cycle while the film movement is starting. The rest of the record is obtained on the moving film. At (a) transient disturbance operates high-speed trip; (b) phase-to-ground fault develops— low-frequency trip operates; (c) breaker clears fault.

Indium—The Indigo Metal

A Newcomer to the Ranks of Economic Metals?

Indium, when warmed, becomes sufficiently plastic to be squeezed through the fingers.

THE rare metal of to-day has not unfrequently proved itself to be the common metal of to-morrow.

In 1855, not very pure aluminium sold at the rate of about £120 per lb., yet nowadays we purchase our commonest household cooking vessels in this metal. Similarly, tungsten was at one time practically unobtainable. In our days, however, it forms the filament of almost every incandescent electric lamp. Cerium, too, is another "rare" metal turned tolerably common. Time was when cerium could not be obtained outside a research laboratory. Nowadays we carry about with us small cylinders of almost pure cerium in the guise of the "flints" of our petrol and other automatic lighters. Magnesium was at one time a scarce metal. Nowadays it is becoming commoner and commoner. The same applies, also, to beryllium, except, perhaps, that beryllium's progress has been held up severely of late years owing to economic conditions.

World's Ore Resources

The fact of the matter is that when a systematic survey is made of the world's ore resources we have perforce to come to the conclusion that very few of the known metals are really rare in the strict sense of the term. Many of them, it is true, are "out of the way" and take some finding. Others are extracted from their ores with great difficulty, whilst still others, although they are fairly extensively distributed throughout the mineral kingdom, occur in such small amounts in commercial ores, that their successful extraction has hitherto proved to be a matter of great economic difficulty.

In this latter class of "rare" metals must be included indium, the "indigo metal," it being so named on account of the fact that its spectrum shows a characteristic intense indigo-coloured band. Discovered as far back as 1863 by two Germans, T. Reich and F. Richter, in a specimen of zinc ore obtained from a mine in Freibergh, indium has until recent times been almost an unknown metal. A decade ago the metal was hardly purchasable anywhere. Since that time, however, its extraction has been commercialised by one or two American firms, with the result that the metal is (or was until the advent of the present hostilities) becoming gradually cheaper and more readily obtainable.

Freibergh Zinc Ore

The Freibergh zinc ore in which Reich and Richter originally discovered indium contained only a trace of the metal. In recent times, however, an ore deposit in Western Utah has been found to contain as much as 2.8 per cent. of indium, whilst the mineral *cylindrite* has been shown to contain about 1 per cent. of the metal. All tin ores, too, have been found to contain traces of indium. So have chalcopyrite and certain ores of silver. In certain industries, such as the manufacture of pigment. lithopone, indium appears along with cadmium in the chemical concentrates which are produced as by-products.

From most of these sources, it is possible to produce pure metallic indium on an economic scale, and, without a doubt, after the present war, indium metal will begin to appear more and more frequently on the commercial metal market.

Indium is a rather curious and unique metal. It belongs to the aluminium family of metals, and, in appearance, it is lustrous and silvery, with a slight leaden hue somewhat like that possessed by pure platinum.

One of the outstanding features of indium is its low melting point (155 degrees Centigrade) and its excessive softness and malleability. When heated in the hand, the metal becomes so soft that it is almost cheesy in texture and can readily be pressed through the fingers in long silvery threads. It is much softer than lead and it can be rolled into foil almost as thin as gold leaf.

Metallic indium, when in the pure state. does not easily tarnish, even in impure and contaminated atmospheres. For this reason. one of its first commercial uses has been in the production of jewellery. Incorporated into almost any jewellery alloy up to the extent of about 5 per cent., metallic indium is said to improve not only the hardness of the alloy, but also its strength. colour, and. in particular. its resistance to tarnishing and to most forms of atmospheric corrosion.

A Rare Metal so Named on Account of the fact that its Spectrum Shows a Characteristic Intense Indigo-Coloured Band.

Jewellery Alloy

A typical jewellery alloy of indium has the following composition :—

Gold	25-35 per cent.
Silver	10-33 ,, ,,
Palladium	2-25 ,, ,,
Copper	10-25 ,, ,,
Indium	5 ,, ,,

Alloyed with pure silver to the extent of 35 or 40 per cent., indium produces an absolutely untarnishable metal which can be guaranteed to resist successfully the most corrosive of atmospheres. Unfortunately. however, this indium-silver alloy is so hard that it is difficult to work.

On account of its corrosion-resistance and hardness-conferring properties, indium is now being used in America in the making of dental plates, dental castings containing between 10 and 20 per cent. of indium having been tried out very successfully in the States. As a metal for tooth-filling, indium has been found to have its uses, the metal being used for this purpose in the form of an amalgam with mercury.

The well-known rhodium plating of silver, whereby the latter metal is given a permanently untarnishable surface, seems likely to be faced with a competitor in the form of indium plating. When indium is electro-plated on a polished silver surface, the metallic indium deposit remains in the characteristic soft condition of the metal. When. however, the plated article is subjected to controlled heat-treatment the plated indium actually alloys with the underlying silver of the object, thereby forming an indium-silver alloy of high tarnish resistance and great hardness. Provided, therefore. that indium can be cheapened considerably, it seems certain that the indium plating of silver and other metals will become well established in due course.

Indium and Wood's Metal

Within the last few years a few British patents dealing with the incorporation of indium in bearing metals have been taken out, although such patents do not appear to have been actually worked up to the present time. It has been discovered. however. that 18 per-cent. of indium alloyed with Wood's metal produces an ultra low-temperature melting alloy which melts completely at 46 degrees Centigrade. Such an alloy could almost be melted by the heat of the hand, and it will undoubtedly find many novel applications in the time to come.

Finally. on account of its low melting point, it has been suggested that indium (either in the pure condition or suitably alloyed) may form a very convenient and useful metal for the filling of high-temperature thermometers. Indium thermometers have actually been experimented with, but, up to the time of writing. it would appear that they have not actually been marketed.

All indications point to indium's becoming a metal of considerable scientific and technical import in the settled period of progress which everyone hopes will be forthcoming after the war. A decade ago, indium was merely a chemical curiosity. Now it has reached the stage of being "not so rare." In due course it will undoubtedly become readily obtainable, particularly as the demand for it increases.

The Art

A section of the beating shop

YOU could beat one ounce of gold into a single sheet covering 250 square feet and 250,000th part of an inch thick, such is the astounding malleability of the precious metal—if you had the skill and it were possible to handle a piece of gold leaf of that area. As manipulation of such a sheet would be impracticable, the manufacturers of leaf for gilding purposes beat 2,500 leaves out of 12 dwts. of gold—and there are 20 pennyweights to the ounce! The equally remarkable ductility of gold is demonstrated in another sphere of industry where they find it necessary to take one grain of it (24 grains go to the dwt.) and draw it out into a wire 500 feet long.

The antiquity of the craft of gold beating—we have evidence of it being practised more than 4,500 years ago—is not apparent in to-day's methods, in which it might reasonably be thought that machinery would predominate. Certainly the initial processes are now mechanically performed, but a hand-wielded hammer is still the main tool. This is due not to any lack of trying to discover new ways but to the fact that no revolutionary method seems possible. The Egyptians used bronze hammers to flatten out their gold into leaves. The modern goldbeater's hammers are of steel, and the leaf is produced considerably thinner; and the latter is the only respect in which to-day's gold leaf differs from that so prodigally produced and lavishly used thousands of years ago. They plastered on their thick gold leaf with extreme generosity. The price of gold has forced us to become niggardly in this respect, as evidenced by any book of gold leaf of the present day.

Gold Leaf Decoration

Marvellously gilded statuettes and other trinkets, and some loose gold leaf, were found in the tomb of Tut-ankh-amen. Chariots and thrones of the Pharaohs were gilded thickly; as was the coffin case of King An-Antef of Thebes, who died about 2,600 B.C. That gold leaf is still in excellent condition—an awe-compelling relic of a monarch who departed this life some 4,500 years back. Even London weather and smoke added to the routine effects of the passage of Time are defied by the gold leaf used in the exterior decoration of St. Paul's Cathedral, the Houses of Parliament, Buckingham Palace, The National Gallery, Tower Bridge, and other famous buildings. Lowlier present-day uses for gold leaf are numerous. It is employed on shop facias, for lettering inside hats and shoes, for gilding picture frames, for beautifying the bindings and page-edges of books, the edges of playing-cards, and even for glorifying street railings.

The highest quality gold leaf is not the thinnest. That which is known as "Best English" (over 23 carat) works out at only 2,000 leaves per ounce of the metal, and this is the best procurable for exterior gilding. For other purposes, a very small quantity of alloy—usually copper and silver—is added to the pure fine gold. By increasing or lessening the proportions of alloy the colour (and of course quality) of the manufactured gold leaf can be varied; shades from white to red are obtainable in this way. The metal, either pure or containing alloy, is prepared in the form of ingots 6 inches long, an inch wide and $\frac{1}{8}$-inch thick.

Numerous Operations

These ingots are destined for a number of operations, carried out by workers of the highest skill, before they take their place in the form of finished leaves between the pages of the small gold leaf books, in which form the product is sold. The operations include a total of $7\frac{1}{2}$ hours' hammering: 30 minutes with a 20-lb. hammer, 2 hours with a 12-lb. hammer, and 5 hours with an 8-lb. hammer. But before the ingots come under the hammers they are passed several times between steel rollers, pressure being increased and annealing being carried out frequently. The result of that treatment is that the ingots become ribbons $1\frac{1}{4}$ in. wide and about one thousandth of an inch thick.

Each ribbon is then cut into pieces one-inch square, each to be hammered out to 4 in. square. Hammering, in this connection, seems almost comparable to using a steamroller to squash a spider's web, but it is not quite so crude as that. The inch squares are interleaved in 200 sheets of fine vellum, this constituting a "cutch" 4 in. square. It is secured around with bands of parchment and then the first beating starts, with a 20-lb. hammer. The cutch rests on a solid marble block, and some of these at the works of Messrs. G. M. Whiley, Ltd., makers of "The Standard of Gold Leaf," established in London as long ago as 1783, are centuries old. The same applies to many of the hammers. Generations of gold beaters have wielded these and stood to their work at the same ancient blocks of marble. Deep holes have been formed in the latter by thumb-action in manipulating the "mould" in which the gold leaf undergoes its final beating.

In the melting shop

Boxwood Pincers

For 30 minutes the 20-lb. hammer continues to rise and fall. At the end of that time each of the 1-in. squares which were interleaved in the cutch have assumed the size of the latter; that is, they are 4 in. square. They have then to be taken out from between the vellum leaves and quartered. But they are not handled. From the time when the gold leaf starts as a ribbon until the finished product is placed in the small paper book, for storing or sale, it is manipulated only with boxwood pincers. These are about a foot long and $\frac{1}{4}$ in. wide. The quartering of the 4-in. squares is done with a "skewing" knife, and for the second period of hammering

Of Goldbeating

Blocking the gold leaf

they are placed between strong skins 4½ in. square; this arrangement is made up of 800 of the skins and is known as a "shoder."

For beating this a lighter hammer—12 lb.—is used, and the pounding goes on for about 2 hours, the gold leaves having then increased their area to that of the skins of the shoder. Yet again they must be beaten, with a still lighter hammer, this time in a "mould" of goldbeater's skin. This skin is prepared from the thin, outside membrane of the intestine of cattle, and 1,000 very thin sheets of this skin form one mould, 5¼ in. square. But the 1,000 bulk only an inch thick and, though their weight is only a few ounces, they are very costly.

Quartering

After being extracted from the shoder and before being inserted in the mould the gold leaf is again quartered, the ticklish operation being performed this time with a sharpened reed. Five hours this mould is beaten, with an 8-lb. hammer. Only the most expert operators are entrusted with this part of the proceedings, for inexpert work shows up here in cracks, holes, stains, or other blemishes which mark the inferior article. After five hours' punishment with the 8-lb. hammer the gold leaves equal the mould in area, and they will be beaten no more. Taken from between the goldbeaters skin they are laid out singly on a cushion made of calf-skin, for cutting to the desired size. As can be appreciated, cutting metal of this almost incredible flimsiness is an art in itself. It is performed this time with what is known (inappropriately enough !) in the trade as a "waggon"—a small frame armed with sharpened reeds. Once more the narrow boxwood pincers come into play and the finished gold leaf is inserted between the thin sheets of a paper book about 3¼ in. square, 25 gold leaves to the book. Large numbers of these will be required for home use, many will be exported to widely-separated parts of the Empire, and other books will go to foreign countries, from Whiley's famous factory in Whitfield Street.

The output there averages about 3,000 leaves per operator per week, a not inconsiderable quantity when the proportion of hand labour to mechanical processes is taken into account. The hammer work is executed solely by men, the operations of cutting, interleaving, booking, etc., falling to the lot of women employees. Long training is necessary for all workers, expert manipulation of the gold leaf in all stages being acquired only by years of practice.

Despite the Efforts of Scientists to find Alternative Methods, Gold Leaf is Still Produced by Beating it with a Hammer

Boys are taken straight from school for training as beaters; unless they are "caught young," prospects of acquiring first-class prowess are rather remote.

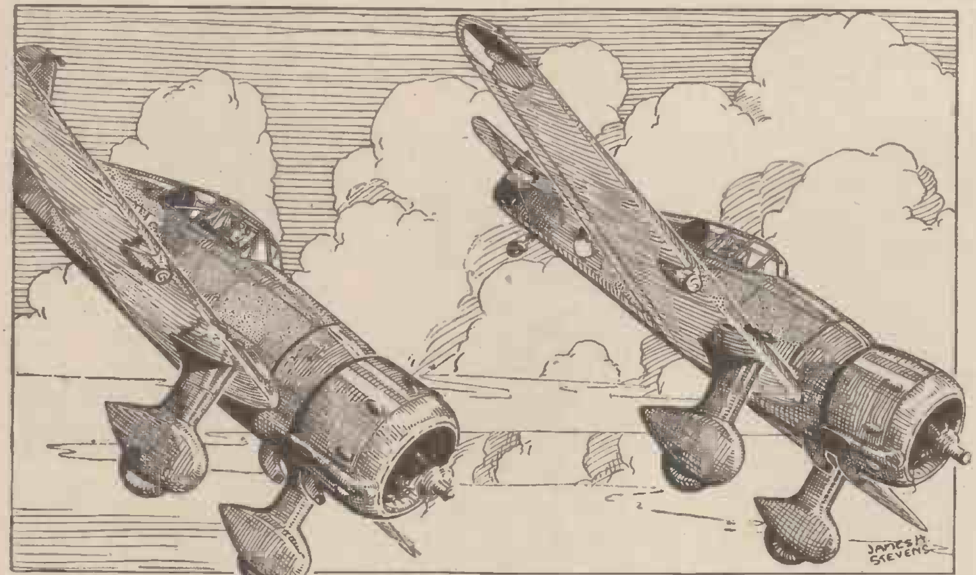
Solid Ornaments

Long before gold was used in coinage it was fashioned into solid ornaments—bracelets, rings, images, and so on—because of the readiness with which the metal can be worked upon and also because of its one-hundred per cent. resistance to any action of air and water. Examples of the goldsmith's art have been dated at round about 3,500 B.C. Sumerian workers in this and other metals attained a very high standard of skill both in design and execution. Samples of their exquisite work have been discovered in (among other places) a king's grave at Ur in the valley of the Euphrates, one of the finest of these being a gold-bladed dagger with a hilt of lapis lazuli studded with gold and provided with a sheath of solid gold. These ancient workers in gold set a magnificent standard for those who were to follow on, and doubtless they had their guilds, or fraternities, as we have to-day.

Long before our Goldsmiths' Company received its first Royal Charter, in 1327, a guild is known to have existed. The object of such guilds as this is to promote good fellowship of the members, to secure mutual help and protection, and to regulate the activities of the craft. The Goldsmiths' Company was granted the corporate title of "The Wardens and Commonalty of the Mystery of Goldsmiths of the City of London" by Letters Patent in 1462. For centuries the company has been responsible, under Statutory Authority, for the assay and hall-marking of gold and silver wares manufactured in this country and imported. It is illegal to sell either gold or silver plate unless this has been hall-marked. The latter is done at the assay office of the Hall of the company. Figures denoting the standard of gold are 22, 18, 14, or 9 carats; parts of alloy are represented by how much those figures fall short of 24 (pure gold).

Anyone who forges hall-marks, transposes hall-marks from one article to another, makes unauthorised additions to hall-marked wares, or sells wares unmarked or below standard, can be prosecuted by the company, whose members since the beginning of the seventeenth century have constituted the jury which "sits" at the Trial of the Pyx—the yearly examination and testing of the gold and silver coins issued from the Mint. Members of this jury are sworn in by the King's Remembrancer, whose duty it is to receive and place on record the verdicts; these are published in the *London Gazette*.

(Left) Cleaning goldbeaters' skins and (right) Rolling the gold into strips



SCALE MODEL AIRCRAFT No. 6

Fokker D. 21 Single-Seater Fighter

By J. H. Stevens, A.R.Ae.S.

A Description of the Last of a Long and Famous Line to see Active Service

ALTHOUGH the Netherlands were quickly overrun by the huge hordes of German troops and aeroplanes, their small Army Air Service put up a gallant fight before perishing practically to the last pilot and plane. Overwhelmed by sheer weight of numbers alone the Dutch pilots succeeded in bringing down a large number of enemy aeroplanes. Chief agent in the opposition to the German bombers was the Fokker D.21, most modern of the Netherlands fighters.

The D.21 is a low-wing monoplane, approximately contemporary in design with our own Hurricane and Spitfire. The arrangement and structure are of a robust and practical, rather than refined design—the neatly-streamlined fixed undercarriage is an example of this. Naturally enough, when designed with the idea of providing a sturdy machine, easy to maintain in the field, a certain amount of performance had to be sacrificed; but, for all that, the D.21 is a good enough aeroplane to have been adopted by the Netherlands, Finnish and Danish air services.

From the days of the last war Antony Fokker (who died at the end of last year) always pinned his faith in compositely-built aeroplanes. The famous Fokker D.R.1 triplane and D.7 fighters of the last war had welded steel tube fuselages with wooden wings, and the D.21 carries on this tradition.

Cantilever Main-Plane Construction

The cantilever low wing of the D.21 has a structure which is very little altered from that of its predecessors of nearly twenty-five years ago. There are two box spars built up with solid flanges and plywood webs. The ribs are of plywood and are very closely spaced. The stress-bearing skin of the wing is bakelite-glued plywood. The ailerons are of the Frise-balanced type and are fitted with mass balances and trimming tabs. Hydraulically-operated split trailing-edge flaps extend between the inner ends of the ailerons, across the bottom of the fuselage.

The main structure of the fuselage consists of four chrome-molybdenum steel-tube longerons, welded to struts of the same material, with wire cross-bracing. The streamlined oval section of the fuselage and the superstructure forming the cockpit enclosure are framed by a light structure attached to the main framework. The forward portion and whole of the top decking is completely covered with light-metal panels. The sides of the rear portion are fabric covered. The large cockpit enclosure is unusually well glazed with Plexiglas—a transparent plastic material—and is placed high over the trailing edge of the wing in order to provide the pilot with a good all-round view.

PRINCIPAL CHARACTERISTICS

Fokker D.21

	Mercury VIII	*Perseus X*
Span	*36 ft. 1 in.*	
Length	*26 ft. 11 in.**	
Wing area ..	*174 sq. ft.*	
Weight empty ..	3,190 *lb.*	.. 3,245 *lb.*
Weight loaded ..	4,510 *lb.*	
Wing loading ..	25.9 *lb./sq. ft.*	
Max. speed ..	286 *m.p.h.*	.. 295 *m.p.h.*
Cruising speed (2/3 power) ..	240 *m.p.h.*	.. 248 *m.p.h.*
Climb to 3,300 ft.	1.15 *min.*	.. 1.45 *min.*
Climb to 9,800 ft.	3.4 *min.*	.. 4.05 *min.*
Climb to 23,000 ft.	10.0 *min.*	.. 10.1 *min.*
Service ceiling ..	36,100 *ft.*	.. 33,100 *ft.*
Cruising range ..	590 *miles*	.. 578 *miles*

**This dimension varies slightly according to the airscrew and engine fitted. The difference lying inside 12 in. for all types.*

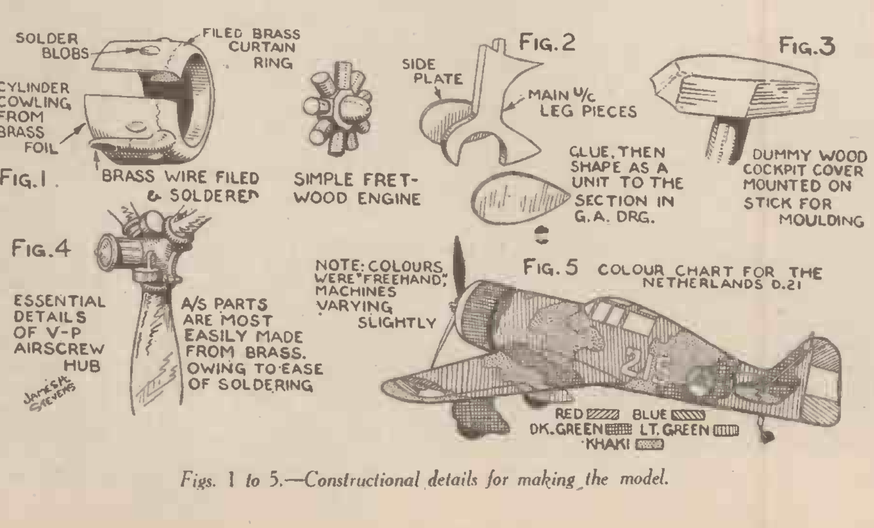
British Engines as Standard

The standard engine fitted to the Dutch, Finnish, and Danish D.21's is the British Bristol Mercury, of one type or another. The machine was, however, designed to be fitted with any air or liquid-cooled engine between 600 and 1,000 h.p. Those built for the Netherlands Army Air Service were fitted with the Bristol Mercury VIII nine-cylinder air-cooled radial rated at only 760 h.p. at 16,730 ft. Considering the comparatively low power the maximum speed of 286 m.p.h. is remarkably good. In the table of performances will be found figures for both the Mercury and Bristol Perseus engined versions. The extra power of the sleeve-valve engine (880 h.p. at 9,020 ft.), it will be noted, raises the maximum speed to 295 m.p.h.; so that it may be supposed that, when fitted with a 1,000 h.p. unit, such as is used on the average modern fighters, the speed would be over the 300 mark.

The installation of the Mercury engine is simple and straightforward. It is enclosed in a long-chord N.A.C.A. type cowling with a Bristol nose exhaust-collector ring and short tail pipe on the starboard side. A 77-gallon petrol tank is carried in the fuselage just behind the engine: extra tanks may be fitted in the wings if a longer range is required. The first machines were fitted with either two or three-bladed fixed-pitch metal airscrews, but the Dutch ones had three-bladed controllable-pitch airscrews.

"Anti-Spin" Tail Unit

The tail unit is of a type designed to give



Figs. 1 to 5.—Constructional details for making the model.

good control in the event of a spin—a manoeuvre which is often uncontrollable in low-wing monoplanes—the rudder being large and the tail plane and elevator being set well forward of the rudder hinge line. The structure of the tail unit components is of welded steel tube with fabric covering. The tail plane and fin are externally braced. The former by struts to the lower longerons of the fuselage and the latter by heavy streamline wires to the tips of the tail plane. The controls are aerodynamically balanced by inset hinges and are fitted, in addition, with the usual mass balances. The trimming tabs on the rudder can be adjusted only on the ground, while those on the elevator are adjustable in flight.

The undercarriage is unusual for a modern fighter in that it is not retractable; however, the unavoidable loss in performance is to some extent offset by the reduced maintenance work. The two main wheels are carried on cantilever oleo-pneumatic shock-absorber struts. Compressed-air wheel brakes are fitted. The tail wheel unit is steerable with the rudder.

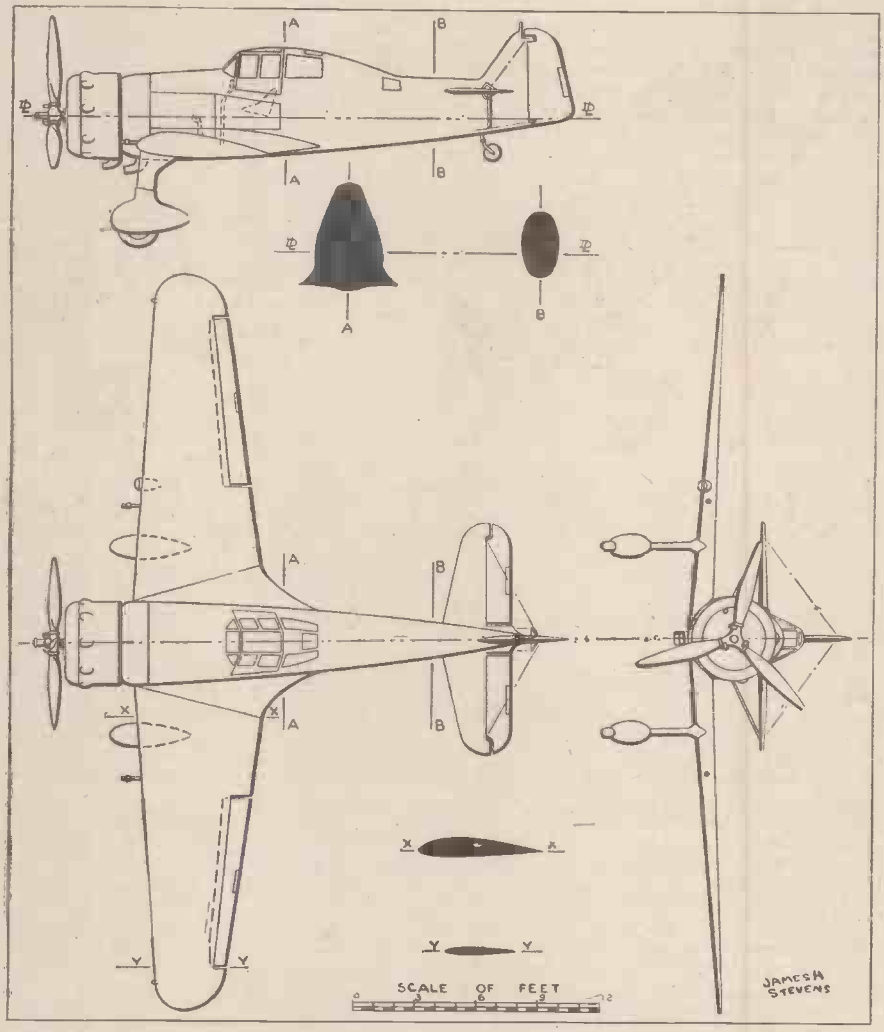
Armament

It is probably in armament that the D.21 is least effective. The outstanding success of our eight-gun, and the French four-gun plus *canon* fighters has proved the need for a very concentrated fire power for the short space of time that modern fast machines can be held in the sights. The D.21 allows of various combinations of guns, but none approaches the massive batteries of Brownings mounted in the Spitfire and Hurricane.

The combinations specified by the makers were: two 0.303-in. synchronised machine-guns in the fuselage with 500 rounds each, and two 0.303-in. machine-guns with 300 rounds each in the wings; or two 0.303-in. synchronised guns with 500 rounds each and two automatic shell guns under the wings with 60 rounds each; or four 0.303 machine-guns in the wings with 300 rounds each.

A full range of instruments is fitted, including blind and night-flying equipment —a landing light is carried in a streamlined bulge in the leading edge of the starboard plane. Electric heating, oxygen, wireless, etc., are all standard.

SIDE PLAN AND FRONT VIEW OF THE FOKKER D 21



The Model

The most convenient method for making this model is to carve the fuselage out of a solid block of whitewood or similar close-grained soft wood. The main plane should be cut and shaped from a piece of fretwood of appropriate thickness. For the smaller scales washer fibre is ideal for the tall surfaces, as it is easily cut and shaped. If a lathe is available the engine cowling can be turned, if not it can be simply made by using a brass curtain ring as the base for the exhaust collector, to which a length of wire is soldered for the main pipe. The cowling may be made from thin brass foil soldered to the ring, with small blobs of solder to represent the cylinder-head bulges (Fig. 1). So little of the engine is visible inside such a cowling that it is scarcely worth doing more than represent it with a nine-armed fretwood blank.

Moulding the Cockpit Cover

The cockpit cover is always a source of some trouble in small models. A piece of thin celluloid or cellulose-acetate sheet is needed. This may be difficult to get now, with the present increasing shortage of materials, and it may be necessary to make do with some very thin material from a commercial packet, such as a chocolate box. A "dummy" should first be made of the whole cockpit (Fig. 3), mounted on a short stick and given a coat of paint or varnish to make it waterproof—this forms the male die. The female, or platen, should be made of any plastic material; a tin of plastic wood, a rubber sponge compressed in a tin, or even soft new bread in a tin—though that, perhaps, should not be used during wartime! A very superior female die can, of course, be made by casting it in plaster-of-paris round the male die, using a matchbox tray as the case for the mould. The cellophane, the die, and (if its material will permit) the platen should be thoroughly heated in very hot water before shaping—a plaster female die should be heated *gently* in an oven. Even very thin material will be found to be quite stiff once it has been shaped, as both the drawing action and the curved surfaces add stiffness. If further stiffening is needed a very light wire frame can be made and glued inside with a cellulose adhesive.

The Undercarriage Fairings

The streamlined undercarriage fairings present something of a problem. Fig. 2 shows a simple way of making them up, either in thin wood or fibre for a small-scale model.

Probably the trickiest part of all is the airscrew. This can be bought as a finished part, otherwise it must be cut and filed from sheet metal. The blades can be made from sheet brass soldered together on a positioning jig, the details of the hub mechanism being added after (Fig. 4). The whole should be tinned to give the correct metallic finish.

Painting Materials

The paint to be used is a matter of personal choice; matt poster paint, oil "art" enamel or cellulose paint all being suitable. For ease of working and general finish the writer prefers "art" enamel as it does not dry too quickly when doing intricate parts, as does cellulose, and it is not easily finger-marked like the poster colour. A good filler should be used on all wooden parts. It might be as well to mention here a very simple method of suggesting the slight ridge that is formed by the ribs or stringers which give shape to the fabric-covered parts, i.e. ailerons, elevator, rudder and rear fuselage. The positions of the members should be accurately marked with a pencil and then a narrow line should be painted with a fine liner's brush. If this is done on top of the undercoating, and the finishing coats are as thin and even as they ought to be, the result will be entirely satisfactory.

Dutch Camouflage

The Netherlands D.21 was originally painted dark green, but in 1938 a camouflage was adopted. The groundwork was a yellowish khaki. This covered the whole of the undersurfaces of the wing, fuselage and tail plane as well as patches of the rest of the machine. The other camouflage colours were a dark olive green and light apple green. All three colours are shown in the heading sketch by dotted, and cross-hatched and dark shading respectively. The national markings were a red-white-and-blue rudder (reading from top to bottom) and insignia on the wings and sides of the fuselage consisting of a circle divided radially into red, white, and blue segments with a yellow centre. After the war had started the markings were altered to a black-outlined orange triangle on wings and fuselage and a black-outlined orange rudder, in order to avoid the risk of confusion with Allied aeroplanes. A large white three-digit machine number was painted on the sides of the fuselage. The exhaust pipe was yellowish-grey and the airscrew polished aluminium with the backs of the blades painted black.

Finnish Warpaint

The Finnish D.21's which, although there were few of them, wreaked considerable havoc among the Russian bombers, were painted dark green with silver under-surfaces and undercarriage legs. The Finnish national insignia is a blue swastika on a white disc, the swastika being set square to the centre line and datum lines of the fuselage on wing and fuselage respectively. There is no rudder marking.

The Danish Fokkers, the only ones not to have seen active service, are (or were) painted entirely silver. The national insignia consisted of concentric red ring and white disc on wings and fuselage only. A black machine letter and number were painted on the sides of the fuselage.

Simplifying The Convoying Of Ships

A New G.E.C. Device for Keeping Convoy Ships In Station

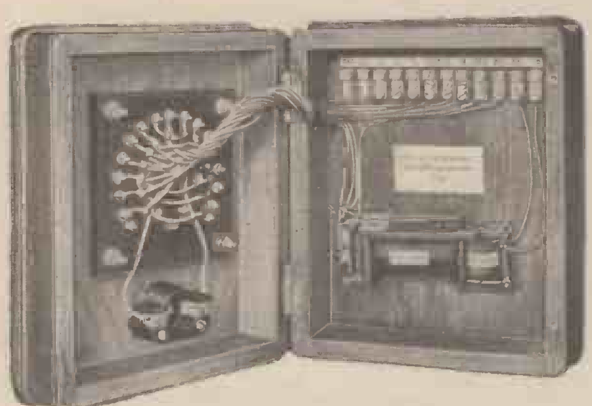


Fig. 1.—Showing the inside of the control switch.

Fig. 2.—A front view of the control switch for transmitting signals.

A NEW device which simplifies navigation of ships in convoy, by providing a means of closely controlling speed, has just been marketed by The General Electric Co., Ltd., Magnet House, Kingsway, London, W.C.2. This is in the form of equipment which supplies a means of transmitting from bridge to engine-room a positive indication of a desired increase or decrease in the propeller speed not capable of being signalled by the engine telegraph.

Equipment

The equipment comprises, firstly, a teak control panel or transmitter incorporating a 14-way radial switch with pointer, an electric reset relay, and an operating push. There are also two surface pattern luminous indicators, one in teak for the bridge and one in steel for the engine-room. These have a bronze-finished front plate framing a glass panel with a light baffled number stencil showing "Increase," "Decrease," and a number, when appropriate lamps are lighted. In addition there is a reset push, loud tone ironclad bell, and bell-relay for the engine-room.

The System

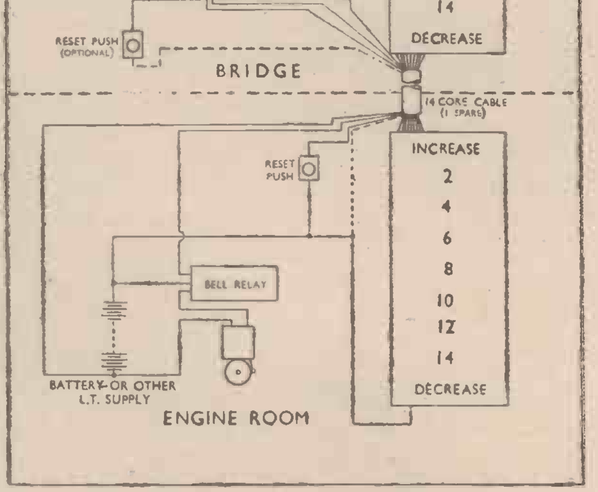
The system, which is shown diagrammatically in Fig. 4, is designed for 12 volts or 24 volts from any existing L.T. supply, or can be operated from dry batteries. Marine type single or multicore cables of standard patterns for L.T. wiring can be used, although it may be necessary to use lead-covered cable for local wiring on the bridge to avoid interference with navigation and comply with regulations.

To transmit any particular signal the control switch (Fig. 2) is rotated to the required position and the operating push depressed. This energises the relay and lights up the appropriate lamps on both indicators (Fig. 3). The engine-room bell will ring only so long as the push is operated, but the indicators will remain alight until the engineer presses the reset push, which is an acknowledgment of the instruction. Lighting of the bridge indicator is proof of the engine-room indicator also being lighted, because the lamps are wired in series. The fitting of an additional push on the bridge allows cancellation from this point also.

Satisfactory

This system has proved very satisfactory in service and permits a quick response to orders from the bridge. It is much more simple to use than telephones. Reports from owners of vessels which are already equipped with it say that they have had no difficulty in keeping their station in convoy.

Figs. 3 and 4.—(Below) Details of the indicators. There are two of these, one for the bridge and one for the engine room. They have a glass panel with a light baffled number stencil showing "Increase" and "Decrease." (Right) A wiring diagram of the system which is designed for 12-volt or 24-volt from any existing L.T. supply, or dry batteries.



Watch Repairing and Adjusting—10

Cleaning and Oiling the Movement

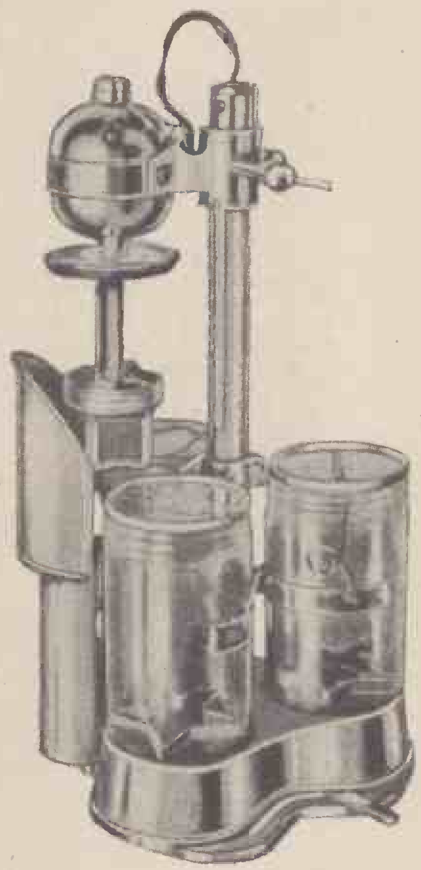


Fig. 1.—A typical watch-cleaning machine.

CLEANING the movement should present little difficulty. After an external examination, the movement should be dismantled and subjected to a further examination. It is not a good policy to clean and polish the movement if it has to be handled afterwards for the purpose of effecting repairs and adjustments. On the other hand, it is impossible to ascertain whether repairs are necessary if the parts are coated with a black, greasy paste.

Before letting down the mainspring a note should be made of any unusual features and adjustments necessary. After letting down the mainspring, remove the various components, which should be placed in a movement tray or a small box. Wine glasses, from which the stems have been accidentally broken, made excellent dust covers and are to be found on many watchmakers' benches. Separating the parts will prevent a mix-up of the screws, many of which are of different lengths. Movements in different states of dirtiness require different methods of cleaning. If the movement is comparatively new and has only stopped because of dust, dry brushing will be effective.

Cleaning the Plates

First wipe the plates with a chamois leather; afterwards hold them in tissue paper and brush them with a circular motion. Brushing in any other way will produce unsightly scratches, which can only be removed by re-gilding. For ease and speed the tissue paper should be cut into small squares about 4 by 3 in., and hung in a convenient place. Several brushes should be in use at the same time. A small brush is very useful when dealing with miniature watches. When in use, a brush should be constantly rubbed on a block of specially prepared chalk. This chalk is sold for the purpose of keeping watch brushes clean. A periodical washing in lukewarm water will prolong the life of any brush.

When the plates have been brushed, they should be carefully examined and the various wheel sinks and jewel sinks pegged free of any dirt which may have adhered to their rough edges. Pegwood, usually supplied in bundles of 25 sticks, is frequently called dogwood. Jewel hole, should be thoroughly cleaned by twirling pegwood dipped in alcohol. The pegwood, which should be sharpened with small facets to aid polishing, should be repeatedly sharpened until it is withdrawn perfectly clean.

Many beginners pay too much attention to outward finish and insufficient to jewel holes, pinions, and pivots. Pinion leaves, like jewel holes, must be thoroughly pegged after brushing. Pivots, too, must be individually cleaned. For small pivots twirl a piece of pith well down to the shoulder; for large pivots use a piece of clean cork. The ruby pin should be cleaned with pith, whilst the fork should be cleaned with pegwood.

Banking Pins

A point which is often overlooked and one which can have a retarding effect upon the balance is the cleanliness of the banking pins. If there is any doubt about the cleanliness of these pins and the sides of the lever with which they mark contact, they should be very lightly scraped. Capped jewels, that is jewel holes fitted with endstones, must be separated in order that they may be scrupulously clean. Oil which remains in the minute space between jewel hole and endstone often becomes congealed. If this is allowed to remain, the clean oil will be contaminated.

A movement which is greasy will not respond to the dry brush method. It will be necessary to immerse it (when dismantled) in some cleansing solution such as very light benzine. For final cleansing the parts can be dipped in alcohol. Pallet stones and ruby pin must be closely watched, as the alcohol is likely to dissolve the shellac by which they are fixed. After removal from the solution, the parts should be dried in boxwood sawdust. When dry, the pinions, jewel holes, etc., must be pegged. Great care must be taken to see that no speck of box-dust remains anywhere. One speck of box-dust left under a balance screw or left in the slit of a balance screw is sufficient to upset the time of a sensitive watch.

Avoid Kinking

Care must be exercised when brushing delicate steel pieces, as the slightest kinking can cause hours of labour when reassembling the movement. Straight pieces should be brushed lengthwise, whilst holding the piece carefully on the bench. A dusty balance and balance spring may be cleaned by stroking it with a camel-hair brush with a circular movement.

Watchmakers who were trained in the hand-and-brush method of cleaning are fast being converted to the mechanical method. The electrical watch-cleaning machine is now an essential item of the modern repair department. Although some of the old school are inclined to frown upon this invention, its efficiency cannot be disputed.

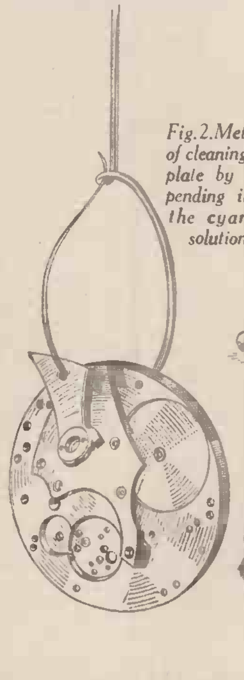


Fig. 2. Method of cleaning the plate by suspending it in the cyanide solution.

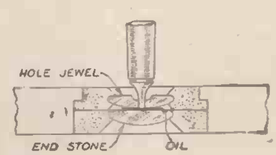
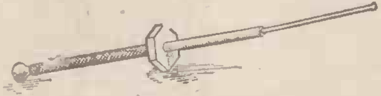
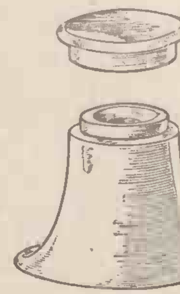


Fig. 3.—Capillary attraction keeps the oil in place.





Figs. 4 and 5.—A watch oiler, so balanced that its point is prevented from fouling the bench and so picking up grit; and (right) an oil pot and cover.

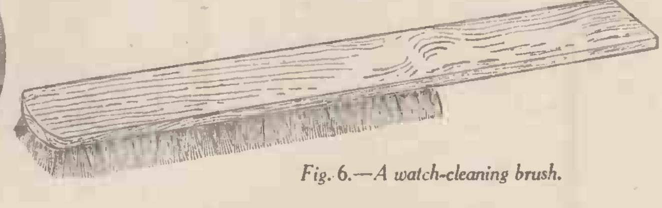


Fig. 6.—A watch-cleaning brush.

There are several types of machine, but the principle is the same. The watch parts are cleaned by fluid friction. Unlike hand brushing, in which the parts are held in tissue paper or the fingers, the mechanical cleaner leaves no finger marks.

The machine consists of an electric motor attached to a basket into which the parts of the watch are placed, jars of cleaning and rinsing solutions, and a drying element. The watch is dismantled in the usual way and the parts placed in the basket—large parts in the bottom section, small parts in the top. The basket is lowered into No. 1 jar. The motor is started and the basket revolved for about a minute, the basket then being raised free of the liquid and any surplus thrown off.

Cleaning Solutions

Automatic sealing of the jars prevents any waste of solution. When removed from No. 1 jar, the basket is placed in No. 2 jar, and finally in No. 3 jar. Surplus solution should be thrown off each time. After the last rinse the basket should be rotated above the heater element and the parts dried. There is no likelihood of the parts being scratched, as centrifugal action holds the parts against the wire basket. The basket should be rotated for about one minute in each solution.

Excessive speed should be avoided, for although the basket may appear to be covered with solution, this is no guarantee that the parts inside are well covered. It is also important that any surplus solution should be thrown off for any which remains is likely to contaminate the rinsing solution. No time should be lost in transferring from one solution to another. Failure in this operation may result in spotted plates or even rusty hairspring coils. Certain conditions cause some rinsing solutions to decompose. These solutions should never be left in strong sunlight.

When re-assembling the movement the parts should be held in tissue paper. A movement holder is very useful for miniature movements. Care should be taken not to breathe on the parts, as condensation is likely to cause rust. A customer who quite casually blew into his watch to remove the dust was very disappointed when told it was full of rust.

Screw-drivers

A number of different sized screw-drivers are essential if the brand new appearance of the watch is to be maintained. The screw-driver should be the same width as the screw. Too large a screw-driver will cause the screw sinks to be mutilated. A screw-driver blade with insufficient taper or too narrow will be inclined to slip out of the slit and damage the screw head.

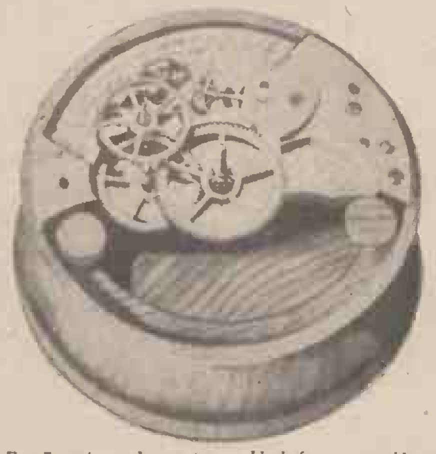


Fig. 7.—A wooden setting-up block for re-assembling the movement after cleaning.

Oiling a watch sounds a simple matter, but in order that the watch shall gain full benefit from the oil, it needs to be applied carefully. A considerable amount of research work has been carried out in recent years with the result that watch oils are now produced in a highly refined state. There are two kinds of oil—mineral and animal or vegetable. Although animal or vegetable oil does not spread, it has the disadvantage of thickening. Mineral oils remain fresh, but have a tendency to spread.

The "Epilame" Process

The introduction of the "Epilame" process has enabled mineral oil to be used. The treatment of the parts with "Epilame" prevents oil from spreading and helps it to form beads at the ends of pivots. One method of applying the "Epilame" is to immerse the parts in the solution so that the whole surface is covered with a most minute film. Another method is to place a little "Epilame" in a bottle with a pith stopper. The pith can be saturated and the pivots pushed into the pith. Sufficient "Epilame" can be applied with a sharpened piece of pegwood for the jewel holes. Note: "Epilame" must not be placed on mainsprings or pallet stones. To make the best use of this process, special oils are prepared and graded in conjunction with it.

For the actual application of the oil, some repairers use a pivot drill, others an ordinary steel pen. A good oiler can be made in the following manner: Cut off a piece of brass bush wire about three inches long. At one end fix a collar to prevent the end of the oiler touching the bench. A brass hexagonal nut soldered to the end will also prevent the oiler from rolling off the bench. The oiler proper can be filed from a needle or a piece of steel wire. Fig. 4 shows an oiler.

Oiling the Balance and Capped Jewels

When oiling balance and other capped jewels, it is important that the oil reaches the endstone. If the oil remains in the reservoir of the jewel hole it will probably spread to the lower end of the roller or towards the hairspring collet. To enable the oil to reach the endstone, use another oiler in which the steel part is filed small enough to enter the jewel hole, thereby permitting the oil to follow through.

In small watches the most difficult part to oil is the top pallet pivot. The easiest way is to apply a spot of oil to the pivot before letting down the pallet bridge. The pallet staff shoulder is so short that more than the tiniest spot of oil is likely to spread and retard the action. Under ordinary circumstances a watch will run for 12 months before the need for further oil.

New Barimar Welding Process

Welding Aluminium to Steel

THE latest scientific welding development is a new Barimar process for welding together ferrous and non-ferrous metals, such as steel and aluminium.

The process, which is complex, must not be confused with any other form of brazing or soldering, as it is a genuine weld; that is to say, there is fusive union of such strength that the breaking point at the junction is not less than that of the weaker metal, as in the case of a weld joining two pieces of the same metal. The success of this development is dependent upon a new form of flux, unusual methods of manipulation, and extremely accurate flame control.

A few years ago Barimar, Ltd., the scientific welding repair specialists, of 14-18 Lamb's Conduit Street, London, W.C.1, introduced a process for welding steel to cast iron. So successful have been the results, that this firm has carried out intensive research in the welding of ferrous to non-ferrous metals, culminating in the success described.

There is no need to emphasise the importance of this Barimar effort; already the new process is being used by this firm for work of a highly important nature. It seems likely that there will be innumerable applications, not only in the field of repair work but also for many manufacturing purposes.

The new Barimar welding process is ideal for welding aluminium to steel. The illustration shows it being used to weld an aluminium flanged end to steel tubing, the component being part of X-ray apparatus.

Safety for Spectacles

THE ideal spectacle case is one which is convenient for the pocket, sufficiently rigid to protect the glasses from a blow or external pressure, and interiorly so arranged that the lenses are immune from being broken or scratched.

It is pointed out by an inventor that the plush with which the spectacle case is usually lined readily picks up and retains dust and dirt. He remarks that it does not fulfil its alleged purpose of preventing scratching. Owing to the fact that the lenses are free to move in the case, detrimental friction with the lining is caused.

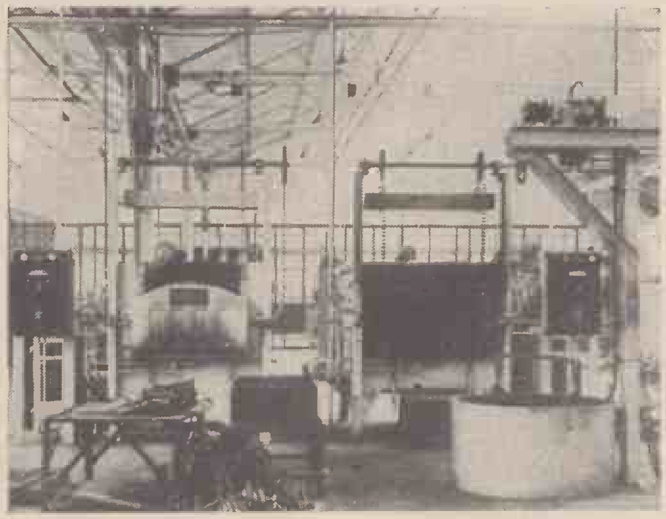
A Special Case

The inventor in question has devised a case in which spectacles are supported in such a manner that at all times the lenses are kept out of contact with the interior walls. At the ends of the case are ledges raised above the bottom, each including a recessed portion, into which fit projecting lugs at each side of the lens-receiving parts.

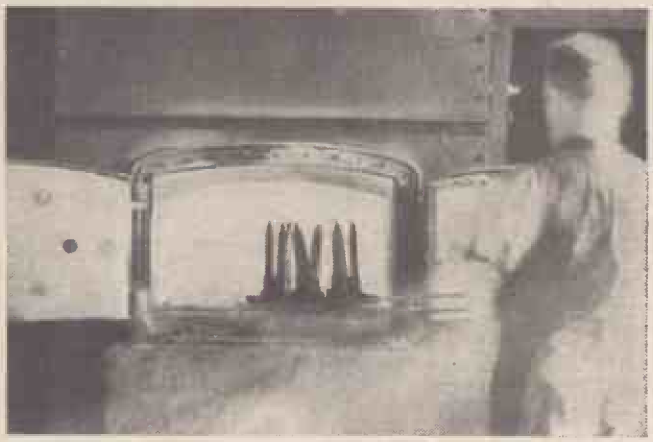
In addition to the useful features of this spectacle case, some ingenious mind should contrive a case which it is impossible to lose. It should be practicable to devise one which could be inseparably tethered to the pocket.

Drop Forging and Heat Treatment

A Clear Description Of The Methods And "Snags" Of Making Drop Forgings For Gear Wheels, Crankshafts And Camshafts, And Of The Process Of Electrical Upsetting, Tempering And Case Hardening



(Above) Part of the heat treatment department at the Standard Works. In the foreground on the right can be seen a quenching tank into which the parts are lowered as they are removed from the furnaces



(Right) Gears being placed in a furnace for heat treatment at the Morris works

REDUCED to its simplest terms, forging consists of heating a bar of metal until it is almost white hot, and hammering the plastic metal into the required shape on an anvil. Forging parts by hand, however, as carried out in the blacksmith's shop, would be far too slow a process for modern production requirements. A large proportion of the parts used in a car, therefore, are produced by the drop forging process.

A billet of heated metal is stamped between dies, in each of which a half-section of the required article is hollowed out, the dies being aligned so that when face to face they reproduce the shape of the required forging. One die is attached to the anvil of the drop forging machine, and the other to the heavy drop hammer, which slides in guides above the anvil.

The drop hammer is lifted mechanically, and an ingot of hot metal is placed on the anvil die. When the drop hammer is released, the impact instantly stamps the metal between the dies to the correct shape.

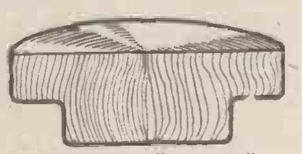
Correct Grain

While drop forging may thus seem a fairly simple operation, a number of complicated factors intrude. In the first place, a billet of steel has a grain flowing through it in much the same manner as a piece of wood. If this grain flow is distorted during the forging of, for instance, a gear wheel blank, the part is likely to become warped during subsequent heat treatment. This can happen if the piece of metal which is put into the die, which is called the "use," is not cut correctly to shape, and is not placed vertically and centrally in the die. In the case of a gear wheel, an additional precaution is usually to drive a mandrel through the centre of the gear blank during the forging operation as this produces a more even grain.

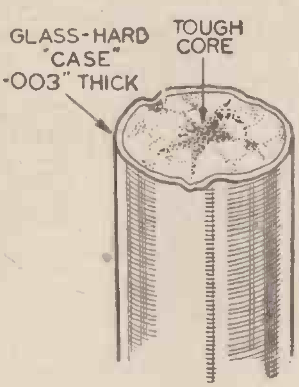
It is quite usual in a modern works for specimen forgings to be cut into sections, and the grain rendered visible by polishing the steel and then etching the surface with acid, studying the grain flow with the aid of a special type of microscope.

Drop-Forged Crankshafts

In the production of a drop-forged crankshaft, three or four stages are often employed to ensure a satisfactory grain flow in the metal and a reliable crystalline structure. The first stage is to forge the original billet of heated iron into the "use" from which the finished shaft is to be produced. This is often carried out on a steam hammer. The billet is then transferred to an hydraulic press which bends and forms the "use" in two stages, so that the crankshaft begins to take rough shape.



An example of well-controlled grain flow in a gear wheel blank; this blank would produce a quiet gear.



The process of case hardening enables a tough core of steel to be retained, surrounded by a glass-hard skin which resists wear and abrasion.

The next stage is to transfer the "use" to a drop hammer which may weigh as much as six and a half tons. In some cases, as with crankshafts for engines with six or more cylinders, it may be necessary to forge all the throws in one plane, afterwards twisting the heated forging in a jig which ensures the correct angle between the respective throws. The red hot shaft is clamped to a base provided with vertical jaws which grip the webs of a pair of throws. "U" pieces grip another pair of webs, which are then twisted through the required angle by hand operating gearing and cables. On smaller shafts, however, bending, where necessary, is often carried out by suitably arranging the height of the dies in the drop hammer.

Electrical Upsetting

While drop forging is unlikely to be superseded for large components, an interesting forging process, known as electrical upsetting, is now coming into general use. In this case the bar of steel is heated locally by means of a high-frequency electrical current amounting to between 5,000 and 9,000 amp. for every square inch of cross section of the bar to be forged. The current is obtained from a transformer, which is built into the upsetting machine, the work forming part of the secondary circuit of the transformer. Although the current is high, the voltage is only 2 to 3 volts. After being heated, the bar is squeezed in dies to the desired form.

This method is now being extended by some makers to the production of more elaborate parts, such as axle shafts, forged with integral hubs, in addition to rocker shafts, drag links, pinions and worm shafts, to mention only a few applications. One of the largest forgings produced in this manner is the Daimler cardan shaft. An interesting development is the electrical upsetting of tubular sections, during the manufacture of hollow, sodium-cooled valve forgings for high-efficiency, racing and aircraft engines.

Among the advantages of electrical upsetting is the fact that there is no tendency to overheat the exterior surface of the metal, the heat being generated through the entire section of the material; the centre of the bar, in fact, is at a slightly higher temperature than the outside metal. The grain flow, moreover, follows the shape of the finished forging, this being strikingly demonstrated in the case of rear axle shafts with integral hubs.

Heat Treatment

Adjacent to the drop forging shop and the foundry is the heat treatment department. The forgings and castings used in a car are subject to various heat treatments, among which are normalising, tempering, and case hardening.

The normalising treatment removes strains set up in the steel during forging, and precedes hardening and tempering in most cases. It is carried out by raising the metal to a point beyond its highest critical temperature, keeping it at this temperature for a short time, and then allowing it to cool fairly quickly. Hardening and tempering are carried out by heating the metal to a high temperature and suddenly cooling it by plunging it into a bath of water or oil.

Gear Wheel Blanks

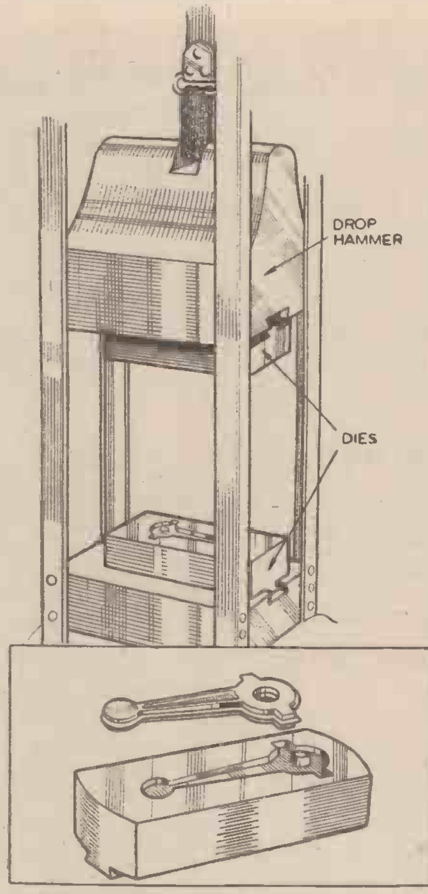
The temperature, time of heating, and method of "quenching" all depend upon the characteristics of the steel and the purpose for which it is to be used. As a concrete instance, however, let us take a typical gear-wheel blank. The stamping from the drop forging department will be heated in a circular gas or oil fired furnace which has a rotating hearth, so that the parts placed on it pass through several zones, gradually attaining a higher temperature. Alternatively, the furnace may be long and narrow in shape, heated by electricity, the floor consisting of slowly rotating rollers which gradually carry the parts through the furnace. When the parts reach a temperature of 850 degrees C. they are removed and dropped into an oil-bath to harden them.

Case Hardening

The next step is to temper the steel, reducing the hardness just sufficiently to provide a tough, but easily machined gear or other component. With this object the part is returned to a furnace and raised to a temperature in the neighbourhood of 650 degrees C., after which it is allowed to cool slowly.

Here, in the case of a number of parts, such as road springs, axles, bumper bars and so on, the heat treatment would end. A large proportion of parts, however, including gear wheels, crankshafts, gudgeon pins and similar components, which must resist heavy loading and wear, will require case-hardening. The steel could be hardened by heating it again and suddenly quenching it, after the machining has been completed. This, however, would render the metal brittle. Instead, the tough "core" is retained, and the outer skin of the metal is converted into a glass-hard "case."

During the final machining the part will be left slightly oversize; it is then packed with a number of other components in an iron box containing carburising material,

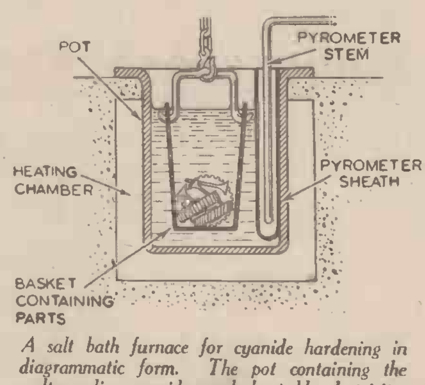


A diagrammatic illustration of drop forging. A heated billet of metal is placed on the lower die. and is stamped into shape between upper and lower dies when the hammer is dropped

which may consist of charred leather, wood, charcoal, bone dust. or a proprietary carburising powder.

Carburising Furnaces

Under modern production conditions the boxes are handled automatically, passing under chutes through which the case-hardening compound falls when a control lever is operated. When a box is loaded, the lid is lifted and the box carried on a conveyor to the carburising furnaces. There the boxes are placed on an electrically operated charging machine which runs on rails in front of the furnaces. The body of this charging machine is swung round opposite a furnace, the furnace door opened, and when the operator presses a button long arms, carrying the boxes, slide into the furnace, deposit the boxes. and withdraw.



A salt bath furnace for cyanide hardening in diagrammatic form. The pot containing the molten sodium cyanide may be heated by electricity, gas or oil

After seven to ten hours the carburised work is removed from the furnaces by the same machine, and taken to the cooling conveyor, which passes outside the building. The work takes approximately eight hours to pass along the cooling conveyor, before it reaches the unloading station. Here the boxes are opened and the parts removed, the used carburising material being passed through a washing machine, dried by a hot air blast, and returned to the storage hoppers for further use.

After carburising, the parts are hardened by heating them in a furnace to about 800 degrees C., and then quenching them in a water or oil bath. This produces the glass-hard surface, so that further machining is impossible; as slight distortion may have taken place, the final finishing must be carried out by grinding, or lapping with abrasive paste.

Small parts which require a fairly thin layer of case hardening such as gear selector parts, valves, gears, and similar items, are often hardened in a cyanide bath. In this case, the parts are placed in a metal basket which is immersed in an electrically heated pot containing molten sodium cyanide. As a liquid is used the parts need not be packed individually, but can be simply shovelled into the basket. Long parts, such as camshafts, can be suspended vertically in the salt, and quenched in the same position, thus preventing distortion.

Parts hardened by the cyanide process have a clean, bright finish. In the case of pack-hardened articles, to which some of the case-hardening material usually adheres, shot blasting is normally required. In most cases the work is carried out in a cabinet through which the operator inserts his arms in protective sleeves, directing a stream of tiny steel shot from a hose on to the case-hardened component.

Nitriding

Where extreme surface hardness is required, the nitriding process is often used. The parts, such as cylinder liners, brake drums, crankshafts, and similar items, are made from Nitralloy, a special aluminium chromium alloy steel, which can be case hardened by the absorption of nitrogen from ammonia gas. The nitriding process is carried out at a temperature of approximately 500 degrees C. for a maximum period of 90 hours, or less, according to the depth of case required. The parts are contained in a sealed box through which a stream of ammonia gas slowly passes. Nitriding gives the hardest metallic surface known, its resistance to wear being at least ten times that of ordinary case-hardened steel, while it will cut glass or quartz.

Surface hardening can, of course, be carried out in other ways. Cast iron camshafts, which cannot be case hardened, have the working surfaces hardened by placing metal "chills" in the moulds, so that the molten metal adjacent to them is cooled suddenly, giving an extremely hard surface to the flanks and tips of the cams. Alternatively, electrical inductance blocks may be used, the principle being somewhat similar to the electrical upsetting process. The strong magnetic field which is set up in the part to be hardened when current is passed through the inductance blocks which surround, but do not quite touch it, generates the heat in the surface of the metal. Unlike the electrical upsetting process the interior of the metal remains unaffected. After four to six seconds, depending upon the depth to which it is desired to heat the metal, the current is switched off, and water is sprayed through holes in the inductor block to "quench" the heated surfaces.

C. L. Sholes, co-inventor of the typewriter, with his experimental model—1870.

MASTERS OF MECHANICS

No. 60.—Latham Sholes and Carlos Glidden, Inventors of the Practical Typewriter

WITHIN the close confines of a typewriter's interior is clustered some of the most precise assemblies of mechanism which the ingenuity and the constructive ability of man has ever brought into being. True it is that the fundamental principles upon which even the most elaborate of modern typewriters function are simple and straightforward ones. Yet the actual design and make-up of a typewriter is a complex one and the mechanism which it embodies must of necessity work with extreme precision and accuracy if the machine is to be of practical and lasting service.

For many years previous to the introduction of the first practical typewriter inventors toyed with the idea of making a machine which would enable words to be printed mechanically as the result of depressing lettered keys. It is on record that Queen Anne granted a patent for a mechanical writing machine to one Henry Mills in 1714, but no details of Mills or of his machine have survived.

An early French patent application deals with another mechanical writing machine and, at a later date, a certain W. A. Burt, of Detroit, U.S.A., took out an American patent for a writing machine in 1829.

Over Fifty Patents

Between the granting of Henry Mills' typewriter patent in 1714 and the invention of the first commercial typewriter in the latter half of the last century no fewer than fifty odd patents for mechanical writing machines can be traced. Some of these early and imperfect models have survived the passage of time. The majority of them, however, went little further than the "paper" stage, being sketched in a more or less fanciful manner by their enthusiastic and optimistic designers and remaining, for the most part, in that nebulous condition ever afterwards.

The modern typewriter is basically the invention of a couple of Americans, who, as it happened, whilst being mechanically inclined, were certainly not professional engineers, or even working and experienced mechanics. Latham Sholes was the principal inventor of the modern typewriter, his partner being Carlos Glidden.

A photograph of the first woman typist—Miss Sholes, daughter of the inventor taken in 1873. She is still living.

The world nowadays seldom hears the names of Sholes and Glidden, despite the fact that these two enthusiasts created between them a huge and a many-sided industry. Like many other inventors, Sholes and Glidden were of a retiring and over-modest disposition. They lacked that which we euphemistically term "push" and, the development and construction of a working typewriter being merely a hobby of theirs, they were content to leave the commercial exploitation of their wonder machine to other hands.

Latham Sholes

Latham Sholes was born at Milwaukee in 1819, whilst Carlos Glidden first entered into this world in 1834. Both men came of middle-class parentage, and both of them previous to their taking up of the problem of the typewriter, had made tolerable successes for themselves in their respective occupations.

Sholes was an editor and a printer in Milwaukee. He had developed a publishing business and, naturally enough, he experienced deep interest in all matters pertaining to type and to printing in general. Glidden, on the other hand, happened to be a lawyer. But, unlike many of his fraternity, he was gifted with a mechanical and a scientific type of mind and, in his earlier years, he had devoted a good deal of his spare time to the development of a mechanical plough for heavy agricultural use in America's "Middle West."

Sholes' Friendship with Glidden

How Sholes and Glidden first met we do not know. We are aware of the fact, however, that for several years before the first really successful typewriter was produced, the two men had allowed an acquaintance developing into a close friendship to grow up between them, for both individuals were similarly constituted and both found interest in each other's novel ideas.

Sholes seems to have been the first to hit upon the idea of the typewriter, and it was late in the winter of 1866 that he initially conveyed to Glidden his decision to attempt the building of a mechanical printing or writing machine.

Sholes' original idea had been to develop a mechanical *numbering* machine—a machine which would number serially the pages of a book or those of a bound volume such as an office ledger.

In Milwaukee at that period there lived a working mechanic, one S. W. Soule, by name, who was himself a bit of an inventor and to whom Sholes entrusted much of the actual working-out of his numbering machine designs.

Numbering Machine

Whether Sholes or his mechanic Soule actually produced the greater part of the numbering machine is difficult to say. The machine, however, turned out to be completely successful. It numbered the pages of a volume in perfect order. What is more, by means of a simple readjustment, it could also be made to letter the pages of a book —*A*, *B*, *C*, and so on.

And then, thought Sholes, if the machine will letter the corners of a book's pages, why should it not be made to print one letter after another letter and thus be coaxed into writing an actual word?

A few modifications of the machine were found to be necessary before it could do that, but ultimately Sholes was able to sit down at his machine and painstakingly print out a now historic line of lettering :—
C LATHAM SHOLES SEPTEMBER 1867

Both Sholes and his co-worker Glidden saw vaguely the possibilities inherent in a successful writing machine. Without being aware in detail of the many previous efforts which had been made to devise a writing machine, they seem to have been impelled by the success of the primitive numbering-lettering instrument to embark seriously upon the invention of a really practical writing machine, one which would enable a line of printed writing to be effected as easily as a line of handwritten characters is accomplished.

Lack of Funds

Unfortunately, however, a very needful factor to the success of their endeavours was lacking—funds.

Glidden, the lawyer, happened to know a successful oil magnate, James Densmore by name, and it was to this James Densmore that one of the world's first typewritten letters was dispatched. It was a missive soliciting financial support from Densmore for the projected writing machine and promising him, in return, a quarter interest in the invention.

Densmore was in a good mood when he received the novel communication and he replied favourably to the extent of 600 dollars. As a result of this financial backing, Sholes and his lawyer companion set to work in great earnest to construct the machine which they had in mind. They made no fewer than 30 separate models, each one more advanced than its predecessor, until, at last, a successfully working machine was obtained. This was patented on July 14th, 1868, in the names of Sholes and Glidden, the patent being issued for a "mechanical writing machine or typewriter."

The Sholes and Glidden typewriter was publicly exhibited in New York City, but it attracted but slight interest. Densmore, its financial backer, however, had decided in his own mind that there existed vast possibilities in the new machine. It was thus that he was given *carte blanch* in the exploitation of the patent by the less commercially minded Sholes and Glidden, and, after some consideration, he decided to offer the new invention to the firm of E. Remington & Sons, of Ilion, New York, a concern which had numerous mechanical facilities, producing, as it did, various articles ranging from firearms to sewing machines and agricultural machinery.

Enter Yost

Sholes jibbed at the idea of personally confronting the Remington concern with his new creation. He was far too modest to perform upon his own trumpet in the required and necessary manner and thereby to vociferate the virtues of his typewriter. Instead, he sent with Densmore one George Washington Yost, a young man whose name was afterwards to become famous as a typewriter manufacturer, to press the claims of the new machine.

Yost and Densmore were eminently successful in their task. Philo Remington, a director of E. Remington & Sons, became vitally interested in the typewriter proposition and, buying the main patent from Sholes and Glidden, the Remington concern lost no time in beginning the commercial exploitation of typewriters early in 1873.

Remington "No. 1" model

The Remington No. 1 model—the direct commercial consequence of Sholes and Glidden's master-patent—was exhibited at the Philadelphia Centennial Exposition in 1876. At that exhibition visitors paid a few cents apiece to have a short message typewritten upon a sheet of paper. Needless to say, the world's first commercial typewriter did not produce exceptionally neat-looking work. In one form, it was mounted upon a sewing machine stand and the carriage return of the typewriter was operated by means of a foot treadle. Again, the machine only wrote capital letters. The alignment of the letters was also not good and the inking mechanism was very imperfect. One letter, for instance, would be considerably over-inked, whilst the immediately succeeding one would only be faintly impressed upon the paper, the whole of the typescript thereby being given an uneven and blotchy appearance.

The Remington No. 1 had a double keyboard, but two years later the shift-key mechanism was invented, thereby making it possible to write capital and small letters with the one set of keys.

Sholes Retires

At this stage, however, we must leave the development of the typewriter, since Sholes and Glidden, having given it to the world, had practically nothing to do with it. Glidden died in 1877—the year after the appearance of the Remington No. 1 typewriter—and Sholes appears to have retired into voluntary obscurity. Little, indeed, is heard again of any activities of his. In 1890, his death was announced in the American papers, but no notice was taken of his demise at the time.

There seems to be little doubt that it was Sholes who had the major share in the typewriter's creation. Glidden, whilst being an amateur mechanic of considerable ability, prided himself more upon his legal and administrative experience and, as we have seen, it was he who first interested James Densmore, the oil magnate and, through the latter, the firm of E. Remington and Sons, in the possibilities of the typewriter.

"No. 1" Remington typewriter, of 1876, on a sewing machine stand

Not Greatly Successful

From a purely commercial standpoint, the first typewriter was not greatly successful. The typewriters were marketed at a necessarily high price and their appeal was made chiefly to literary men, lawyers, clergymen, and other professional workers, all of which regarded the machine with great suspicion and as being unworthy of their attainments. The idea of the typewriter entering the business world seems only to have occurred at a considerably later date.

World's First Typist

It was found very early on that typewriting was an occupation exceptionally well adapted to female workers. "Female type-writers"—the expression is a quaint one to modern ears—were, however, unobtainable when the first of the Remington No. 1 machines were marketed.

The world's first typist was Miss Sholes, the daughter of the typewriter's inventor. She trained other women in the new art of mechanical writing and, gradually, typewriting schools came into an active existence in order to supply the numbers of typists which were subsequently required after the typewriter "made good" in the American business world.

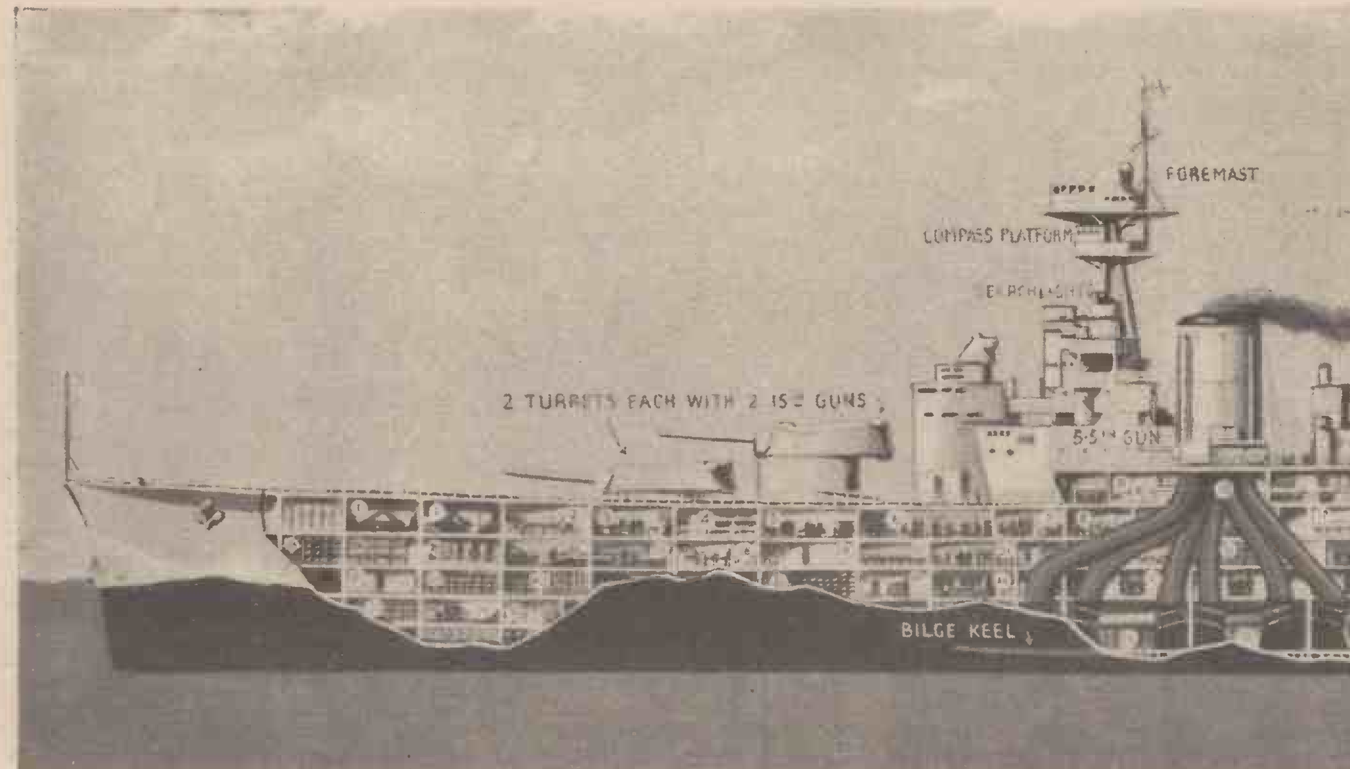
Small and Capital Letters

Unfortunately, Sholes' death in 1890 precluded him from witnessing the rapid increase in popularity which came upon his invention at about the turn of the present century. Latham Sholes, however, lived to see several improvements effected to his original machine, the most notable of which was the introduction of both small and capital letters on the one machine.

Typewriter refinements, however, such as we see nowadays came long after Sholes' time. That pioneer, could he revisit the scenes of his lifetime, might now be genuinely astonished to witness the operation of the tele-typewriter and other up-to-date mechanical writing instruments, but, nevertheless, it would surely impart to him a thrill of pleasure and of legitimate pride to observe that nearly all of these modern and highly ingenious writing machines are fundamentally based upon the principle of that first crudely built and laboriously working instrument upon which he once spelled with so much concentrated care and attention the legend :—

C LATHAM SHOLES SEPTEMBER 1867

One of the first Remington typewriters to be used in England. The "No. 1" model of 1877-8



The Welding Of

By S. M. REISSER, B.Sc. (Eng.), A.M.Inst.C.E., A.M

(Concluded From Last Month's Is

A Brief Review of the History of In Naval Construction

THE construction of destroyers is another instance where the employment of the arc process has been incorporated to a large extent even as far back as 1935, during the building of the "F" class. The welded assembly of such important parts as, for instance, bulkheads is now standard practice.

During this time the development of "D" quality steel welding has been proceeding satisfactorily and had its first practical application in the welding of the forepart of the "D" steel hull of the 5,270 ton cruiser H.M.S. *Penelope*, which was launched from Messrs. Harland and Wolff's Belfast yard in 1935.

H.M.S. "Ark Royal"

The launching in April, 1937, of the 22,000 ton aircraft carrier H.M.S. *Ark Royal*, from the Birkenhead yard of Messrs. Cammell Laird & Co., Ltd., 65 per cent. of whose structure of welded construction marked a further stage in the progress towards the all-welded warship, which was finally realised in this country with the launching in July, 1938, at the Devonport Dockyard, of the 815 ton mine-sweeper, H.M.S. *Seagull*. Both these vessels have been described in detail at last year's Spring Meeting of the Institution of Naval Architects, but it may be noted in passing that both ships lived up to expectaions and that, in addition, H.M.S. *Seagull* showed a saving in weight of some 10 per cent. over her riveted counterpart H.M.S. *Leda*, which was built at the same time.

American Cruisers

The particulars of present-day construction must, of course, remain secret, but it is understood that the King George V (35,000 tons) class battleships are partially welded, and it may be mentioned that all new additions to the British Navy likewise incorporate the use of the process to a greater or lesser degree.

In the United States, the beginning of the same period was marked by the extension of welding to large structural members, such as bulkheads, important fittings and piping of the first two treaty cruisers, *Pensacola* (9,100 tons) and *Salt Lake City* (9,100 tons), which were launched in 1929. Since then the progress has been continuous and it has been announced that some 35 per cent. of the structure of the 35,000 ton battleship *Washington* laid down in the New York Navy Yard, Brooklyn, in 1937, is of welded construction, which, in a ship of this displacement, should amount to a marked increase in either offensive or protective armament.

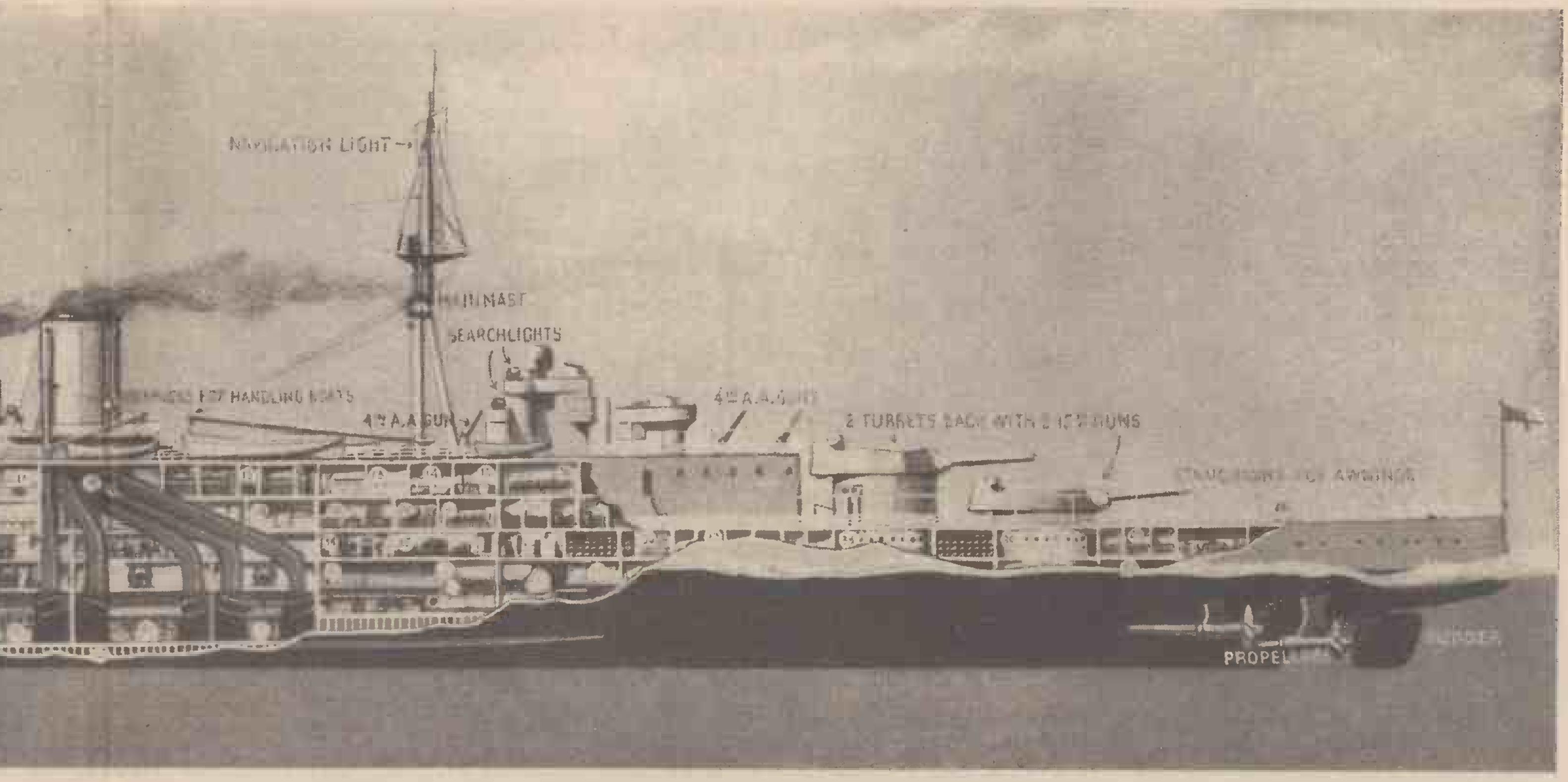
In Germany, as previously mentioned, the extensive use of welding in naval work had already been standard practice for some years, and the arc welding process continued to play a major part in the construction of the remainder of the new German Navy during the succeeding period, a fact significant in itself, the principal ships launched up to 1939 being the 6,000 ton cruiser *Nürnberg* in December, 1934, the 26,000 ton battleships *Scharnhorst* and *Gneisenau* in October and December, 1936 respectively, the 10,000 ton cruisers *Admiral Hipper* and *Blücher* in February and June, 1937 respectively, and the cruiser *Prinz Eugen* in August, 1938. Because of these achievements and in spite of the lack of specific information with regard to U-boat construction, it may be assumed that these craft likewise incorporate a considerable amount of welding, especially in view of the progress made in this direction by the British Navy, whose development of welding in the construction of surface ships is still behind that of the Germans from the quantity point of view.

French Cruisers

With regard to the other countries, the available detailed information appears to be somewhat scanty, but it is known that, as a result of its application to the construction of a number of destroyers for some years previously, the arc welding process was used extensively on the French 9,380 ton cruiser *Dupleix*, launched in 1932, as well as on the Japanese minelayer *Yaeyama*, which was launched in 1931. In view of the progress since made in welding research generally and in its applications to British, American and German warships in particular, as well as to merchant shipping in most countries, there appears to be no doubt that the use of the process has since been extended also both in France and Japan, and that most other navies are following in the same direction.

Advantages of Welded Ship Construction

A full discussion of the pros and cons of welding in general is outside the scope of the present article, and those interested in this subject are referred to the numerous



Warships

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Welding

papers and articles in connection with the applications of welding to this type of work, the particulars of a number of which will be found in the March-April issue of "The Welder." It may, however, be of interest to note that one of its chief advantages in warship construction is the resultant saving in weight, which enables a welded ship of a given capacity to carry a heavier offensive and/or defensive armament as compared with its riveted counterpart. Typical German figures, quoted as far back as 1933, were of the order of 8 to 10 per cent. for the whole ship, whilst the figure for H.M.S. *Seagull*, in spite of certain limitations which had an adverse effect in this connection, also amounted to some 10 per cent. so that it would appear that even greater savings can be effected to-day in vessels especially designed for welding.

Accidents to Welded Ships

The advantages of welded construction, however, would be of a purely theoretical nature if the welded seams were incapable of standing up at least as well as the joints of riveted construction to the very severe stresses set up in the course of normal service conditions of a warship by (1) heavy seas, (2) the firing of salvos, and (3) damage by enemy action.

With regard to the forces set up by heavy seas, it has already been pointed out that the welded warship has been in existence for a number of years, and it is inconceivable that the applications of the welding process should have been continued and extended had it been found to be incapable of resisting the stresses set up. Furthermore, in this particular instance, the experience obtained in welded merchant shipping is likewise of value, since the forces to be resisted by both types of vessel are of a similar nature; nor is there any evidence to cast the least aspersion on the suitability of the process for the building of ships properly designed and constructed with reasonable care and of suitable materials. On the contrary, however, there have been cases where all-welded trawlers have been washed ashore and suffered severe denting of the shell plating without any effect on the water-tightness of the hull—a very different picture from that presented by similar accidents to riveted trawlers.

Severe Trials

In the same way it is inconceivable that the very severe trials preceding the acceptance of a vessel, and including the firing of broadsides, should have failed to reveal any deficiencies in the welding due to this latter cause; and it should also be noted that at least one of the German pocket battleships took part in the bombardment of Almeria during the Spanish Civil War, which, no doubt, afforded an extra opportunity of observing the behaviour of the welds during gunfire on active service, and that the use of welding in German naval construction was not interrupted as a result of this engagement.

Finally, the Spanish Civil War was likewise responsible for the first demonstration of the effect upon the welding of damage due to enemy action. A full description of the damage sustained by H.M.S. *Hunter* as a result of striking a mine off the Spanish coast in May, 1937, was the subject of a paper by Mr. Stanley, R.C.N.C., containing the following passage, which requires no further comment :

" An interesting feature of this accident is that it illustrates the behaviour of welding under explosive force. Much has been

WORLD'S LARGEST BATTLESHIP

WITH a displacement of 42,100 tons, an overall length of 860 ft. 7 in. and a beam of 105 ft. 2½ in., the "Hood" is the largest battleship in the world. Her armament consists of eight 15-in. guns, twelve 5.5-in. guns, eight 4-in. A.A. guns, four 3-pounder guns, five machine guns and 10 Lewis guns. She also carries multi-machine guns and 21-in. torpedo tubes. This diagram-picture shows you the complex interior of this mighty ship. Here is the key to the numbers seen on the diagram:

1. *Capstan.*
2. *Operating theatre.*
3. *Men's reading room.*
4. *Sick bay.*
5. *P.O.'s reading room.*
6. *Petty Officers' mess.*
7. *Marines' mess.*
8. *Barber.*
9. *Bakery.*
10. *Uptakes.*
11. *Kitchen.*
12. *Cabins.*
13. *Lobby.*
14. *Bathrooms.*
15. *Pantry.*
16. *Dining-room.*
17. *Seamen's washrooms.*
18. *Stewards.*

19 *and* 20. *Captain's cabins.*

21. *Ward room.*
22. *Cabins.*

23 *and* 24. *Stores.*

25. *Detention quarters.*
26. *Carpenters' workshop.*
27. *Artificers' workshop.*
28. *Medical distribution room.*
29. *Lobby.*
30. *Marines' washplace.*
31. *Marines' reading room.*
32. *Stores.*
33. *Fan.*
34. *Engineers' office.*
35. *Boat-handling gear.*
36. *Wireless office.*
37. *Cabins (officers').*

38 *and* 39. *Trunk of turrets.*

40. *Officers' cabins.*

41 *and* 42. *Fresh-water tanks.*

43. *Provisions.*
44. *Launderer's store.*
45. *Gyro compass.*
46. *Switch room.*

47 *and* 48. *Fans.*

49. *Engine rooms.*
50. *Turbines.*
51. *Lift.*
52. *Capstan motor.*
53. *Carpenters' store.*
54. *Dynamo.*
55. *Stores.*
56. *Boiler rooms.*
57. *Double bottom.*

H.M.S. Renown.

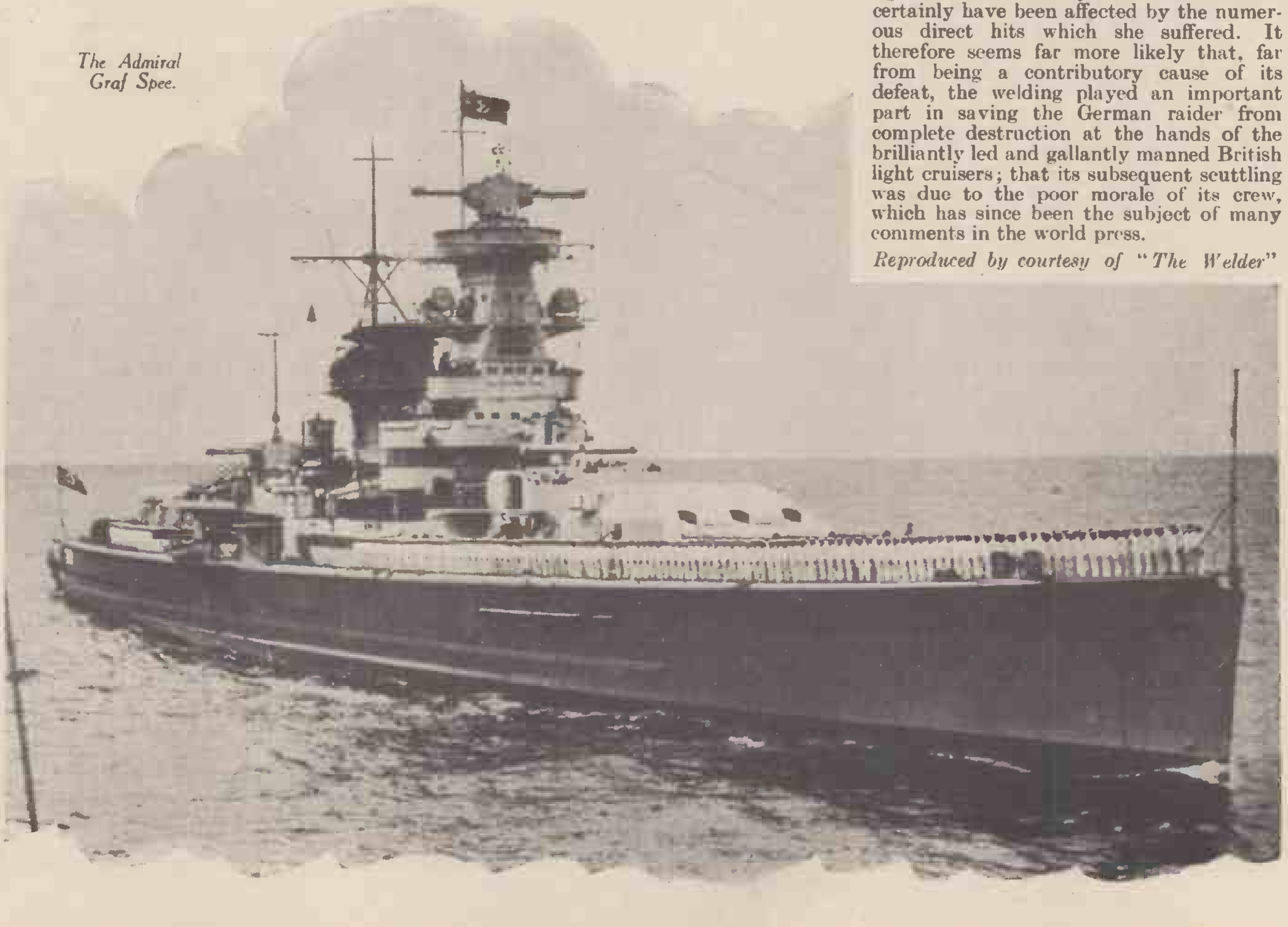
written and said of the strength of welding under various tests, but here is a larger structure under the most searching test of all, and it is satisfactory to note that the welding stood up well, particularly on the bulkheads, which are of thin mild steel, and where the welding in many places had to withstand severe crumpling."

A considerable proportion of the German fleet is already accounted for, but there is no evidence that this is due to the adoption of welding in its construction; and the fact that *Scharnhorst* managed to get away—to fight, or, more probably, scuttle herself on another day—although seriously damaged by the 15 in. guns of H.M.S. *Renown*, would appear to be a pointer in the opposite direction.

Similarly, in spite of severe damage, the *Admiral Graf Spee* managed to elude its pursuers, and the appearance of the damage itself does not seem to reflect unfavourably on the welding. In this connection it must be borne in mind that the use for welding of unsuitable materials or wrong procedure may result in failure, which, however, cannot then be regarded as a condemnation of welding; but, in the absence of definite particulars, any such suggestions with regard to the *Graf Spee* would appear to be ill founded in view of the fact that the vessel was apparently ready for sea in the course of a few days, an achievement which in itself could hardly have been accomplished in the case of a riveted hull, the watertightness of whose joints would almost certainly have been affected by the numerous direct hits which she suffered. It therefore seems far more likely that, far from being a contributory cause of its defeat, the welding played an important part in saving the German raider from complete destruction at the hands of the brilliantly led and gallantly manned British light cruisers; that its subsequent scuttling was due to the poor morale of its crew, which has since been the subject of many comments in the world press.

Reproduced by courtesy of "The Welder"

The Admiral Graf Spee.



Eccentric Turning

A Device for Use in Repetition Work

IN some forms of repetition work it often happens that a piece has to be turned having one part eccentric with the other. This can be done, of course, by chucking in the three-jaw chuck and turning the biggest of the two eccentric ends and then re-chucking by this turned part, so that the piece runs eccentrically by the required amount.

This re-chucking can be done in the three-jaw chuck by packing under one jaw. In some cases, where the amount of eccentricity required is suitable, it can be done by withdrawing one jaw of the chuck and replacing it one thread of the scroll (which advances the jaws towards or away from each other) backward or forward as the occasion demands. But in all cases packing will be necessary, and packing is a rather indefinite procedure where accurate repetition work is concerned.

Re-Mounting the Chuck

When this work is to be done in quantities the proper way is to re-mount the chuck so that the chuck itself can be adjustede eccentrically to the lathe mandrel axis while still keeping the chuck axis, in any condition or amount of eccentric adjustment, parallel with the lathe mandrel axis. A rig for accomplishing this is shown in the accompanying drawings.

The back plate of the chuck is removed and a new base plate is made to fit the lathe mandrel nose. It is shown at A in Figs. 1 and 3. Fig. 2 is a front view of the completed job. This back plate is not circular but oblong in shape, with concentric rounded ends. It is shown in Fig. 3 in front view. It has the rear boss bored and screw-cut exactly like the old chuck back plate, but it does not hold the chuck. Across its face is a steel strip B, extending its whole length and centrally disposed. This strip B is quite parallel and is held to the face of the back plate A by the countersunk screws shown and located by the two dowels at C.

The dowels are fitted first, driven through reamered holes in both back plate and steel strip and then the holes D for the 3/16 in. countersunk screws are drilled, tapped in the back plate and cleared of threads in the steel strip and the latter is screwed up to the elongated back plate.

A wooden pattern is made for this back plate and it is chucked on the face plate, bored, screw-cut and cleared and faced to fit the mandrel nose. It is then screwed on the lathe mandrel, its flat front faced off or surfaced dead flat, and its ends turned concentric with its centre. Then the steel strip, which should be 3/16 in. thick and about 1 in. wide, (according to the size of the chuck) is dowelled and screwed as described.

A Back Plate for the Chuck

A back plate E for the chuck of the same size and shape (shown in Figs. 1 and 4) is then turned from 1/2-in. thick metal to fit the chuck. But the chuck is not yet fitted to it. Across its back are fitted the 3/16 in. steel strips F in exactly the same way as the strip on the new back plate which screws on the lathe mandrel nose. They are at a distance apart to fit exactly above and below the single central strip on the new mandrel nose back plate, Fig. 3, so that the new chuck plate, Fig 4, can slide along the new mandrel back plate A.

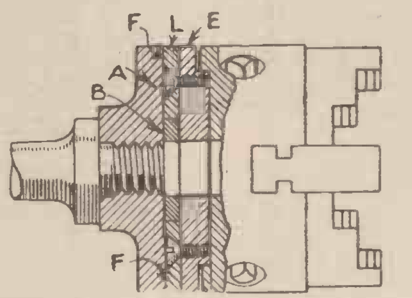
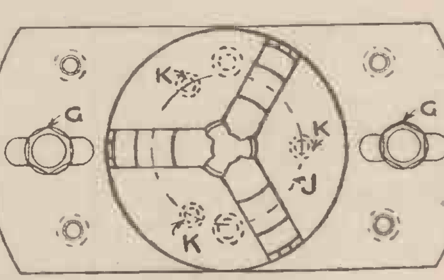


Fig. 1.—The back plate of the chuck is removed and a new base plate (A) is made to fit the lathe mandrel nose

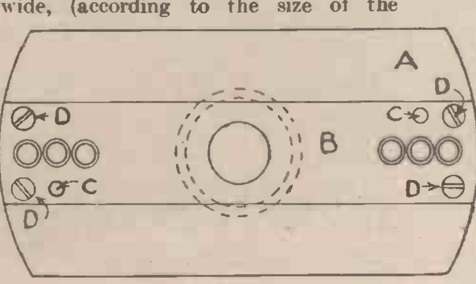
The new chuck plate, Fig. 4, is elongated like the new mandrel plate and the same shape. It has a slot each end; the centre line of these two slots crossing its axis. These slots are 3/8 in. wide to clear 3/8 in. set screws. The mandrel back plate has three tapped 3/8 in. holes each side into which the set screws G screw through the slots in the front plate, i.e. the chuck back plate. Thus the front plate can be slid along the back plate and clamped by the two set screws in any position. These screws and slots are also shown in the front view, Fig. 2.

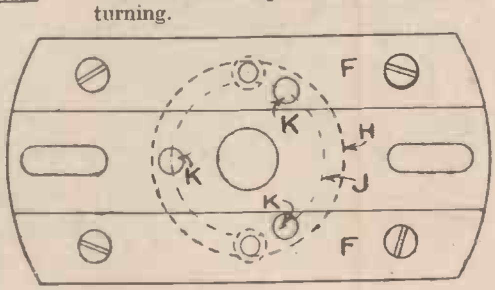
Facing Up the Plates

This is then rigged up, so that the two back plates coincide, and screwed on the lathe mandrel. The front plate is then faced up, and screwed to the back plate by the two set screws, which will pass through the slot and through the central line of the long strip on the mandrel back plate. It will thus form a solid piece.



Figs. 2 and 4.—Details of the new base plate





The face of the plate is now surfaced so far as it can be without the tool catching the set screws. The latter should be in the outer of the three holes each side, and an upstanding central part, shown dotted at H. Fig. 4, is left standing 1/16 in. higher than the rest of the surface, and of a diameter to register dead true with the fitting recess in the back of the chuck. It is shown at H in Figs. 1 and 4. Then the set screws are removed and placed close to the inner ends of the slots and bolted up. This makes it possible to face up the remaining end surfaces of the chuck plate to the same surface as that already dealt with.

It will be necessary to bore and tap these holes for the studs in the mandrel back plate each side. While all is still on the mandrel. scribe a circle equal to the circle of the three screw hole centres in the chuck, and on this mark off three equal dimensions to get the centres for the screws through the back of the chuck back plate. These holes, K in Figs. 2 and 4, are of a diameter to take the chuck-holding screws a little loosely. The chuck will be located by the raised flange H (Figs. 1 and 4) on the face of the back plate, and these screws should clear the holes all round to prevent them from drawing the chuck to one side out of truth.

The screws will have countersunk heads. and will be recessed in countersinks in the back of the new chuck back plate. One of them is shown in Fig. 1, in the side view.

In this way is provided a means of sliding the chuck across the mandrel axis to any amount required (within the limits of the slots and the two screw holes central in the mandrel plate) and the slots in the front plate will allow the chuck to be offset for eccentric turning.

Position Marks

In the front view the set screws are shown in the central position in the slots. and all is concentric. The two inner and outer holes, which were used for facing the whole of the front plate and chuck plate surface, are not now used. In use only the central screw hole is used each side for the set screw through the slot.

Before moving one plate laterally along the other, and while still on the lathe mandrel nose, it is advisable to file the edges of both plates flush with each other at L, Fig. 1, and polish a small surface on one edge at the middle. On this surface, using a square on the face of the plate, scribe a fine deep line. This will give the position of dead concentricity of the chuck to the lathe mandrel, so that after being adjusted for eccentric turning it can be easily returned to the dead central position for concentric turning.

"PRACTICAL MECHANICS" WIRELESS SUPPLEMENT

A Stand-By Receiver

A Simple Single-Valve Receiver For Stand-By Or Regular Use—Low In Cost And Simple To Operate

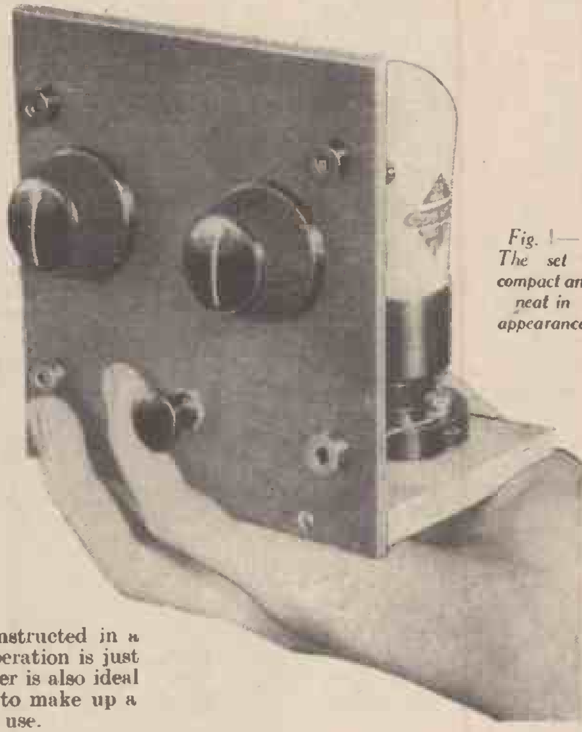


Fig. 1—The set is compact and neat in appearance.

THE readjustment of broadcasting in this country, has made the use of many multi-valve receivers unnecessary. There are also many listeners who now require to listen to the Home Service or Forces Programmes in order to obtain the news bulletins or special announcements, and who previously have not made use of a broadcast receiver. A simple one-valve receiver is, therefore, quite a valuable piece of apparatus at the present time, and many requests have already been received for a set on these lines.

We have therefore produced a simple single-valver, which may be built from odd parts which you may have on hand or which may be obtained quite cheaply, either from standard firms or from surplus stores. As will be seen from the accompanying illustrations, the set has been compressed into the smallest possible compass, the baseboard measuring only 5 in. by 3 in., and the panel 5 in. square.

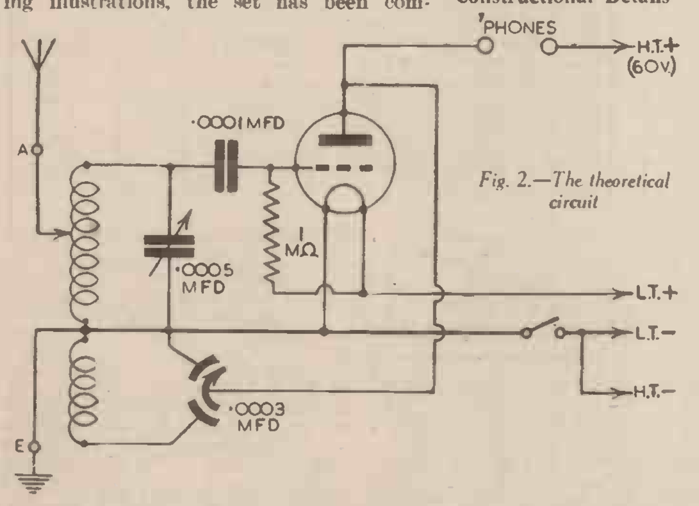


Fig. 2.—The theoretical circuit

Circuit Details

It may thus be placed in a small box and stored away in an odd corner of the dug-out or air-raid shelter so that special announcements may be followed during an air-raid, or for the reproduction of any music which may be broadcast at the time. It may also be used as a stand-by receiver in the home, and will, with the necessary batteries, only take up a very small amount of space. The coil is designed for medium-waves only, and may be home-made or obtained from Messrs. T. W. Thompson by whom it is manufactured. It consists of a tapped grid coil with over-wound reaction winding, and provides adequate selectivity and sensitivity for the purpose for which it is used. The standard gridleak and condenser arrangement is employed, with a differential reaction condenser control. This condenser, together with the tuning condenser are of the solid-dielectric type, and these are obtainable from Messrs. Polar, Bulgin, J. B. or similar firms. An on/off switch is placed centrally on the panel, and aerial and earth and 'phone connections are made by means of standard Clix plugs and sockets.

It will thus be seen that components are reduced to a minimum and accordingly the entire receiver may be constructed in a very short space of time. Operation is just as simple and thus the receiver is also ideal for the beginner who wishes to make up a one-valve receiver for general use.

Constructional Details

The baseboard is cut 5 in. by 3 in. from any ordinary stout wood or ply, a thickness of $\frac{3}{8}$ in. or $\frac{1}{2}$ in. being desirable to enable the front panel to be held firmly by screws driven into the edge of the baseboard. The panel, on the other hand, may be cut from the thinnest plywood, and is, as already mentioned, a square—5 in. by 5 in. The holes for condensers, switch and sockets are drilled as indicated in the wiring diagram, and these parts may then be mounted and locked into position. The coil is attached to the baseboard by passing a screw through the cross-strip inserted at the lower end of the coil, and the valve-holder is then placed next to it. The fixed condenser is attached to the grid terminal of the valve-holder, and the grid leak is joined across the grid and positive filament terminals. The remainder of the wiring may be seen from the wiring diagram, and the battery leads are, of course, cut from ordinary single flex, obtainable from the local stores. Four wander plugs are attached to the ends of the flex as indicated in the wiring diagram and when wiring is complete the receiver is ready for test.

The set will operate even with a simple indoor aerial of quite small dimensions, but obviously the performance depends upon the locality and the strength of the signals which are available at the listening point. On the other hand, quite a large aerial may be used without any serious difficulty from the selectivity point of view being experienced.

The Rating Details

For the L.T. quite a small 2-volt accumulator may be used as the total consumption is only .1 of an amp. For the H.T. 60 volts is adequate and provides perfectly smooth reaction, so that a small 60 or 66 volt H.T. battery is suitable. The headphones should be of the high-resistance type—2,000 or 4,000 ohms and should always be inserted into the sockets in the same relative position—keeping the "positive" tag of the phones (usually marked by a red thread running through the cotton covering or by some similar means), in the red or lower phone socket. Connect aerial and earth and pull out the switch. The receiver is then ready for tuning and the best plan is to rotate the right-hand control slightly until a "breathing" sound is heard in the 'phones and then to turn the left-hand control until a station is heard. The right-

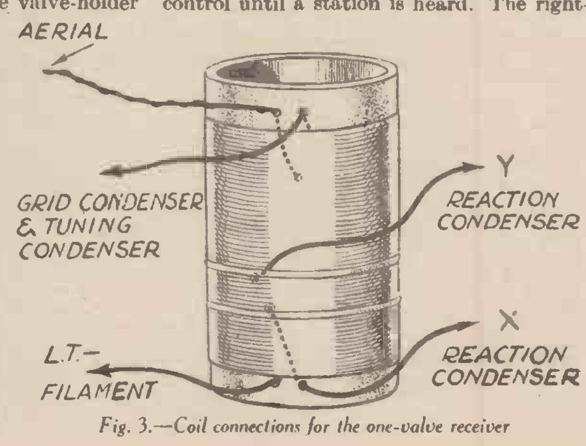


Fig. 3.—Coil connections for the one-valve receiver

hand control strengthens signals, but also increases selectivity so that until the station is exactly tuned in, it may be found that signal strength appears to weaken as the right-hand control is rotated. A readjustment of the tuning control will, however, result in the desired increase in volume and at the same time an improvement in quality, as maximum quality is only obtained when the circuit is exactly tuned to the frequency of the signal being received. If the receiver is used in a position where signals are too loud, even with reaction at minimum, the best way of reducing the signal strength is to lower the value of H.T. applied, going down to 15 volts if necessary. This will not have any deleterious effect on the valve or any other components, but if the low voltage is used very frequently that part of the H.T. battery will become discharged quicker than the rest of the battery, and then when an increase in voltage is required some difficulty may be experienced due to the increased resistance of the lower section of the battery. Beyond this, there are no special precautions to be observed and the receiver may be used with the utmost confidence.

Coil Construction Data

As already mentioned, the coil can be purchased ready wound but, for the benefit of those who would rather experience the thrill of making as much of the receiver as possible, we give below the essential details of its construction. The former is 1⅜ in. in diameter and 2½ in. long., and should be made from a piece of ordinary postal cardboard tubing or, better still, a length of paxolin tubing if such is available. If cardboard is used, it is absolutely essential to see that it is perfectly dry, in fact, it is advisable to impregnate the tube after drying it in a slow oven for a few minutes. Ordinary shellac may be used for the impregnation.

The actual winding is carried out with 22 gauge enamel wire winding this with 70 turns close wound, that is, each turn lying close up to its neighbour. After 23 turns have been put on, a tapping loop has to be made for the aerial and this is accomplished by doubling a length of the wire and pushing it through a hole in the former. It must be kept taut whilst the rest of the coil is wound. After the winding has been finished a length of paper or Empire Tape ½ in. wide should be wrapped round the lower end of the winding, its position being about ½ in. from the lower end of the coil. On this insulator 20 turns of the 34 S.W.G. enamel wire are wound, and these must be in the same direction as the first winding. One way of anchoring the ends of this additional winding is by means of sealing wax or Chatterton's Compound, whilst another way is to pierce holes through the former, between the turns of the first winding. In this case great care must be taken not to scrape off the insulation where the wires cross. The overwound winding is for reaction, and the tapping on the main winding is the aerial connection, and the relative connecting points of these ends is shown in the diagram Fig. 3. The coil is mounted on the baseboard by means of a 1 in. strip of wood screwed inside the lower end of the coil former. The ends should be rounded and screws passed through the coil former to attach the wood firmly.

WIRING DIAGRAM OF THE A.R.P. ONE

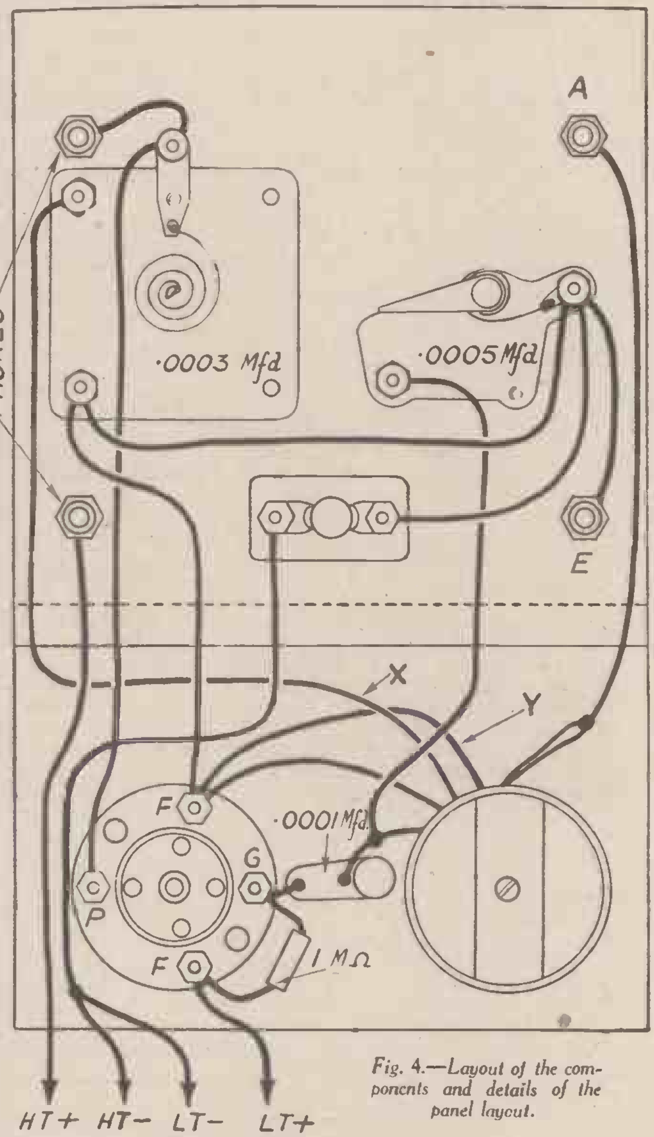


Fig. 4.—Layout of the components and details of the panel layout.

Helicopters Here Again

Remarkable Experiments with a new-type Helicopter

AN aircraft that will rise straight from the ground, that will hover like a hawk, and descend steeply but safely to earth has long been the dream of inventors. A century before the secret of level flight was found, a helicopter, or vertical flying machine, had been designed—if not flown—by an Englishman, Sir George Cayley.

Success with "rotating wing" aircraft seemed often to be near achievement. But whilst the fixed wing aircraft made gigantic progress, the compleat helicopter remained a dream.

Now from America comes news of some remarkable experiments with a new-type helicopter, the invention of the veteran Russian aeronaut, Igor Sikorsky. It is called the V.S.-300.

Theory

The theory underlying the helicopter proper is quite different from that which governs the flight of ordinary fixed-wing aeroplanes. These derive "lift," or suspension in the air, from their forward movement through the air. Hence the need for a tractor airscrew or a pushing propeller. But the helicopter hangs on an overhead revolving screw or set of wings, like a parachutist on his 'chute. Lift, independent of forward speed, is the principle aimed at. Forward, sideways, or for that matter backward movement, is theoretically possible by varying the inclination of the rotor. A variant of the helicopter, the gyroplane or autogiro, invented by the Spaniard de la Cierva, combined the principle of forward traction with suspension from an overhead rotor. Although not a true helicopter it has similar features in an extremely wide speed range, a short run for take-off, and a steep descent. Unlike previous helicopters—it flew!

An autogiro was successfully used by the Air Component of the B.E.F. mainly for the transport of Army Staff officers on inspections of new positions and camouflage for which "hovering" flight was particularly suitable.

Control in the Air

In all the experiments made with helicopters, control in the air has been the biggest single problem. Modern petrol motors and high-duty light metals have largely solved the difficulties of power and weight. But, being designed to fly independently of a constant forward movement through the air, ordinary rudders and ailerons cannot be employed.

Sikorsky's latest model employs a series of airscrews at the points where, on normal aircraft, flying control surfaces are found. Besides the large overhead rotor which provides lift and forward movement, smaller ones mounted on the tail exert pressure corresponding to rudder and elevator movements. If this new idea should prove capable of successful development, it may perhaps mean as much to practical flying as did the historic flight of the Wright Brothers at Kitty Hawk nearly forty years ago.

A NEW SERIES

The Story of Chemical Discovery

No. 2—The Elixir of Life and the Philosopher's Stone

An alchemical laboratory, as reproduced in the museum at Munich.

THE Age of the Alchemists, if we may so characterise the long period during which the quest for rudimentary chemical knowledge remained more or less in the hands of pseudo-mystics, imposters, charlatans, adventurers, would-be gold makers and stupid theorisers generally, lasted from Egyptian times right up to the beginning of the eighteenth century, to the days of Robert Boyle, the "Father of Chemistry," whose commonsense investigations and, particularly, whose method of scientific attack upon a problem revolutionised chemical thought and brought in its train a host of discoveries which banished for ever the nonsensical jibberings of centuries of alchemists or "adepts," as many of them preferred to style themselves.

Wrapt in Mystery

Alchemy was at one time regarded as the "Sacred Art," the "Divine Science" or the "Occult Science" because its few practitioners wrapped their meandering mixing operations in an atmosphere of the greatest possible mystery. It was also termed at times the "Art of Hermes" or the "Hermetical Art," in consequence of the fact that the "adepts" of the various centuries of alchemical mysticism claimed a certain Hermes Trismegistus, an Egyptian, as the originator of their system of experiment. Whether this celebrated Hermes ever existed or not is a moot point. Nevertheless, it was reputed that Hermes left a vital manuscript, known to the alchemists, as the "Emerald Table," in which he noted down all the reputed secrets of his "Art" and, in particular, the secret of making gold out of base metals.

To prepare gold, the alchemist is directed by Hermes to "catch the flying bird" (by which is implied quicksilver or mercury) and to "drown it so that it may fly no more." In the subsequent centuries this latter process came to be termed the *fixation* of mercury, or in modern language, its alloying with gold. Mercury, as we know well nowadays, readily alloys with gold. Hence, by this process a small quantity of gold could be increased considerably in weight by the simple process of combining it with a maximum amount of mercury. Thus was mercury (and possibly lead) changed into gold !

Utter Nonsense

The *Emerald Table of Hermes* which the alchemists religiously followed and pondered over for centuries comprised a veritable mine of utter nonsense. Here, for instance, is one paragraph from it, selected almost at random :—

"True, without error, certain and most true ; that which is above is as that which is below, and that which is below as that which is above, for performing the miracles of the *One Thing*; and as all things were from one, by the mediation of one, so all things arose from this one thing by adaptation ; the father of it is the Sun, the mother of it is the Moon, the wind carried it in its belly, the nurse of it is the Earth. This is the father of all perfection, the consummation of the whole worth."

It is true that there has existed a few individuals whose lives seem to prove that they followed the alchemical art with almost the fervour and the sincerity of a religious vocation, but, as a general rule, as we have already mentioned, the alchemists were characterised by a mass stupidity which was almost blatant and which stamped the majority of them as skilled performers in the role of professional charlatan.

For all that, however, the alchemists did at times make discoveries, and, occasionally, highly important discoveries in the chemical arts.

The first alchemist of whom we have any really clear record is Geber, an Arabian philosopher of the eighth century, whose real name (shortened afterwards to *Djafar*) was Abu Musa Dschabir Ben Haijan Ben Abdallah el-Sufi el-Tarsusi Kufi. Geber, to a certain extent, was a man born before his time. He left a good deal of chemical writings and it would appear that he discovered, or, at least first clearly recognised, green vitriol (sulphate of iron), corrosive sublimate (mercuric chloride), saltpetre (potassium nitrate) and other equally important compounds.

Geber's Theory of Elements

Geber, too, had his own theory of elements. According to his views, all metals are composed of the same fundamental thing or substance, but the majority of them are contaminated with impurities. Gold was the only pure metal. Rid the impurities from the other metals, and the latter will automatically turn into gold. As Geber quaintly puts it : "Bring me six lepers that I may heal them"—the six lepers being the six imperfect metals known in his time.

All metals, said Geber, contain sulphur and mercury. Mercury was the metallising agent, sulphur the non-metallising agent. Gold and silver were supposed to contain an extremely pure form of mercury, combined, in gold, with a red variety of sulphur, and, in silver, with a white variety of that substance. You have, therefore, merely to find a method of varying the proportions of sulphur and mercury in metals in order to change one metal into another and all metals into gold.

The Philosopher's Stone

And so, in the course of time, we find evolving the notion of what came to be termed the *Philosopher's Stone*, which material was commonly supposed to consist of a brown powder having the property of being able to change base metals into the purest gold. Nearly all the alchemists in their rambling treatises, describe the Philosopher's Stone. Some say that it will change metals into gold merely at a touch. Others aver that it must be melted with the base metal to the accompaniment of a definite alchemical ritual, whilst still other alchemical "adepts" state that the Philosopher's Stone is a mysterious entity compounded of fire, water, air and earth.

Another aim of the alchemists, particularly of the medieval practitioners, was the discovery of the *Elixir of Life*, a "most subtle fluid" which, when found, would possess the property of conferring perpetual bodily life and continual good health upon the individual who consumed it. The search for the Elixir of Life at one time went on with great determination. Countless obscure alchemical adepts in their hidden recesses and secret "elaboratories," compounded and mixed, distilled, fired, extracted, retorted, calcined and engaged upon other devious alchemical operations in their endeavours to hit upon the secret of the Elixir of Life or the Philosopher's Stone.

According to the current instructions of the time, the Elixir of Life could not be prepared by the same method as the Philosopher's Stone. But when neither of these wonderful and long searched for entities were forthcoming in actual substance, the notion began to gain ground that, in reality the Elixir of Life and the Philosopher's Stone were one and the same thing and that, when found, the "Stone" would confer perfection and incorruptibility upon the human body just as it would inoculate a base metal with those attributes and so convert it into gold.

Many Recipes Given

Many were the recipes which were given (and followed) for the making of the Philosopher's Stone and the Elixir of Life. Indeed, the elucidation of the mysteries of their preparation (for the published recipes always ended in failure) became the ruling passion of numberless lives devoted to alchemy. Even the names given to this wonderful "Stone" or "Elixir" were as fantastic as the properties claimed for it. At various periods in alchemical history this was termed : *The One Thing, The Essence, The Stone of Wisdom, The Heavenly Balm, The Divine Water, The Virgin Water, The Carbuncle of the Sun, The Old Dragon, The Lion, The Basilisk, The Phoenix* and *The Celestial Ruby*.

As a sort of interesting, but much more mundane sideline, the alchemists sought for the preparation of the *Universal Solvent*, which liquid, when discovered, would be found to possess the property of dissolving anything with which it came into contact. But when, ultimately it was stressed that even if the Universal Solvent were actually discovered, it would be impossible to devise any vessel to contain it, the enthusiasm over its discovery abated and, in time, disappeared altogether.

Albert Groot

One of the best-known and most "scientific" alchemists after Geber was Albert Groot, a German, better known as *Albertus Magnus* and recently canonised as St. Albert the Great. St. Albert was a Dominican friar of the 13th century. He was a theologian, philosopher, physician, astronomer and alchemist all rolled into one. Perhaps, he is best known as the teacher of that towering genius of philosophy and theology, St. Thomas Aquinas, who was also a member of the Dominican Order, and who contributed much to the scientific philosophy of his day, and who made a special investigation of amalgams.

In his chemical opinions, St. Albert followed Geber. Metals were to him mixtures or compounds, of mercury and sulphur. He knew that "strong waters" or acids could dissolve metals and he seems, also, to have been acquainted with the technique of sublimation or "dry distillation."

His English contemporary, Roger Bacon, also devoted some of his time to alchemy, and he wrote a book on the subject—*The Mirrour of Alchemy*—in which he follows the ideas of Geber and his successors. Bacon has been credited with the discovery of gunpowder, but this discovery is probably not attributable to him, despite the fact that in the sixth chapter of his *Secret Works of Art and Nature* he gives the instructions : "Mix together saltpetre and sulphur and you will make thunder and lightning if you know the method of mixing them."

Raymond Lully

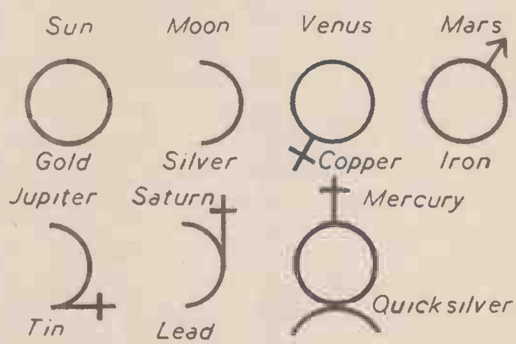
Another alchemist of interest whose name should not be allowed to be passed over is Raymond Lully, a Spaniard, who, following a disappointment in love, devoted himself to religion and apparently studied alchemy during his mature years. Although Lully wrote an enormous amount of alchemical jargon and nonsense, he does seem to have known (if not actually to have discovered) nitric acid. He knew how to make potash, sulphate of iron and copper and alcohol. His opinion of alcohol was a high one, for he terms it *consolatio ultima corporis humani*—the final comfort of the human body.

Raymond Lully, like other alchemical devotees, spent much time searching for the secret of the Philosopher's Stone, but when finally he convinced himself that his quest was a useless one, he seems to have relinquished his chemical activities entirely and to have given himself over to theology.

Medicinal Chemistry

In the course of time, disappointed with the failures of their efforts to wrest from Nature the supposed secret of the Philosopher's Stone and of the Elixir of Life, alchemical experimenters began to devote themselves more to that which we would now call medicinal chemistry, the discovery of drugs and other chemical materials for the purpose of curing or, at least, alleviating the many ills to which our flesh is heir.

Galen, an alchemical physician who lived and flourished in Greece in the second century of the Christian era, introduced the



The curious Astrological symbols used by the alchemists to denote their seven known metals.

taking of certain mineral salts in cases of illness, but it was not until the time of Basil Valentine, a Benedictine monk of the 15th century, that we find a renewed attempt to direct the course of alchemy towards medicine and away from the everlasting theme of the hypothetical and absurd *Philosopher's Stone*.

Doubt has been cast upon the actual existence of Basil Valentine, and some think that his name is merely a *nome de plume* under which a number of German alchemical works were published. Whatever may be the truth of this matter, there is no doubt that Valentine's curious work entitled "*The Triumphal Chariot of Antimony*," in which he attempts to give a scientific survey of the chemistry of antimony compounds and of their various uses, is one of the first technical works directed to a more or less utilitarian purpose.

Hydrochloric Acid

Of course, Basil Valentine, as far as we can now make out, believed in many of the older alchemical theories. He seems to have tried his hand at finding the Philosopher's Stone and other equally fantastic things, but he also seems to have discovered a method of making hydrochloric acid, and, furthermore, the preparation of sulphuric acid (by distilling sulphate of iron) is first properly described by Valentine, although this particular acid was apparently known to Geber, long before Basil Valentine's time.

Basil Valentine knew how to dissolve iron in sulphuric acid. He observed that a gas ("spirit") was evolved when the iron dissolved in the acid and that "this solution, when put aside in a cool place, soon forms beautiful crystals." "This material," he goes on to say, "is an excellent tonic." Which is a perfectly truthful observation for sulphate of iron, like most iron compounds, has high tonic properties. Basil Valentine observed, also, that sulphate of iron, when externally applied, made an admirable *styptic* to stop the bleeding of wounds.

Georgius Agricola, Henry Cornelius Agrippa, and Johann Rodolph Glauber were other practitioners of medical alchemy whose names have more or less renown attached to them. Glauber, the German alchemist, whose first used sodium sulphate as a purgative has his name imperishably enshrined in *Glauber's Salts*, by which sodium sulphate is commonly known. Cornelius Agrippa, also, like Glauber, a German, dabbled in medical alchemy, after having been unsuccessful in the Philsopher's Stone and the Elixir of Life business. This experimenter, however, ended up somewhat petulantly by publishing a work on the vanity and the uncertainty of the Sciences !

Georgius Agricola

Of Georgius Agricola much could be written, for, although he was a physician at Joachimstahl, a mining town, he became essentially interested in the mining art. Eventually he published a book, *De re Metallica*, which was for a long time the standard work on metallurgy and metal science. He was the pioneer of mineralogy in Europe and he is supposed to have been the first to discover the element, bismuth.

Yet, for all his scientific work, Agricola was imbued with much superstition, since he firmly believed in the existence of strange demons which haunted mines and made strange noises to frighten unsuspecting miners out of their senses.

As a result of the work of these latter individuals, beginning, let us say, with Basil Valentine, alchemy or early chemistry began to make some little scientific progress. But it was uphill work. Fifteen hundred years or more of false ideas were not to be shed from men's minds in the space of a year or two. Besides which fact, alchemy, in addition to being an experimental quest, an art, was, to many, a variety of mystic religion. Much, indeed, of the alchemical works are highly tinged with religious inferences. The ceaseless striving for perfection of the alchemists, their constant efforts to discover "the one perfect thing" have all been held to represent the inner strivings of the human soul in its search after Essential Truth and Good. And probably there is much veracity in such assertions. Nevertheless, from the purely chemical aspect in which we must necessarily view the old alchemical doctrines, with their conceptions of Universal Solvents, Elixirs of Life and Philosopher's Stones, we must brand them all as highly fantastic and nonsensical and as absurd notions which, in themselves, could not possibly lead anywhere.

Our Busy Inventors

By "Dynamo"

Automatic Machine "Talkie"

THE latest brand of peepshow is an automatic machine which exhibits a moving picture with the novel feature that it is also a "talkie." The sound record on the film is reproduced in earphones or by a loudspeaker. It is designed for the pleasure of one patron at a time and there is an arrangement to prevent any person standing near from enjoying a free show. The possible intruder is frustrated by flanking wings which project, and there is also a hood. This prohibits overlooking of the screen by a bilker—that is, an unprincipled person who has not put a coin in the slot.

A patent has been applied for this miniature cinema show, which one may expect to see on piers and in amusement saloons, air-raids permitting.

Sums Without Sobs

THE idea of teaching by means of games is not new. This is the principle of the kindergarten system which educates by self-tuition enlivened by singing, toys and other amusement. Card games have been in vogue in the past, which, after the manner of a sugar-coated pill, have pleasantly imparted useful information. For example, some years ago, there was a game of this description called "Counties and Towns." The players aimed at collecting complete groups of towns, which were pleasingly illustrated on the cards. As a consequence, the impressionable mind of youth acquired and retained a knowledge of the geography of England, which was eminently useful in after life.

A game of this educational character has just been patented in the United States. It is qualified to train the mind in arithmetic without tears. On some of the cards there are not very abstruse mathematical problems, while on other cards the solutions appear. For instance, a card bears the elementary addition sum $2 + 5$; another has $3 + 4$. The solution card shows 14, the sum of the two totals. Presumably, the object of the players is to secure the problems and the related cards upon which are printed the solutions. It is possible to make the calculations less simple. In this way there would be upon the mind of the player a reflex action—a mental gymnastic which would develop its powers.

Room at the Top

IT has been said that there is plenty of room at the top. This is certainly true of the motor-car, the roof of which furnishes a space that may be usefully employed to accommodate even heavy articles, provided the vehicle has a pressed steel body. It will be observed that many saloon-cars carry ladders and stretchers on the roof. Owing to the moderate height of the vehicle, the load is easily accessible. Also a lengthy load may be carried without increasing the elongation of the car. This facilitates the manoeuvring of the car in a confined space.

An improved device which simplifies the use of the roof of the modern saloon as space for carrying a load is undoubtedly of considerable interest. A roof luggage carrier, for which a patent in this country has been applied, consists of two or more cross-bars which are secured by means of holding-down clips. These are hooked under the water-plate channel or drip-moulding of the cant rail. In order to protect the paint work, rubber pads are provided.

One advantage of this carrier is that it can easily be removed from the roof, leaving the car with its normal appearance.

The invention as described is essentially a device for securing outside cross-bars to the roof. It may, however, be elaborated so that the cross-bar forms part of a roof trunk or tray.

In days of yore the old carrier, whose chief business was to transport goods, used to make room for a passenger or two. Barkis in "David Copperfield" was always "willin'" to do this. At the present time the motor-car returns the compliment. Primarily designed to carry people it may now with this special roof luggage carrier also act as a beast of burden. And what, in the good old times, was placed beneath the stage coach in the boot, will now be carried above the heads of the passengers.

The information on this page is specially supplied to "Practical Mechanics" by Messrs. Hughes & Young (Est. 1829), Patent Agents of 9 Warwick Court, High Holborn, London, W.C.1, who will be pleased to send readers mentioning this paper, free of charge, a copy of their handbook, "How to Patent an Invention."

Self-Lighting Cigarette

AN application has been made to the British Patent Office to patent what is termed a self-igniting cigarette. To the end of the cigarette there is applied a composition consisting of tobacco—charcoal and gum solution. Superimposed on this is a drop of matchhead material.

The inventor states that the dipping of a cigarette in any liquid, owing to capillary attraction and the delicate nature of the materials, has a derogatory effect. It makes the cigarette unsavoury. Therefore, he applies the fusing composition from above, the cigarette being held vertically.

In each packet of cigarettes, in place of the usual picture card, the inventor places loose a piece of paper or cardboard treated on one side with match-striking composition and on the other with a sticky substance. The latter enables the card to adhere to the dashboard, windscreen or other suitable place on a car or in the house.

Curious Cigarette Packet

THERE has recently been patented in the United States what is described as a cigarette package designed to grow progressively smaller as the cigarettes are consumed. It is apparently a packet of cigarettes in a larger container, and between the two there are sandwiched a number of loose cigarettes. When the latter have been smoked the small packet remains and the large container can be thrown away.

Upside Down but Safe

AN unhappy landing sometimes causes an aeroplane to emulate a turtle. To mitigate the unpleasant effects of this turnover, a safety device has been submitted to the British Patent Office. The invention is an improved means of providing a clear way of escape for the occupants of an aeroplane overturned upon reaching ground. In the event of an accident of this kind, particularly when the machine is a monoplane, should the crew occupy open cockpits, they are exposed to risk of serious injury. Even if the impact did not damage them, they would be imprisoned, since some openings of cockpits would be pressed against the ground.

In certain aircraft, in which the crew are housed in roofed cockpits, the inversion of the aeroplane might render the use of the exit impossible.

The new device furnishes the upper surface of the body of the aeroplane with members so placed to come into contact with the ground, should the plane be overturned. These members are resiliently mounted in such a manner that, on contact with the earth, they will be deflected. And this deflection will bring into action mechanical means for causing supporting or jacking members to be extended.

Aerial Island

THOSE Goering-shaped sky wardens which appear to be straining towards the stratosphere are very familiar objects. Their silvery corporations, however, are inoffensive—that is to say they are limited to defensive protection.

It is now proposed to elevate guns on air-buoyant bodies akin to the balloon. An application for a patent in this country has been made for an aerial island designed for anti-aircraft aggression. It consists of a body adapted to float in the air. A central part has streamlined ends and there is an upper platform for the crew and guns. The machine is stabilised by a lateral balance in combination with the central part.

This floating body comprises a skeleton of light metal fitted with a gas-tight envelope for the reception of gas such as hydrogen or helium. In addition to the impregnated textile substance generally used for balloons, sheet aluminium may be used in the manufacture of the envelope.

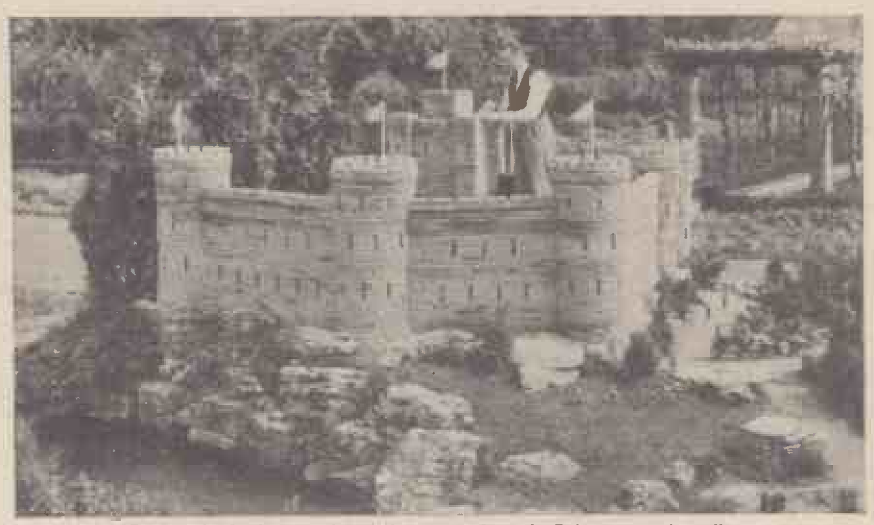
Normally, this aerial island will be anchored to the ground by a cable after the manner of a barrage balloon. It is sufficiently buoyant to carry a light anti-aircraft gun and at least two machine-guns. To avoid tilting, there may be provided means for keeping the platform horizontal. A gyroscope would serve this purpose on an automatically shifting ballast.

Instead of being continually connected to the ground, the island may freely float. The elevation could be regulated by allowing gas to escape or by introducing gas from bottles stored up. There may be panelling means strong enough to prevent lateral displacement. Such means may be a propeller driven by petrol or, an oil engine.

Anti-Blast Door

THE air-raid shelter still occupies the attention of the inventor. In this connection, one of the most recent contrivances is a door sufficiently strong and heavy to form an effective closure for a shelter. This door is practically a metal box filled with concrete within which is embedded one or more steel diaphragms or sheets having dovetail or like corrugations thereon. These divide the door into two or more interlocked sections.

"MOTILUS" PEEPS INTO THE



Putting the finishing touches to the new castle in the Bekonscot garden village.

The Work of Amateur Modellers.

THERE are ways of making money and just as many ways of spending it, and among the wealthy in this country many indulge in the hobby of models, including quite probably some of the readers of this page. There are also a number of what some folk would call "eccentric" persons, who like to create a thing of unique interest that will last after they have passed away and give pleasure, instruction, or information to other people.

Such a man was the late George Burt, Esq., J.P., C.C., one time Sheriff of London and senior partner in the well-known firm of contractors, Messrs. Mowlem & Co., Greenwich. It was at his firm's depot at Greenwich that forty odd tons of Portland stone was taken for the purpose of creating the famous Great Globe, which is situated on Durlston Head, in the grounds of Durlston Castle. Everyone around Swanage has heard of the Great Globe, but it owes its wider fame to the fact that it is unique. It is a scientifically accurate representation of the earth, carved in stone, with the continents in base relief, and at least 10 ft. in diameter.

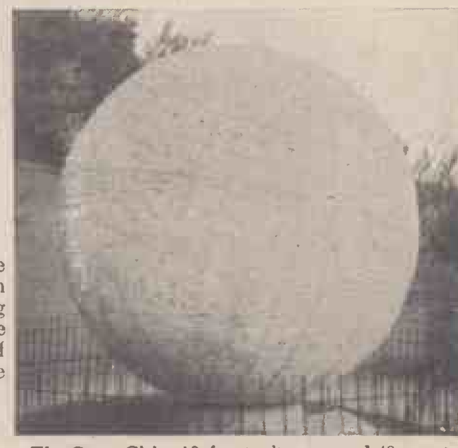
Close by the Great Globe there are stone tablets and carvings giving various data in a popular form. One is a map representing the South Coast in base relief, and there are tablets giving details of the convexity of the ocean and the tides, clock times, and the duration of days.

Model Railway

A recent attractive addition has been made to Durlston Castle in the form of a model railway. At one time accommodated in the large conservatory on the late Sir Edward Nicholl's estate at Littleton Park, near Shepperton-on-Thames (now a film studio), this railway is 2-in. gauge and contains 500 ft. of track. It is suitably arranged with effective scenery, intersected with villages, towns, an aerodrome, bridges spanning moving water, etc. It would interest readers, no doubt, to know that this famous model was built by Sir Edward Nicholl, the well-known shipowner, for the benefit of his grandchildren. The fascination of such a railway, with its cleverly arranged inclines, innumerable tunnels and bridges, appeals to young and old alike, and while the children like to see the trains running in and out, everyone cannot fail to be interested in the variety of this collection of models, one of the most comprehensive displays of its kind in this country.

A Model Clipper

Recently in the south-west of England I paid a visit to the Russell Cotes Museum at Bournemouth, which is situated in a commanding position on the cliffs facing the sea. On the veranda of this museum, which was once the residence of Russell Cotes, are two exquisitely made models of old-time ships. One was the *Royal William* (1719), to a scale of $\frac{1}{48}$th, and the other the *Clementine*, a vessel of about the 1870 era. This latter ship is a three-masted barque,

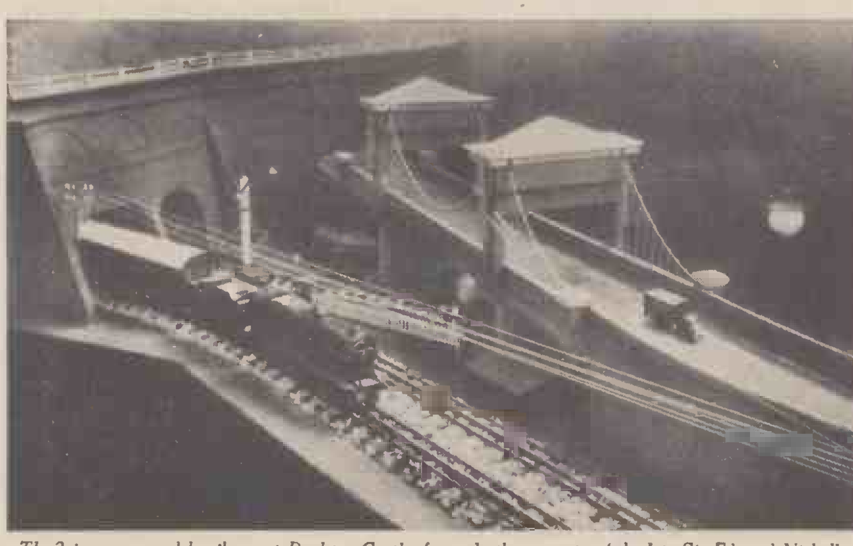


The Great Globe, 10 feet in diameter and 40 tons in weight. (Below) One of the stone tablets set up near the Great Globe.

square-rigged, and designed for fast sailing and, therefore, called a clipper. The hull of the model is in bad condition owing to exposure to the weather, otherwise it is satisfactory, and the various parts of the ship are carefully labelled, so it is useful to students who visit the museum.

Model Village

The Bekonscot Model Village is still as popular as ever to model lovers from districts far and near the vicinity of Beaconsfield. Owing to war conditions, the staff there this summer is a very limited one, but the trains are being run occasionally for a



The 2-in. gauge model railway at Durlston Castle, formerly the property of the late Sir Edward Nicholl.

MODEL WORLD

short while on Sundays. Even without them the village itself, with its miniature sea and docks, the route of its railway, with stations, village, bridges, tunnels, and last, but not least, its zoo, is a pleasant and fascinating spot in which to spend an afternoon. The trees, shrubs, and the garden flowers are a wonderful feature of this model village and railway, which, since it was opened a few seasons ago, has been visited by many high-born personalities, both British and foreign.

Ken View Model Railway

The boys of the Ken View model railway have set an example which all their comrades would be proud to emulate, in the building of this comprehensive line. Since August, 1932, when it was opened, on an average visitors have numbered around 20,000 a year and contributions to charity have been raised to over £250. Their three main objectives, to provide educational and instructional facilities for staff and visitors, to provide a public exhibition in Finchley for the borough, and to raise money for charity, have, Mr. Arthur Beach (who is the originator, guardian, and exhibitor of this railway) tells me, been more fully realised than they had ever hoped for.

The display now comprises two entirely

distinct and separate layouts—the "O" gauge outside, and the "OO" gauge running inside, the first constructed under the supervision of G. Barry and the second under C. Horder.

The "OO" layout consists of four ovals of track and occupies a space 12 ft. by 10 ft. There is a main terminus station of four tracks, two main lines starting on a level and two suburban, which rise to clear and cross over main line, afterwards dropping slightly whilst main line rises, thus bringing all four tracks flush opposite the main-line station. The main line then drops to original level and the suburban lines continue at approximately the same level. It passes over the end of the terminus station with a scale flyover bridge, and the main line completes its circuit with a double junction point. There are 18 working points, with a centre lever frame working with piano wire through copper tubing. The control board is entirely home made, with a control for each track, and there are also 18 isolating switches for sidings and main-line tracks. The scenery consists of two stations, an arterial road, model village, and a viaduct, which passes over the main line and leads to an aerodrome. It is interesting to note that the oldest engine—an L.N.E.R. tank—has been running for nine months and has run over 1,000 miles, 800 miles of which were covered before it was overhauled, and the driving bearings fitted with phosphor bronze bushes.

The Track

The gauge "O" track has all been relaid and adapted by conversion to continuous running for public displays, by loops which enable the trains to run round a circle extended at the ends of the main line, instead of the termini, which originally necessitated the turning of the train by hand.

As you enter the main gates, you see the main-line terminus on the right and one of the loops, which is built on an embankment and leads upwards to a junction station, shortly after which it tunnels under the garden path and continues to climb round a semi-circle, eventually running inside the fence on the north-west side to the main gates, where it loops round a Welsh mountain scene, as in the case of the commencement of the track. Thus the circuit is completed.

The Zoo, latest addition to Bekonscot village

A point leads out to a bascule suspension bridge across the entrance path connecting with the original loop by the main-line terminus.

Control Panel

A new control panel has been constructed out of sheet brass, with 24 section switches and an automatic cut-out. The track is made to the Ken View model railway's own design, a 3-in.-wide baseboard, without battens and well creosoted, sleepers of ⅛ in. by ⅜ in. strip wood, and Bassett-Lowke running rail and chairs—the whole constituting a track considerably stronger than the usual scale track.

The Clementine—Model clipper ship at the Russell Cotes Museum

Another innovation is the telephone system, which has been found necessary owing to the large lengths of track outside the visibility of the operator. Telephones also connect to the loco engine workshop, thus enabling the operators to obtain help in the shortest possible time.

The Viaduct

It is an interesting fact that the viaduct now under construction for the loop by the terminus station is the largest metal-work piece attempted on the railway. It is built of mild steel, bent, drilled, and braced, and is a considerable improvement on wood viaducts, which are so apt to warp and buckle. It measures 9 ft. across at the widest point.

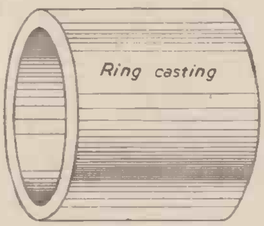
The workshop used for the gauge "O" railway and equipment has been re-equipped to give working space for six. It now has testing panel, exterior speaker for the radio, amplifier, and the telephone system, while a number of precision tools have been collected, specially suitable for model railway work.

Scene on an outdoor model railway

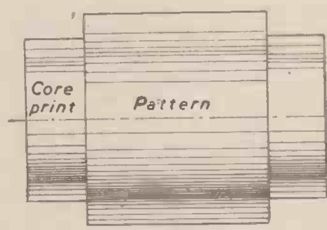
SPECIAL PISTON RINGS

A Simple and Effective Method of Making Piston Rings on a Lathe

PISTON rings for both steam and internal combustion engines are now a mass produced article of commerce. But there are occasions when it becomes necessary to make special rings, and the method shown here will be found to be the quickest and most effective when the plant available is the ordinary engineers lathe. Cast-iron rings, if made from a casting of the proper proportions, will give a spring pressure sufficient for every purpose of gas seating.



Figs. 1 and 2.—(*Left*) Details of a ring casting and (*right*) Pattern for the casting.



The spring is inherent in the casting and is due to the internal stress set up as the casting cools and contracts. When this force is released by the cutting of the slot the metal springs outwards. Steel piston rings could be tempered which would spring with greater pressure but this is not practical as the heat of the expanding gases in an internal combustion engine or the superheated steam in a steam engine would draw the temper.

The spring or outward expansive force of a cast-iron ring is not affected in this way except at higher temperatures than it will attain in an engine unless the latter is attaining a heat which would cause the piston itself to seize in the cylinder.

Cut From Castings

Piston rings are best cut from a casting as shown in Fig. 1. This is cast from a simple pattern, Fig. 2, of the same length and diameter and with core prints each end smaller than the internal diameter of the casting we want. It is best to have this casting very near to size both in outside diameter and core size as the size of the ring. The wall or skin of the casting as it leaves the mould is usually harder than the internal part and this hardness is an asset in this particular application. No core box is required. The foundry make cylindrical cores without boxes.

The casting should be long enough to be chucked the full depth of the three-jaw chuck jaws and leave sufficient projecting to make four or five rings. In calculating this the width of an ordinary parting tool should be added for each ring required.

The shape of the ring, before the slot is cut and the outside finish turned, should be as shown in Fig. 3. The outside diameter is a 1/32 in. larger than the bore of the cylinder—that is for all cylinders up to 3 in. in diameter. The width will be equal to the width of the slot in the piston less sufficient to let the ring move in the slot easily but without any shake in the line of the piston axis.

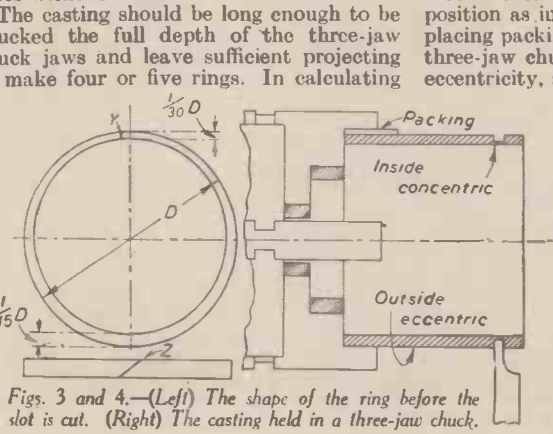
The ring is, as the drawing shows, eccentric. The width of the widest part should be just under the depth of the piston groove, say 1/64 in. less than groove depth. The width at the narrowest part—diagonally opposite—should be two-thirds the width at the widest part.

Maximum Efficiency

The dimensions given in terms of the diameter of the ring will give the mechanic a means of providing a ring which will give maximum efficiency and spring enough to prevent by-passing of the gases on power or exhaust strokes and yet not impose such a pressure, as against ring edge surface and the surface of the cylinder wall, as would prevent adequate lubrication or set up scoring of the wall. The thickness or depth, of the ring—if not already decided by the piston ring grooves it has to fit—may be $1\frac{1}{2}$ times the width of the ring at its maximum, i.e., opposite the cut. (Y in Fig. 3.) These proportional dimensions will give a good ring, they are the dimensions of the ring as turned and before cutting the gap.

The casting should be chucked in the three-jaw chuck faced off and turned outside to the decided dimension as above, i.e., cylinder diameter plus one thirty-second of an inch, for the whole length projecting from the chuck jaws.

It is then chucked eccentric to its first position as in Fig. 4. This can be done by placing packing under one of the jaws of the three-jaw chuck. To verify the amount of eccentricity, scribe a circle around the face or end of the casting with a scriber set to give, at what will be the wide part of the ring the dimension required. Give the piece half a turn and see that this scribed circle is half the width on the opposite diameter as was shown in Fig. 3. Adjust the packing to obtain this.



Figs. 3 and 4.—(*Left*) The shape of the ring before the slot is cut. (*Right*) The casting held in a three-jaw chuck.

We can now bore out the casting with an inside boring tool parallel and of a diameter of the inside of the rings we are making. Then each ring can be parted off as shown. The outside is now running eccentric but will not affect our parting operation since the parting tool will come through on a concentric under surface and will part off the ring cleanly. If we had bored the inside first and then turned the outside and then parted off, our parting tool would have broken into the eccentric inside bore and smashed tool or casting.

The Ring Gap

The rings parted off should be rubbed on emery glued to a flat board to take off the burr of the parting off *but no more.* Then the ring gap at Y which should be as wide as the ring is at Z, should be cut with a hacksaw and the ring closed. The diameter should then be measured and it should be slightly larger than the diameter required to enter the cylinder. Now close the ring and chuck it on the improvised mandrel shown in Fig. 5. Fasten the central screwed mandrel tight in the chuck jaws and turn two discs 1/16 in. under closed ring diameter. Now bolt the discs up tight and true the ring edge by tapping it until it is running true. See that the gap is closed and with a very sharp tool take a fine cut along to reduce the ring to exact size (with gap closed) to fit up the cylinder.

This final turning of the outside surface,

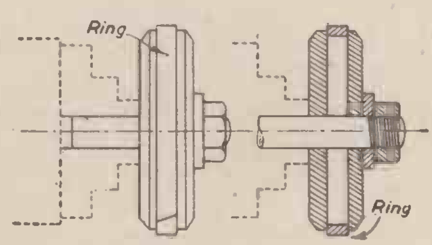


Fig. 5.—The ring closed and chucked on an improvised mandrel.

while compressed with the gap closed, is an important part of the procedure and just enough metal should be left when turning the outside of the casting in the first place to allow for it.

Facts About Metals

(*Continued from page 493 of August issue*)

N

Native.—Metals are said to be in the "native" condition when they are actually found in the metallic state, and not combined with other elements in the form of ores. Gold, platinum, iridium, osmium, palladium, silver and mercury are some of the metals which occur at times in the native condition.

Needle Antimony.—Commercial term. Is sometimes applied to antimony sulphide, but NOT to the metal.

Neodymium.—Metallic element.—Chemical symbol, Nd; At. No. 60; At. Wt. 144; M.P. 840° C.; Sp. Grav. 6.9562.

An important member of the cerium group of rare metals, its chief ore being cerite. Discovered in 1885 by Auer von Welsbach and named by him "Neodidymium" (from the Greek, *neos*, new; *didymos*, twins) in allusion to its then constituting a newly-discovered element similar to Lanthanum. Subsequently, the name "neodidymium," being too much of a tongue-twister, was, by general consent, contracted to neodymium, which is the present-day accepted name of the metal.

Neodymium is a silvery-white metal, with a very slight yellowish hue. It is fairly stable in air, but is said to decompose water slowly in the cold and rapidly at the boiling point, with the evolution of hydrogen and the formation of neodymium hydroxide. The metal alloys with cerium and its related metals.

Neonalium.—A copper-aluminium alloy containing 6% of copper. Of Swiss origin. Tensile strength, 23,000 lbs. per sq. in Brinell hardness, about 100.

Nickel.—Metallic element. Chemical symbol, Ni; At. No. 28; At. Wt. 59; M.P. 1435° C.; B.P. 2450°C.; Sp. Grav. 8.8; Sp. Ht. .10916; Coef. Exp. .0000128; Elec. Cond. at 0° C. (Mercury=1) 7.37; Brinell Hardness No. 75-95.

Chief ores: Kufernickel or Niccolite NiAs, Nickel Blende, NiS, Nickel Glance, NiAsS. Occurs intimately mixed with cobalt ores.

Nickel seems to have been known to the Chinese. Two hundred years ago the Germans applied the term "kupfernickel" (false copper) to minerals having the appearance of copper ores, but which contained no copper. Such ores were nickel-bearing ones. The name "nickel" is a German one, meaning "the devil." It was first specifically applied to the metal by Cronstedt, in 1751.

Nickel, when pure, is a highly lustrous white metal. It is hard, easily polished, ductile and malleable. Nickel, like cobalt, is slightly magnetic. Until recent date, it was used enormously as a plating metal, since plated nickel gave a fine finish to base metal. Added in small amounts to steel, the metal forms the various nickel-steels which are exceedingly hard and which have been employed for armour-plating purposes, as well as for other uses. In these, the proportion of nickel may be as high as 20%.

Nickel is a most ubiquitous alloying metal. It enters into a large number of alloys of widely varying characteristics and properties, and it is, indeed, as an alloying metal that it is mostly made use of nowadays. A certain amount of pure nickel is employed for the making of instruments, etc.

LIST OF ABBREVIATIONS

The following abbreviations are used throughout this Dictionary:

At. No.	Atomic Number
At. Wt.	Atomic Weight
M.P.	Melting Point
B.P.	Boiling Point
Sp. Grav.	Specific Gravity
Sp. Ht.	Specific Heat
Coef. Exp.	Coefficient of Expansion
Therm. Cond.	Thermal conductivity
Elec. Cond.	Electrical conductivity

Nickel Amalgam.—A plastic metallic mass made by rubbing an amalgam consisting of 1 part of sodium and 99 parts of mercury with a concentrated solution of nickel chloride. Sometimes used as a metallic cement.

Nickel-Chromium-Manganese Steels.—Similar to the nickel-chromium-molybdenum steels (which see). They are non-magnetic, hard, and tough. Brinell hardness, 250 approx. Used for bullet-proof plates and, also, in some instances, for the retaining end rings of dynamos.

Nickel-Chromium-Molybdenum Steels.—These are chrome-nickel steels "reinforced" with a small amount of molybdenum, which increases their strength without increasing their brittleness. Such steels are tough, resistant to fatigue and shock, and are employed for armour-plating and similar purposes.

The Hadfield "Hecla/134" alloy steel is of this type.

Nickel-Silver.—Also called "German Silver." Contains copper (56-60%), zinc (20%), nickel (20.25%), and sometimes small amounts of cobalt, lead, and iron. Inferior qualities contain not more than 7% of nickel.

Owing to its white colour, lustre, toughness, tenacity, malleability, ductility, and chemical resistance, any good quality nickel silver or German silver is a very useful metal for ornamental work. It has a high electrical resistance, and is also used for the manufacture of electrical resistance wire.

The nickel or German silvers have a fairly high tensile strength of from 25 to 40 tons per sq. in.

Nickel Steel.—One of the earliest of the alloy steels, and one of the most important and most used. First employed about 1888. Nickel steels contain nickel in amounts up to 50%. They are hard, tough, and resistant and are mostly able to withstand continuous wear and shocks.

Above a nickel content of 2%, 1% of nickel adds about 2½ tons per sq. in. in tensile strength to the steel up to about 8-10%. The fatigue resistance is also increased.

Steels containing 10-15% nickel are brittle.

The great bulk of nickel steel contains from 2% to 4% of nickel and from .2% to .5% of carbon. It is used for varied structural and engineering purposes. Also for seamless tubes of bicycles and motor-cycles and for car parts, etc.

Nickel-Tungsten.—An acid-resisting alloy. Composition varies greatly. Approximate limits are: Nickel, 75-90%; tungsten, 8-25%.

Nickel White Iron.—One of the "alloy cast irons" which has a high abrasion resistance. Typical composition: Nickel, 1.8%; chromium, 0.8%; silicon, 0.5%, these constituting the alloying ingredients of the iron. Its latest development is "Ni-Hard."

Nilex.—A low expansion nickel-iron alloy containing about 36% of nickel. Its expansion is not more than 1½ millionths per degree Centigrade. Used in instrument work, etc.

Niobium.—This was the original name of the rare metal, Columbium (which see). The metal has a strong resemblance to tantalum, and it was originally named "Niobium" by its discoverer, H. Rose, in allusion to Niobe, the mythological daughter of Tantalus.

The name "Niobium" (together with the symbol, Nb) is still employed in a number of chemical text-books and reference works.

Noble Metals.—Name given to gold and the platinum metals (osmium, iridium, platinum, ruthenium, rhodium, palladium) and sometimes, also, to silver in allusion to their great permanence and durability in contact with air, acids and weathering influences.

In contradistinction to the so-called noble metals, all the other common metals (iron, copper, lead, etc.) are referred to as "Base Metals."

Noheet.—an anti-friction metal which was at one time known as "tempered lead." Was used as a bearing metal during the Great War, when tin was scarce. Average composition: sodium, 1.3%; antimony, .11%; tin, .08%; remainder lead.

The tensile strength of "Noheet" is said to be between 13,000 and 15,000 lb. per sq. in. and its compressive strength some 22,000 lb. per sq. in.

Nomag.—A non-magnetic cast iron introduced in 1924 by S. E. Dawson. It contains, as alloying ingredients, from 10% to 12% of nickel and from 5% to 6% of manganese. Used for the production of non-magnetic castings of high electrical resistance.

Non-ferrous Metals.—Metals or alloys which do not contain iron. (From the Latin, *ferrum*, iron.)

Nongro.—A nickel-iron alloy containing about 36% of nickel. Its coefficient of expansion is very low, being not more than 1½ millionths per degree Cenitgrade. Used for high-grade clocks, instrument work, etc.

O

Odour of Metals.—Some metals emit a faint but distinctive odour when they are rubbed, particularly in the warm state. Apart from the case of volatile metals, such as mercury, arsenic, etc., this phenomenon has not been adequately explained.

Occlusion.—The property possessed by some metals (in common with other substances) of absorbing gases and retaining them. Palladium will absorb nearly 1,000 times its volume of hydrogen. Gold absorbs 46 times and nickel 15 times their respective volumes of hydrogen. Silver, aluminium, lead, iron, cobalt, and other metals absorb hydrogen, oxygen, and other gases in varying volumes, particularly when the metals are in powder form. The real nature of metallic occlusion is unknown.

(From the Latin, *occludere*, to shut up.)

Onions' Alloy.—A fusible metal. M.P. 197° F. Composition: bismuth, 5 parts; tin, 2 parts; lead, 3 parts.

Open-Hearth Steels.—Steels which have been manufactured by the "open-hearth" process, which consists in smelting the steel in a gas-fired "regenerative" furnace consisting of a shallow trough or "hearth." The idea originated with W. Siemens (1863) and was substantiated by E. Martin (1864). Hence the process is sometimes known as the "Siemens-Martin" process, the steel, also, at times being given that name.

Osmiridium.—A native alloy of osmium and iridium (and other related metals) which is exceedingly hard. Used for tipping the gold nibs of fountain pens. Average composition: osmium, 27.2%; iridium, 52.5%; platinum, 10.1%; ruthenium, 5.9%; rhodium, 1.5%. It also contains traces of palladium, copper, and iron. It is also known as "Iridosmine."

Osmium.—Metallic element. Chemical symbol, Os; At. No. 76; At. Wt. 191; M.P. 2300° C.; B.P. 2950° C.; Sp. Grav. 22.47; Sp. Ht. .03113; Coef. Exp. .00000657.

Osmium is one of the platinum group of metals. It invariably occurs in Nature in the metallic condition alloyed with platinum and other metals of the group. The metal was discovered by S. Tennant in 1802-3, and given its name from the Greek *osme*, a smell, in allusion to the peculiar odour of its volatile oxide, OsO_4. Osmium is a lustrous, white metal, having a bluish cast. Like platinum, it is unoxidisable, even at high temperatures, and, like platinum, also, it can be dissolved by *aqua regia* (a mixture of strong nitric and hydrochloric acids).

A naturally occurring alloy of osmium and iridium, "osmiridium," is exceedingly hard, and is used for tipping the nibs of fountain pens and for similar purposes.

The most important compound of osmium is osmium tetroxide, OsO_4 (the so-called "osmic acid"), which, although a solid, has the property of boiling about 100° C. and giving off exceedingly irritating vapours which are very poisonous.

Otto's Alloy.—A speculum or mirror metal. Composition: copper, 68.5%; tin, 31.5%.

P

"P.2" Alloy.—A light aluminium alloy developed by The Birmingham Aluminium Casting Co., Ltd. Used for pressure die castings. Contains: copper, 3%; nickel, 1.75%; magnesium, .5%; iron, 2%; silicon, 4%; manganese, .5%, the remainder being aluminium.

Palau.—A palladium-gold alloy. Composition: gold, 20%; palladium, 80%. It is used as a substitute for the more expensive platinum. Laboratory crucibles are sometimes made of it.

(The name "Palau" is a contraction of "Palladium" and "Aurum" (gold).)

(To be continued)

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.

Substitute for Olive Oil

MY wholesale chemist can no longer supply me with olive oil for making shaving cream, but suggests I use Arachis oil. Do you think this oil would do equally as well and do you think there will be any danger of skin irritation ?—T. K. (Ayrshire).

ARACHIS OIL (sometimes termed peanut oil) is very similar in properties to olive oil, and we consider that you will be able to use it as a substitute for olive oil with every success.

A Hot Air Engine

I AM constructing an emulsifier of about 1 gallon capacity and am wondering how I can drive it cheaply, unattended for about 4 hours. Could I construct a hot air engine powerful enough for this purpose, and would it be safe to leave it without attention until the mixture was cold ?—A. L. (Bristol).

VERY definitely a hot air engine would not be suitable for driving the agitator of an emulsifying vessel, for most liquid emulsions reach a stage at which they "pull" very heavily.

A foot-operated treadle drive could, of course, be employed, but there is no doubt that an electric motor would be the most serviceable. Could you not obtain a small 12 v. motor and run it off an accumulator ? This should be sufficient to agitate a small vessel of emulsifying liquid.

Converting A Dynamo

I HAVE a 6 v. dynamo that has 29 commutator bars, and wondered if it were possible to convert it into a 230 v. A.C. motor—F. G. (Cheshire).

THERE are very few instances when the ordinary car-lighting dynamo can be satisfactorily converted into an A.C. motor. The two methods usually employed are either to short circuit the brushes together and supply current to the field winding alone through a variable resistance, adjusting the brushrocker until the best results are obtained as a "repulsion" motor or else rewinding both armature and fields for high voltage and using the motor as a "series-commutator" type machine. In both cases the objection is that the speed depends entirely upon the load, and if this is varied the speed rises or falls accordingly, so that there are very few duties for which the motor is fitted. Another objection is that if the fields are solid instead of being laminated the motor will get very hot. Low voltage machines seldom have sufficient commutator bars to enable sparkless operation, and the brushes soon burn away. As a general thing it is much better to spend the money on a machine designed for constant speed and high voltage, than attempting to effect what will at the best be a makeshift after putting considerable work into it.

Rewinding A Motor

COULD you tell me how to rewind a single phase-split phase motor ? The motor in question is a ⅙ h.p. 230 v. 50 cycles with 32 slots in the stator. Also, what size of motor is required to drive a 3½ in. Drummond lathe ?—E. A. (Rochdale).

A MOTOR of one-eighth horsepower is scarcely large enough to drive a 3½-in. Drummond lathe to its full capacity, and one-sixth to one-quarter horsepower would be advisable. It would have assisted in giving you a winding specification for your ⅙ h.p. motor had you supplied us with the dimensions of the rotor and stator, but assuming these to be approximately 3½ in. diameter × 1 inch long with a stator about 6 inches overall diameter with 32 slots, the following winding is recommended for 230 volts 50 cycles 1,400 r.p.m. as a split-phase-start single-phase squirrel-cage motor.

Rotor. 25 bars consisting of No. 5 SWG tinned copper (bare) with copper short-circuiting end rings ⅛ in. thick.

Stator. Running coils 12 in number, concentric grouping, 4 poles, 3 coils per pole, each coil consisting of 50 turns of No. 22 SWG d.c.c. copper. Starting coils 4 in number each with 150 turns of No. 28 SWG d.c.c. copper, positioned half a pole-pitch in advance of the main running coils.

In starting, the two sets of stator coils are put in parallel, and when speed is attained the starting coils cut out of circuit.

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

Colour Changing Liquid

I HAVE constructed, entirely in glass, a 4-ft. model of a house hot water system for demonstration purposes in school science lessons. Can you tell me of any liquid with which I can fill the model, which will change colour on being heated, and return to its original colour on cooling, so that movements in the apparatus can be clearly seen ?—P. F. (Gt. Yarmouth).

YOUR project is an interesting one, and we have no doubt that, in better times, the construction of these model hot water systems could be commercialised.

Very little work has been done on the subject of liquid thermal colour changes and, in our opinion, there is scope for a certain amount of discovery in this direction.

However, in your case, we should try out either of the following solutions, both of which we think you will find satisfactory :

(*a*) A strong solution of cobalt chloride. When heated, this turns blue. On cooling it assumes a claret-red colour.

(*b*) Make up a half per cent. solution of Methyl Orange and add to it (in the cold) a few drops of tincture of iodine just sufficient in amount to impart to it a muddy brown coloration. On heating, the liquid will take on a bright cherry red colour, and will return to its brown muddy colour on cooling.

Neither of the above solutions will stain, but solution *b* may leave a deposit on the cold portions of the glass. This deposit, however, will entirely disappear on heating.

Chlorine

WHAT is the simplest method of making chlorine in the laboratory ? I proposed heating manganese dioxide and hydrochloric acid in a flask.—T.L. (Ewell).

THE usual method of preparing chlorine in the laboratory is to heat concentrated hydrochloric acid with manganese dioxide. This method is a somewhat "messy" one, and, in the opinion of many chemists, a better way of preparing laboratory supplies of chlorine consists of very gently warming concentrated hydrochloric acid with dry potassium permanganate or potassium dichromate. Either of these two latter materials oxidise the hydrochloric acid, liberating its chlorine.

Place a quantity of dry potassium permanganate in a flask and, by means of a dropping funnel fitted to the flask, allow hydrochloric acid to drop slowly on to the permanganate, the flask being very gently warmed the while. Chlorine will be abundantly produced.

An article dealing with the preparation of chlorine appeared in our "Chemistry for Beginners" series, issue of "Practical Mechanics," dated August, 1939.

Wind-Driven Dynamo

I HAVE recently tried to make a wind-driven dynamo for charging on the lines of an article described in the October, 1939, issue of "Practical Mechanics." However, I have been unsuccessful because I cannot get sufficient speed for the dynamo to charge. The propeller speed is fast, but not fast enough when coupled directly to the dynamo. I have experimented with various designs of propeller, so can say definitely that the trouble is the high charging speed of the dynamo. Can you answer the following queries ?

1. The necessary alterations to the dynamo to ensure it's charging at about 280/300 revs. per minute ?

2. Where dynamos of this running speed can be obtained and the approximate price ?

3. Any suggestions for gearing the dynamo so that it runs quietly ?

The dynamo I have is a secondhand 6 v. Lucas car type with a single field coil.—R. S. (Tavistock).

THE dynamo you have in use at present does not appear to be suitable for direct-coupling, as probably its cutting-in speed is very much higher than the normal r.p.m. of the propeller. On the other hand gearing up from propeller to dynamo means an inevitable loss of power, and if direct-coupled the only solution is to employ a more suitable dynamo, such as the A/900 recommended in the article referred to in "Practical Mechanics," the cutting-in speed of which is about 450 r.p.m. Messrs. Joseph Lucas, Ltd., of Great King Street, Birmingham, manufacture this type of generator. The only alternative to the above is to employ either a specially designed generator with permanent-magnet fields, or to separately excite the field circuit of an ordinary generator from the main battery of accumulators. In either case the armature will then begin to generate directly it revolves, at no matter how low a speed, as the field is constant and not dependent upon the armature output.

Magnetic Field

WILL you please inform me of the maximum range of field of force that can be set up in a magnet, electro- or permanent, for any given amount of material ?

Also, can this field of force be deflected so as to act right ahead, from the end of the pole only, as the field along the sides seems to be wasted ?

Please state the process for both, and take as an example a small, easily handled magnet.—D.L. (Southend(.

THE maximum range of a magnetic field is practically infinite when undistorted by the presence of any other magnetic body, but the intensity of the field falls off in accordance with the "square law." If at one inch distance from its poles 100 lines pass through an area of one square inch, at double the distance there will be $100/2^2$ lines in the same area, and at three times the distance $100/3^3$ lines. Every line proceeding from the magnet pole is ultimately re-entrant, but it may pass away almost to infinity before returning to the opposite pole. Magnetism cannot be insulated, but it can be guided in any definite direction by placing in that region magnetic material of greater permeability than air, but even then a certain number of lines will leak away and no definite strength of field in any particular direction can be calculated without a knowledge of the magnetic dimensions of the whole circuit. This is a matter best studied by reading the elementary chapters of any standard electrical textbook such as S. P. Thompson's "Elementary Lessons in Electricity and Magnetism." The strength of an electro-magnet depends on the number of ampere-turns per unit length, the area of the magnet itself, and the magnetic permeability of the material of which it is made.

Editor : F. J. CAMM

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All letters should be addressed to the Editor, "THE CYCLIST," George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2.
'Phone : Temple Bar 4363.
Telegrams : Newnes, Rand, London.

Comments of the Month

By F. J. C.

The Bath Road "100"

THE BATH ROAD CLUB decided, for reasons which are entirely the affair of the Club, to abandon its classic "100"—The Blue Riband of the road—this year. This decision is entirely a domestic affair for the Bath Road Club, which is, like all other democratic cycling clubs—entitled to plan its programme as it thinks fit. It is known that the chief reasons for the abandonment were, firstly, that it was unpatriotic to run a National event of the importance of the Bath Road "100" during wartime; that few riders have had the necessary time, owing to overtime and seven day working, to put in the necessary intensive training; thirdly, that most riders are being called to the colours or otherwise not able to compete; fourthly, that there would be a considerably restricted entry; fifthly, that it would be unfair to previous winners of this classic that some mediocre rider should take advantage of the absence of the crack riders to win it and thus to have his name enshrined as a winner of this famous event. There are other reasons. It was by no means certain that the roads of the course would not be occupied by the military, that they would not be obstructed, nor that the riders would not suffer delay at the hands of the authorities in the matter of identity card inspection. No doubt some of these objections could be surmounted. The main point is that the Bath Road Club is merely following the practice it adopted in the last war.

Certain journalists, however, have seen fit to direct criticism against the Bath Road Club for its patriotic action and have pointed out that the club has a duty to the sport.Weexpect the B.R.C. thought so, too, and that is why it cancelled the event. The critics, however, in, we feel, some spirit of hostility, worked to promote through another club an event to replace the famous B.R. "100." The arrangements were made and the event was run off. It was won by an unknown man, and without wishing to belittle his performance, such a result is sufficient justification of one of the reasons advanced by the B.R.C. for not running it. It has been suggested by some that the B.R.C. had a duty to the press, but clubs are not concerned with providing news for the sake of providing news. We congratulate the club which at such short notice organised the substitute "100," but we do not congratulate those who, behind the scenes thought that, by supporting such an event, they were metaphorically administering a castigation to the Bath Road Club. Those who talk so freely of true sportsmanship should themselves act as sportsmen. The press criticism would lead some to presume that club events are run for the press—and timekeepers! We are glad to learn that the action of the B.R.C. is supported by many of the older clubs, some of whom deplore the opportunism of the younger clubs.

The Cyclist Road Club

ALTHOUGH, owing to the acute paper shortage, this journal is compelled to appear as a monthly supplement to *PRACTICAL MECHANICS*, it is still carrying on the service to readers which was such an important feature of the weekly issues. We are still planning readers' tours, advising them on legal problems, and answering technical queries.

Similarly, the activities of The Cyclist Road Club are continuing. As with so many other clubs, many members of this large organisation have joined the colours, but they have made arrangements for the local centres to be carried on during their absence.

Marguerite Wilson Again

THAT incredible girl, Marguerite Wilson, on a recent Sunday rode from Liverpool to London, a distance of 201 miles in 10h. 2m. and thus secured the record. She now owns fifteen of the sixteen W.R.R.A. bicycle records. The Women's Road Records Association, which is a comparatively new organisation, homologates records made by women, and in the few years of its existence it has done a vast amount of work to popularise cycling for women. Its president is Petronella, who has enthusiastically devoted herself to the affairs of the W.R.R.A.

Lack of News

THERE is a general flatness in the cycling movement and hence a lack of news. The only outstanding events of the past month have been Miss Wilson's successful attempt on her own fifty-mile record and her collection of the Liverpool-London record, which stood in the name of Mrs. Uren. Miss Wilson knocked 1h. 50m. off this record. It is said that a rider of her calibre arises only once in a generation, and certainly no one appears on the women's cycling horizon who will be able to achieve such an immediate succession of successes. One after the other she has sailed into the sixteen records. Amongst the men there have been a few similar examples. What will happen when all the records stand in this lady's name? Many of them, including the Liverpool to London, have been lowered to a figure where it will be difficult to beat them by anything but a narrow margin. Some of the records, such as the Land's End to the John O'Groats will be difficult to attack because of the restricted area through which the course passes. Such records are difficult enough for professionals; they are almost impossible for amateurs.

As far as the mere male is concerned, there have been no professional records since the war started, and it seems that the R.R.A. records will stand in the names of their present holders until hostilities are over. We hope, therefore, that those responsible for supplying cycling news to the newspapers will not resort to the reprehensible practice in seeing news where none exists, nor of elevating to the importance of headlines, trifling events which would be better ignored.

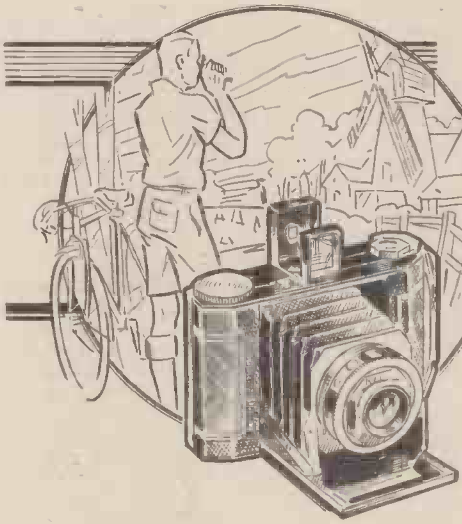
About Watches

ACCURATE watches are essential for the correct checking of cycle events and records. Very few, however, are able to afford that mechanical treasure, a Kew A watch, even though they may be able to afford a watch of Kew quality. The value of a Kew watch lies not so much in its mechanism as in the costly work involved in eliminating position errors, in compensating it for changes of temperature, and in adjusting it to within a fraction of a second a day. It takes several weeks to adjust a watch to pass the very rigid forty-four day Kew A test. For this reason the R.T.T.C. recently lowered the time-keeping standard and will accept watches within the extremely coarse limit of 30 seconds a day in the pendant up and dial up positions. This limit is so coarse that it could be passed by a half a crown watch. A watch of Kew quality can be purchased for a few pounds, but once it has received the highest hallmark of watch perfection, a Kew A certificate, it is worth anything from £50 to £100 according to the marks awarded it.

Those who are interested in the fascinating subject may like to know that we have recently published "Watches : Adjustment and Repair," 6s. or 6s. 6d. by post. It deals with time and the origin of watches, tools and material, the parts of a watch, the compensating balance and the hairspring, the lever escapement, the cylinder escapement, dismantling, fitting mainsprings, cleaning a watch, pivoting, adjusting the balance, hairspringing, fitting teeth, jewels and hands, watch case repairs, watch rate recorders and testing machines, the National Physical Laboratory watch tests, timing a watch for a Kew certificate, the British hallmarks, demagnetising a watch, and useful tables. The book is fully indexed. The chapter on tuning a watch for a Kew certificate should be particularly interesting to timekeepers as well as to those with sufficient mechanical skill to be able to apply the methods given.

Spitfire Fund

THE N.C.U. Spitfire fund has topped the £200 mark at the moment of going to press. This is a goodly sum, but still a long way off the £5,000 or so necessary to buy a Spitfire. Whilst so many Spitfire funds are in operation (incidentally, why concentrate on Spitfires? we require other makes of aeroplane), we suggest that the C.T.C. should start an Aircraft Repair Fund. The repair of damaged aircraft, so that they are kept in commission, is equally as important as building new machines, and cyclists, who may not be able to raise funds for a Spitfire, could each month subscribe sufficient money to repair many.



Paragrams

Current News Reviewed

Place of Honour

THIS year the place of honour for modern bicycles of British manufacture at the New York World's Fair has been given to a Raleigh bicycle. It is on exhibition in the British Pavilion aud is placed next to the first pedal-operated bicycle made by Kirkpatrick MacMillan in 1839, and dramatically shows the progress in bicycle construction during a century.

Scottish Records

TWO records were beaten in the recent Greenock United "25" when Will Scott beat his own personal record for a "25" by clocking 1h. 0m. 54s., and Glasgow Wheelers won the team race with a time of 3h. 9m. 59s.

Loss to F.O.T.C.

MR. A. G. DYKE, who was a well-known figure in the cycling world, has just died at the age of 76. He was president of the Fellowship of Old Time Cyclists in 1923.

On Leave

WE are glad to report that Monty Southall, who has been in hospital suffering from war wounds, has now left the hospital and is home on leave. He will shortly be rejoining his unit.

The Only Irishman

HARRY REYNOLDS, who was the only Irishman to win a world's cycling championship, has recently died at his home in Dublin. He won the one-mile title in 1896.

Death of Sylvere Maes

IT is now learned that Sylvere Maes, who last year won the Tour of France, has been killed in action. He was one of Belgium's greatest road riders, and was killed when the Germans invaded his country. He also won the Tour of France in 1936, and last year he led all road riders in a points table.

German Road Race

ALTHOUGH Germany is at war they held the professional road race as usual. It was won by George Stach, Berlin, with W. Gerber second, and F Scheller third.

Tour of Italy

THE Tour of Italy, which is divided into twenty stages and covers a distance of nearly 2,175 miles, was this year won by Fausto Coppi. E. Mollur was second, and G. Cottur third. One of the surprises of the race was Gino Bartali, who finished ninth. He is considered one of the best riders in Italy.

American Accident Figures

ACCIDENT figures published in an American journal show that the motor car causes one death every 16 minutes, a pedestrian is killed every 42 minutes, and a cyclist is killed every 750 minutes. Therefore, if you want to live to a good old age, ride a bicycle.

Duchess takes up Cycling

IN order to save petrol, the Duchess of Atholl has taken up cycling. As president of the County Red Cross Association and interested in the schemes for prisoner of war comforts, and other public spirited enterprises, the Duchess finds the cycle of great use and practical economy in these days of rationed petrol.

Rene Menzies as Chauffeur

RENE MENZIES, who held the British year's cycling record in 1937, and the 100,000 miles completed in 1938, is in the Free French Army, and is now acting as chauffeur to General de Gaulle.

Played Against W.G.

MR. JOHN EDWARD BEASLEY, who has just died at Skegness at the age of 85, was for over 30 years with the Raleigh Cycle Company. He played in one of the Company's teams which played against the famous W. G. Grace—and won.

Bicycle Radios

APROPOS a recent paragraph in an American journal stating that America is now designing radio sets especially for bicycles, English cyclists should note that a Government Order recently issued by the Emergency Powers Act states that no person shall use or have in his possession or under his control any wireless receiving apparatus installed in any road vehicle.

That cycling is as popular as ever is shown by this photograph, taken outside a bathing pool in Hertfordshire.

NOTES OF A HIGHWAYMAN

By L. ELLIS

ONE of the best-loved touring spots in the whole of the British Isles is that marvellous strip of coast road along the north side of Devon, and to be fair, including a good piece of Somerset. There are at least two good reasons why the tourist lingers hereabouts. The first is that the hills are so fierce and so numerous that anything like a big mileage in the day is quite impossible. The second is that no one but a hardened mile-eater could risist the charms of the locality, and no mile-eater would choose such a road. There are magnificent views all along the road, and the acute slope of Countisbury Hill sends us precipitately into Lynmouth. Here we can breathe and start to look around. Eastward

Watersmeet Valley, Lynmouth, Devon

lies the Watersmeet Valley, although the junction of the East and West Lyn actually occurs at Lynmouth Bridge. It is an enchanting walk along the East Lyn and may be continued to Brendon. The watersmeet of Watersmeet Valley is not that of the two Lyns, as is sometimes supposed, but of the East Lyn and the Hoaroak Water. The East Lyn itself is composed of the Oare Water and Badgeworthy Water, all the names being inseparably connected with the novel "Lorna Doone." Lynton is on the cliffs and literally overhangs Lynmouth, which is on the sea. The road connecting the two reaches a gradient of 1 in 4½. Westward of Lynmouth is the celebrated Valley of the Rocks and miles of enchanting touring country.

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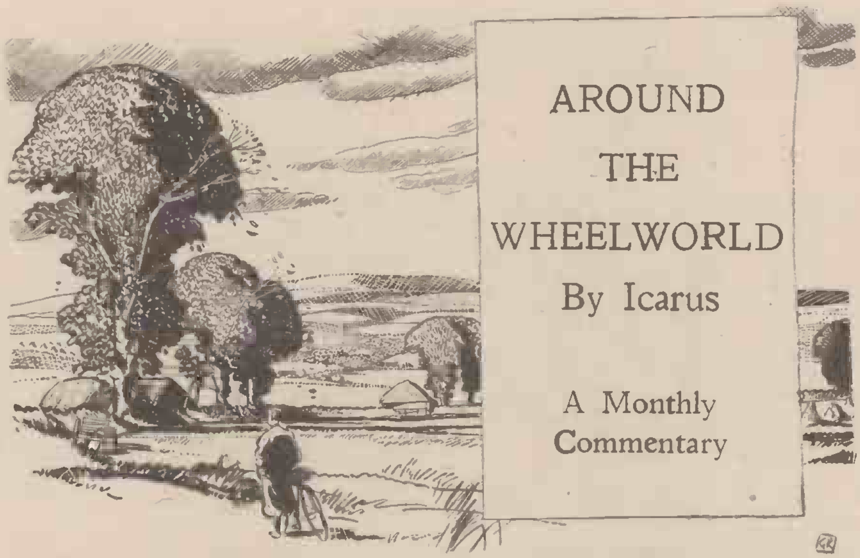
AROUND THE WHEELWORLD

By Icarus

A Monthly Commentary



The Bath Road "Do"

ALTHOUGH the Bath Road Club cancelled its "100," it would be impossible to extinguish the flames of enthusiasm which burn ever fiercely within the ranks of this famous old club. For reasons which have been explained they decided, as they did in the last war, not to hold their famous "100" this year. Realising, however, that apart from the trial itself this was an annual occasion when many members and their wives met socially overnight and down the road on the morning, they sprang a dinner at the Clarendon Hotel, on Saturday August 3rd, with the club president, J. Burden Barnes, O.B.E., in the chair. Nearly 70 members, wives and guests, sat down to a well-arranged dinner which was punctuated with the cross talks and well-meaning badinage for which the club is renowned. There were but two toasts, that of the ladies and that of the guests. Joe Callway proposed the former, whilst Mrs. Bentley replied, and the toast of the guests was proposed by the president, the response coming from H. H. Angleterre. The editor of the *Bath Road News* was presented with an illuminated timepiece, to commemorate the publication of his latest book on watches. This was the first occasion in the history of the club in which ladies have been present at a club function. The club wishes me to deny the suggestion that this indicates that they are going "soft."

George Berger

I HAD a letter from George Berger, who is now on defence engineering work. He tells me that it is improving his physical condition and that he has made arrangements to resume training as soon as the military situation and his duties will allow it. He was with the British army fighting in France and was evacuated from Dunkirk. It is his intention to fight also for this country in the next Olympic Games. George was, of course, a corporal in the former Austrian Army.

Committee Procedure

IN a recent issue I drew attention to a prevailing idea among cycling clubs that, by marking their club journals "Private and Confidential" they thus escape risk of a libel action. I pointed out that editors of club journals, as well as every member of the club, is liable and responsible for matter appearing in the club journal. It may be that, in this mistaken belief, many amateur editors sail a little too near the law of libel (some even beyond it), unaware of the risks to which they are exposing their clubs.

Of course, there is a good deal of badinage and friendly leg-pulling in club journals and most club members accept it in the right spirit. I cannot trace that a libel action has ever been brought against a club because of matter published in its journal.

The Halfway Inn, Kintbury, Berks.

There are in every club a few thin-skinned members who "cannot take it," and it is just as well for editors, as well as club members to know where they stand. The thin-skinned members are always those who come in for the greatest amount of ragging.

Another point. Unless the rules include one that the contents of the journal are private and confidential, members are not bound to keep them so. The words have no more value in law than "Errors and Omissions Excepted" on an invoice, or "Private and Confidential" on a letter.

Editors, too, often print at the top of the correspondence page the ambiguous words "The Editor is not responsible for the opinions expressed by his correspondents." Unfortunately, he *is* responsible in law. What such editors mean to convey is that they do not agree necessarily with the opinions of their correspondents.

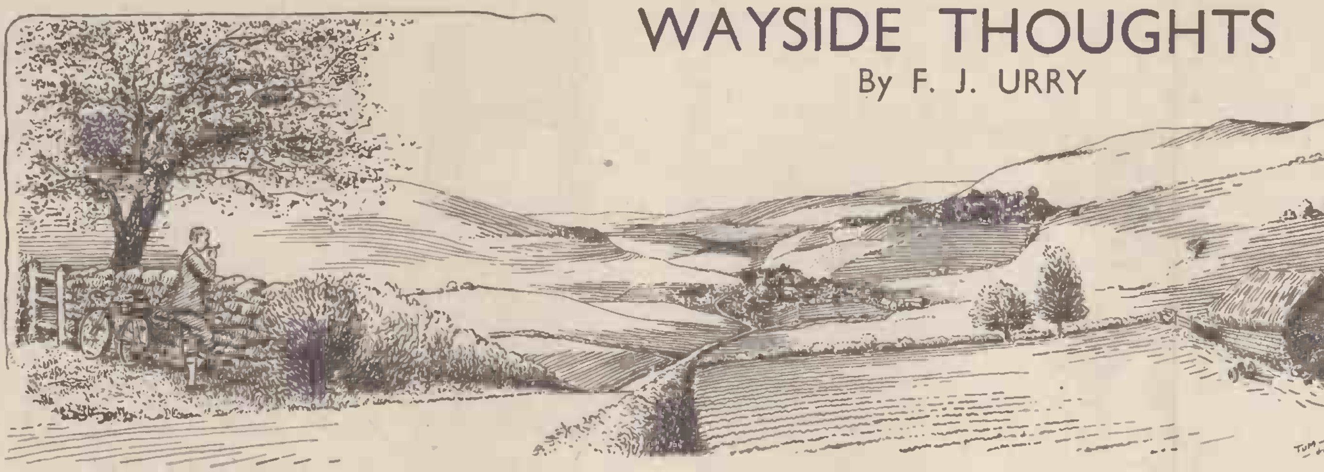
Committee Proceedings

I FIND similar confusion of thought among members of committees. They have a dim notion that committee meetings are privileged occasions at which they can indulge in the wildest slanders, and escape the penalties of such slanders. Let me set their minds at rest upon that point. A committee meeting is a privileged occasion under certain circumstances. For example, the committee of a cycling club are perfectly entitled to discuss events concerned with the club and its members, providing that such matters are discussed free from malice. They are even entitled to discuss members of the committee, but they could not escape from the penalties of a slander action if a member of a committee felt that he had been slandered in committee by another member of it.

Moreover, the privilege of the occasion does not entitle members of the committee to attack the personal integrity of club members or committee men, nor does it entitle them to discuss matters outside the province of a committee. Again, committee matters are confidential and should not be discussed by the committee members outside the committee room. If they are, the plea of privilege which might otherwise be advanced, vanishes, and an action for slander, if proved, could succeed. It is the duty of the chairman to impress upon all committee members that the discussions must be kept private; especially is it necessary when the members of a committee may not be expected to know the legal penalties. A chairman who fails to point this out could himself be held as negligent. Fortunately, most old established clubs understand these finer points of club life, and there is little about which to complain, but in some clubs which seem to have more than their quota of spiteful and malicious people the committee is merely used for the furthering of private vendettas.

WAYSIDE THOUGHTS

By F. J. URRY



That August Week

BECAUSE there was the tan of sun and wind and rain on my brow the week after August holiday people asked me where I had been, and when I told them I had been camping their invariable reply of "poor devil" evoked an explanation. Yes, I had a week under canvas, following the habit of twenty-five years and more, and though I have known finer weeks, never I think a happier one than that of August last. As one of our party of a dozen old campaigners said in the middle of a twenty-four hours thunderstorm, "Our English climate is so exciting, you never know what will happen next." And that was the spirit of our camp on the edge of the Pembroke coast during those early days of August when the weather was so erratically mixed, and the calms and storms followed with their quick changes to make one wonder that such assortments could be compacted in a few short days. We erected our camp in a sea-mist with the South Bishop booming its warning to the mariner; and we struck it on a Sunday morning amid a blaze of perfect weather, with the wide sweep of St. Bride's Bay asleep in the sunshine. More than twenty-five years of camping has given us an experience of tent life which is invaluable in stormy circumstances, and naturally our equipment has grown until we are practically immune from anything short of a flood or lightning. But I felt sorry for the lightweight tenters in this south-western corner of the land, for many of them must have had a damp, and possibly an uncomfortable, time in their tiny wigwams, for there were hours when the rain was savage, and trodden earth became a quagmire. We were lucky in our site, and more fortunate still in our equipment and its means of conveyance, for weight with us is not a counting factor with a lorry to take the load. Three of us rode down, or at least we attempted the journey, starting on the Friday before August Monday. It was close to New Radnor the rain came out of the hills to meet us, great grey swathes of it, as if the rounded hill-tops themselves were dissolving in moisture, borne on the south-western gale. Right into it we went, over the Forest Inn Pass for the Builth road, and it was like riding into a wall of thin water. My friends looked at me just beyond the Wyeside town while we were walking a hill, and the water was oozing from our lace-holes, and then voiced the question I had been expecting for some time; "was it worth the hard struggle?"

The Mixture To Test Tempers

With the long drag to Llanwrtyd ahead of us, followed by the pull over Sugar Loaf to Llandovery, I was bound to agree the prospect was not genial; so we called at Garth and found a train in twenty minutes —replete with tea-car—would transport us to Llandilo in time for an evening jaunt to Carmarthen; and that did it! Perhaps we have gone beyond the stage of heroics, and perhaps our years in total justified the fall from grace; but the fact remains that we thoroughly enjoyed a quiet ride in the calm dampness of the evening over the strangely deserted road that follows the Towey from Llandilo to Carmarthen. True there was little to see, for the hills were under the mist, and the well known way lacked its pleasant characteristics; but the warm moist air was good to breathe, and the spare dry stockings wise folk carry in the bag were comforting, so the colourless sunset saw us into Carmarthen without distress and full of hope for the morrow. But we got no further than Whitland on the Saturday morning when a thunderstorm struck us with its brutal rain, and I think wisely we took an early lunch and a convenient train to Haverfordwest. We laughed to think of ourselves as cycle tourists; but what would you when camp has to be erected, and the prospect of a drenched start is not inviting? The day was still dreary at Haverford, a silvery mist, wet as a dew-drop, sweeping in from the sea; and it was in this putheriness we erected camp, and did the job well for we almost sensed what might be coming. Later that Saturday evening it started to patter, and the dim horizon was aflicker with electricity; yet under a bemused half moon I surveyed that camp before turning in and deemed it well chosen as to site, and well equipped as to gear. My job in camp is breakfast, given me for propensity for early rising; and I like to wander round in the dewy morn and watch the day awake. But on that Sunday the wet wind drove me to our big awning which serves for a dining room and cook-house, where-under I lit the buzzing stoves and in due course, and beneath the protection of a gay golf umbrella, paraded camp with the early morning cup of tea. The sunshine came later, hot from the fiery sky, making the curl of the wave as it smote your body a cool delight.

Breakfast In Bed

On a perfect August day we went to Marloes, a lovely stretch of beach below the rugged village, that may one day become a famous watering place. All day the thunder rumbled in from the sea, as if in defiance of the splendid sunshine, but the warning was sound if not fiery, for ere nightfall "heaven's artillery" was in full operation, and its accompanying downpour washed out our camp-fire and sent us early to bed. It was Tuesday, however, that made the welkin ring with detonations, for five thunderstorms circled our camp all day, and arrived in the afternoon, announcing their descent with most unpleasant vigour.

50 Mile Record Courses

By FRANK SOUTHALL

MISS MARGUERITE WILSON did not lose her 50 mile record for long. Although her ride was made on an inferior course to the one used by Mrs. Briercliffe, I understand that the conditions in Scotland were much better than in the case of Miss Wilson's course, starting in Oxfordshire. This latest 50 mile time of Miss Wilson's more forcibly bears out my prediction made last year when I put her on this Newmarket course on the occasion of her 2h. 9m. effort. I said then that she would easily beat two hours on the Glasgow-Edinburgh route. Strange to say, several well-known personalities in the record world seem to think that this course isn't much good and that the course used by Marguerite for her 2h. 7m. effort is faster. As far as my memory goes back, the 50 time recorded on this stretch of road was H. James 1.49 odd, but on the other hand, the rides put up on the Glasgow-Edinburgh route are those standing to-day as R.R.A. best ever. A couple of Scottish lads on a tandem, although quite a good combination but not exactly up to Mills-Paul standard, hold the "50" with a ride of 1.37 odd and then again, Watson of Edinburgh trundled a bike a few seconds outside 2 hrs. Both these rides I think were done on steel wheels. Harry Hill clocked 1.44 also on steels. This beat my ride of 1.46 on the Newmarket course which I used in 1934.

The reason I used this route was because T. Lauterwasser used it and I wanted to show my speed over the same route. The latest and present record by Shake Earnshaw 1.39 odd over 30 m.p.h. all the way, makes the record for the 3 types all in Scotland.

After these rides it rather amuses me to hear people say that this course is slower than the route used by James for his 1.49. Yes, I think under good conditions Marguerite will ride 50 miles in about 1 hr. 55 m. on the "*Record*" course.

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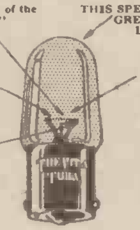

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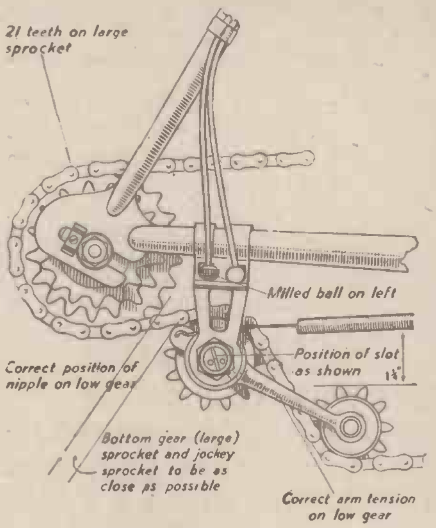
Gears and Gearing

By A. W. BRUMELL

(Concluded From Page 20 of Last Month's Issue)



The mechanism of the Cyclo three-speed gear.

ANOTHER form of derailleur which is very popular on the Continent—though comparatively rare over here—achieves its result by means of a double chain-wheel and a quarter-circle, chain-shifting device attached to the seat tube just above the larger chainwheel. This device moves sideways and pushes the chain from one chainwheel to the other, a tension pulley near the rear drop-out keeping the chain at the correct tension. Though in itself quite a useful two-speed, this model is used principally to double the number of gears available on a three-speed already fitted. Used in conjunction with a medium ratio hub-gear it can give a very fine selection of six gears ranging from the 80's down into the 30's, each gear being only about a mere ten inches apart. In conjunction with a four-speed, the selection is even greater. Using a 48/30 toothed chainwheel and the medium ratio hub with a 17 sprocket in a 26 in. wheel, it is possible to get the following gears: 80, 73, 66 and 55 on the larger chainwheel; 50, 46, 42 and 36 on the smaller. This would appear to approach as near as possible to my ideal of a gear for every eventuality, however big or small a change is necessary. Many people who have never tried grouping their gears close together may think the change too slight to make any difference. But they can take it from one who has been experimenting with *all* kinds of gears for years, that a few inches more or less can often make all the difference between slogging and pedalling, while there are numerous occasions when to make a large change in gear means a definite loss of both energy and rhythm. How many times, for example, does a rider of a wide ratio gear slog up a slope that is just too steep for the gear he is using rather than change down to a gear on which he appears to be treading on air? The closer one's ratios the more frequently one takes advantage of the variety of gears available, and the more one learns to appreciate the art of skilful gear-changing.

The double chainwheel can also be used in conjunction with an ordinary derailleur that has the tension pulley at the rear. It cannot be used with one whose tension arm is fastened near the bottom-bracket. Though very popular on the Continent, I cannot fancy this combination, though I admit to not having tried it myself. The chain is too often so far out of alignment while I should think that the two chainshifting devices would sometimes dislodge the chain at the wrong end, especially when it was beginning to get a bit worn. It, however, has the advantage of saving the weight of the tension arm and pulley since the original three-speed will have these already.

Another method of obtaining multiple gearing is to combine a hub three-speed with a derailleur three-speed and so obtain nine gears. This involves fitting a triple cog to the three-speed hub and can only be done, at the moment, when the latter permits of a screw-on type of cog. It should be borne in mind, if this combination is contemplated, that most cogs on three-speed hubs these days fit on by means of a spline and locking ring. Though in theory there are nine gears available, some of these overlap and so cancel one another out. The main disadvantage is that all the extra weight is concentrated at the rear of the machine, besides being largely revolving weight. Added to which, there is the awful headache the rider gets trying to work out exactly what gear he really is using!

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