FIGHTERS OF THE R.A.F.

NEWNES

PRACTICAL MECHANICS

AUGUST 1940

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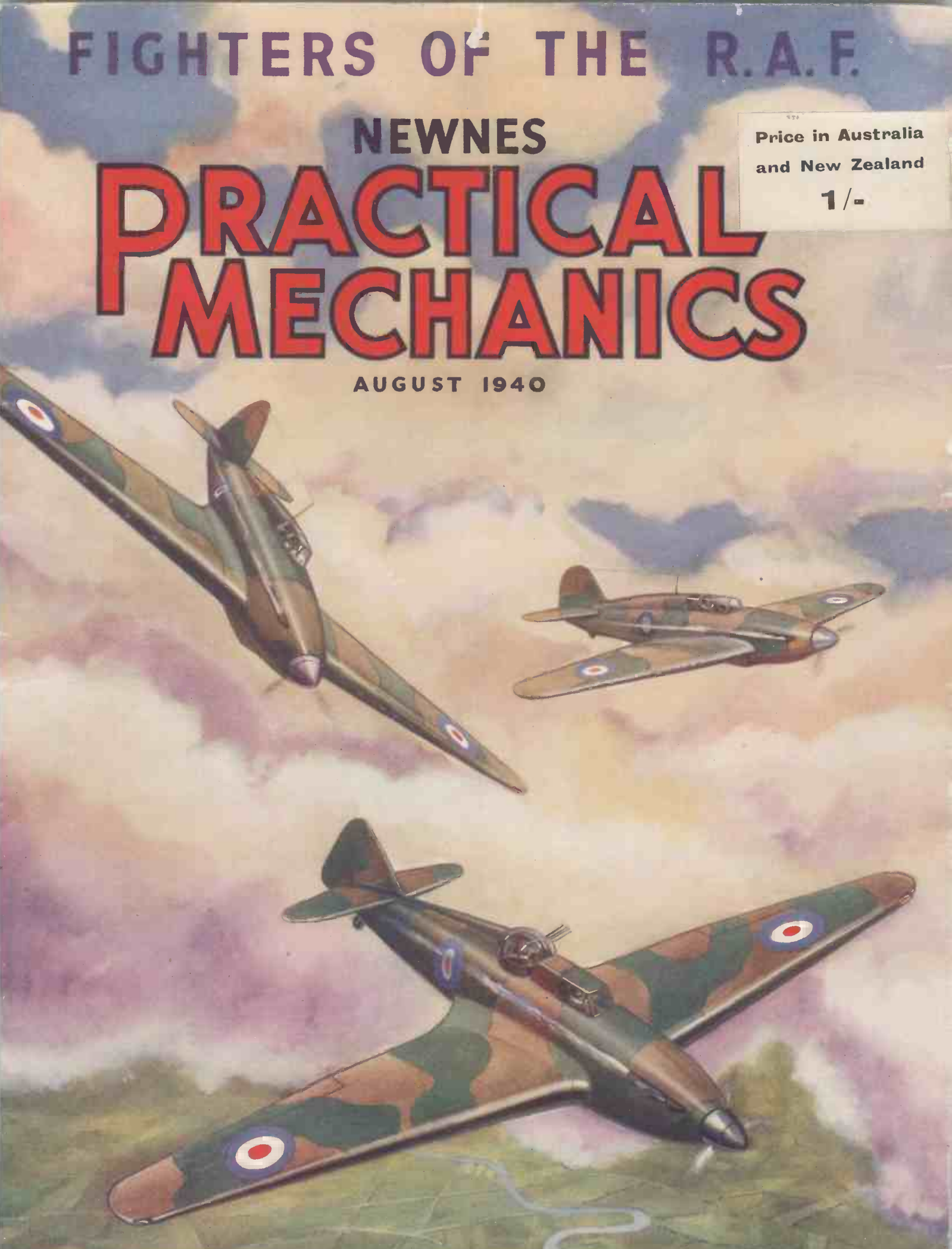

DO NOT CONCENTRATE ON WAR

Do not concentrate your thoughts upon war subjects. You will find it very worrying and very bad for the nerves.

Read, write, sketch, paint, study your vocation; anything that will occupy your mind and your time. Make use of your spare time by concentrating upon something useful.

During the last war many people learned how to write short stories, etc., to-day a number of them are world-famed authors.

By becoming efficient in your vocation you can give the best service to your country and to yourself. The more you increase your earning power the better it is for the country and for yourself personally.

War or no war, earning power always brings its possessor to the front. It is no use waiting for better times. The ideal opportunity never arrives. We have to make the best of existing conditions. Therefore, delay is useless; it is worse, it is harmful.

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Editorial and Advertisement Office: "Practical Mechanics," George Newnes Ltd.
Tower House, Southampton Street, Strand, W.C.2.
'Phone: Temple Bar 4363.
Telegrams: Newnes, Rand, London.
Registered at the G.P.O. for transmission by Canadian Magazine Post.

PRACTICAL MECHANICS

Owing to the paper shortage "The Cyclist" is temporarily incorporated

Editor: F. J. CAMM

VOL. VII. AUGUST, 1940. No. 83

FAIR COMMENT

By the Editor

Amateurs May Help

AMATEURS who have a lathe or other workshop facilities are afforded an opportunity of assisting to make certain small parts necessary for armaments. Many technical institutes having a workshop are already doing so. Those interested should write direct to me, and I shall be glad to advise them as to how and where their services may be made use of.

There must be a great amount of useful equipment in the workshops of amateur craftsmen, which could be put to good account if the owners were suitably directed. Obviously contracts cannot be placed with them direct by the Government, but there must be many firms who could place small but important jobs with them, especially such firms as are local to the readers concerned.

I therefore propose to keep a book of names and addresses of readers who are able and willing to undertake sparetime work. I also invite letters from manufacturers who would like to get into touch with such spare-time workers.

Inventors

WARS give a great fillip to inventors. In the past six months I have received and examined hundreds of inventions for new types of aeroplanes, and engines, tanks, systems for destroying ships and aircraft, new types of guns, new methods of making munitions, new types of substitute material, and so on. In only a few cases have I discerned a practicable idea. Most of them have been thought of before and discarded as impracticable. My general advice here to inventors is that they should not waste time on the obvious, for what is obvious to them is also obvious to thousands of others. They should not presume that the War Office, the Admiralty and the Air Ministry are staffed by incapable people who are not constantly searching for new methods. It is unthinkable that the obvious has not also occurred to them. The Government, during the war, has the power to make use of any invention it requires, and compensation is considered after the war. It is much better for inventors to obtain a Provisional Patent for their ideas and to write direct to interested firms, asking them to take the matter up on their behalf.

Inventions Department

MOST firms have an inventions department, and they will be able quickly to investigate the idea, to have a search made at the Patent Office, and if they decide to proceed to make an arrangement with the inventor concerned. But inventors usually are mistrustful people. They imagine that they will be cheated of their creation. They write to me for advice, merely giving the broad claims of what their invention will do; they do not give practical details to enable me to see whether their claims are well-founded. So here I remind readers that they may send their ideas to me in confidence, knowing that they will not be published. In any case, I always advise them to make use of the services of a reliable patent agent. Such will save them money and time. Unless you can disclose details of an invention, it is impossible for advice to be given. I do not accept the claims of inventors without proof. And once again I cannot undertake to supply lists of firms likely to be interested in the idea.

Experiment

MOST manufacturers are now so busy on tried and proven devices for war that they have little time for experimental development and quite a number of inventors with a bland idea expect firms to experiment to demonstrate whether the idea will work. Every inventor should either make a model or in some other way conduct experiments. The workshops of this country would be packed with crazy ideas if every firm undertook to do the work of the inventor. The inventor must create, test and prove; it is for the manufacturer to assess its value and to make it.

A Reminder

MANY districts in this country have been compulsorily evacuated. A reminder, therefore, to readers that they must re-order this journal when they reach their new district. It is not available on sale or return. We only print such copies as are ordered owing to the paper shortage. I mention this because several readers who have moved have complained when they have not been able to obtain a copy. Although dozens of announcements have appeared in the daily, weekly and monthly journals and periodicals, exhorting readers to place a regular order, many still fail to perform that mild service to themselves and to us. If this paragraph applies to you, will you please place the order with your newsagent to-day? It will save you the trouble of writing a letter asking whether we can supply a copy, and also two lots of postages.

New Books

NEW books recently published from this office are the "Superhet Manual," which costs 5s. or 5s. 6d. by post; "The Radio Engineer's Pocket Book," 3s. 6d., or by post 3s. 10d. (waistcoat pocket size with round corners); "Diesel Vehicles: Operation, Maintenance and Repair," 5s., by post 5s. 6d.; and "Watches: Repair and Adjustment," 6s., by post 6s. 6d. The last-named book includes a chapter on how to adjust a watch to obtain a Kew certificate and deals with the repair of modern watches. "The Radio Engineer's Pocket Book" will be appreciated by those thousands of wireless enthusiasts who are now in the services, for it is small in size and easily fits the uniform or waistcoat pocket.

Our Formidable Fighters of the Air

Loading the thousands of bullets into the eight Browning machine-guns of a Hawker Hurricane. The aircraftmen call this "putting the Hurry in the Hurricane."

How the Defiant, Hurricane and Spitfire Compare with the Fighter Planes of Other Countries.

IN just over 20 years development the aeroplane has become the most formidable of the war machines. In no way can the S.E.5a's, Dolphins, Snipes and Camels used in the last war be compared with the modern fighters. The latter differ in design, in speed, range, striking and defensive power. Speed which is essential in all successful types of fighter craft, shows an amazing jump of over 200 m.p.h. Whereas the fighters used in 1914-18 had a maximum speed of 120 to 150 m.p.h., the Vickers Supermarine Spitfire has a maximum speed of 367 m.p.h., the Hawker Hurricane 360 m.p.h. and the Defiants the incredible speed of nearly 400 m.p.h. The appearance of the plane has altered, too, for, whereas in the last war they were all bi-planes or high-winged monoplanes, to-day, anything but a low-wing streamlined monoplane is an exception.

Landing Speed

This radical change has also meant that a new technique of landing must be learned as with the modern machine the old methods of shutting off the engine and side-slipping in at the last moment is impossible. Now the "rumble" landing, as it is called, is adopted. Speed in landing is retarded by flaps in the wing which are let down by the pilot, and when the machine touches the ground automatic hydraulic brakes are brought into operation to bring the aeroplane to a standstill.

The "ceiling" of the old type of fighter was roughly 20,000 feet; as against this the modern machine can climb to something like 30,000 feet.

Armaments, too, have shown a revolutionary change. In the beginning of the last war the pilot defended himself against the enemy with a revolver or rifle which he carried in the cockpit, but this necessitated the pilot releasing the controls in order to take a snapshot at the enemy pilot or machine. Some time elapsed before a gun mounted on the machine was used, and then it was mounted on a device something like a motor-car spring in appearance. Then came the two guns firing forward through the propeller. Now study the armaments of a present-day fighter. The Hurricane and Spitfire carry a formidable battery of eight guns—four in each wing—all of which are operated by a single control-button in the cockpit, whilst the Boulton and Paul Defiant has a retractable gun turret which mounts four Browning guns.

Manœuvrability

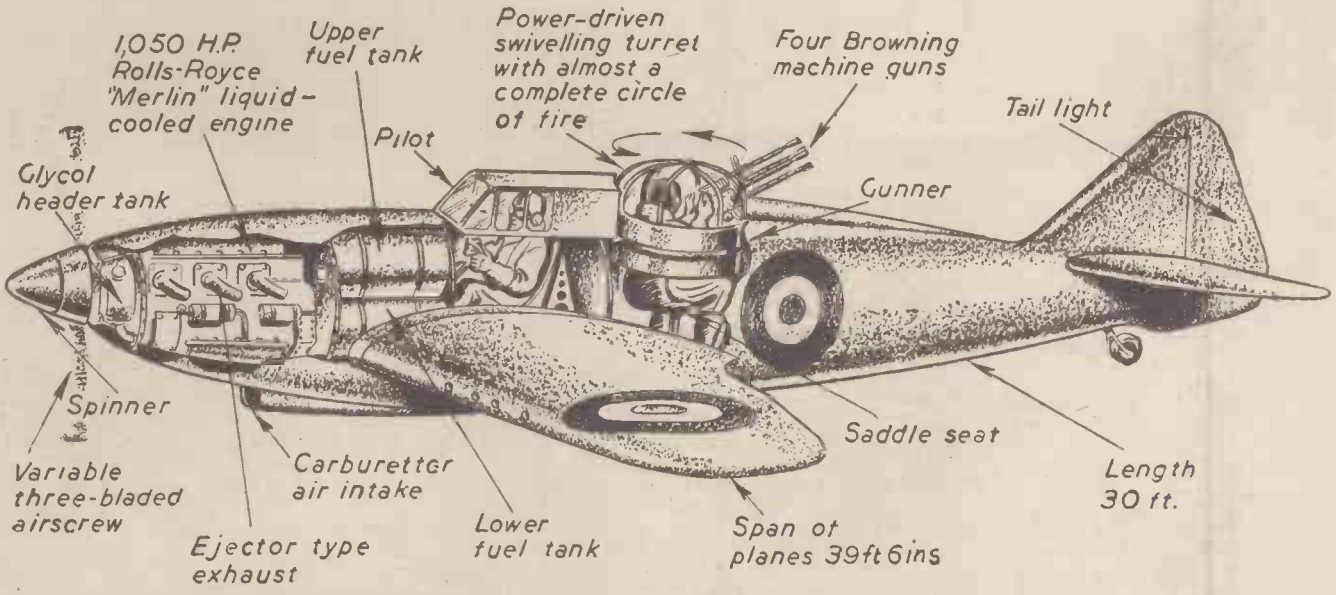
Once a machine left the ground during the last war the pilot had no means of communication with his base. To-day, he can keep in constant contact by means of wireless and pilots can even talk to each other whilst in the air.

The trend of aircraft design has shown that manœuvrability has been sacrificed for speed. In the last war the biplane was preferred because, owing to its short wing span, it had great manœuvrability. Thus a pilot was able to score a victory over another by trick pilotage. The pilot of a modern fighter has been deprived of this great asset of manœuvrability and he now relies on his heavy battery of guns and great speed to deliver an attack and then get out of range of his opponent.

Now let us examine these remarkable types of British fighters. First, we will describe the Defiant which is a two-seater fighter. It is made by the Boulton Paul Aircraft, Ltd., and is the most recent addition to our fighter aircraft. It is a low-wing monoplane and is graceful and well-streamlined in appearance. It is powered with a Rolls-Royce Merlin engine, and can attain the incredible speed of nearly 400 m.p.h. Some years ago the R.A.F. used a two-seater fighter made by the Hawker Company—the Hawker Demon—and the Defiant is a successor to this machine.

Its armaments consist of a retractable gun turret situated half-way along the fuselage which mounts four Browning guns. The Defiant has a wing span of 39 ft. 6 in. and is 30 ft. in length. The fuel tanks are situated in front of the pilot and the air-screw is of the variable three-bladed type.

The main secret of the outstanding success of this type of fighter which has



The Boulton Paul Defiant, which is a two-seater fighter. It is a low-wing monoplane, and is graceful and well streamlined in appearance. Note the power-driven swivelling gun turret, with almost a complete circle of fire. It mounts four Browning guns.

already been proved in France, lies in the swivelling gun turret which enables the gunner to deal with attacks from almost any quarter, whereas the Hurricane and Spitfire are vulnerable to attacks from sides and rear.

The Hawker Hurricane

We now come to single-seater fighters and there is hardly anything to choose between the Hurricane and the Spitfire. They are officially known as day and night fighters, which means they are ready at short notice to take off in daylight or in the dark to intercept and engage enemy aircraft.

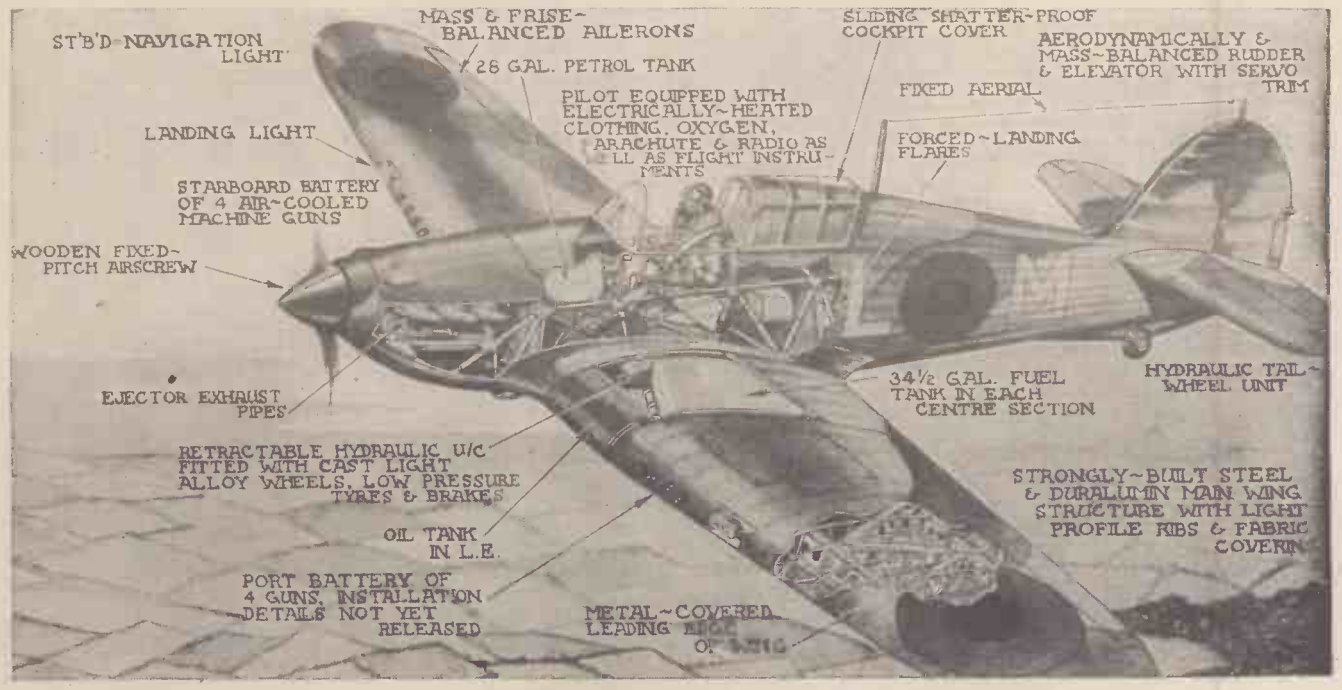
The Hawker Hurricane was designed by Mr. Sydney Camm, chief designer and a director of Hawker Aircraft, Ltd. It is powered by a Rolls-Royce Merlin II 1,050 h.p. engine and is capable of a speed of 360 m.p.h. It measures 40 ft. from wing-tip to wing-tip, is 31 ft. 5 in. long and 13 ft. 3 in. high. It has a cruising speed of 300 m.p.h., a range of about 700 miles at full throttle, can climb to 15,000 ft. in 6.2 minutes and has a service ceiling of 32,000 ft. Its armament consists of eight Browning guns housed in the wings. The instrument equipment of the Hurricane is very elaborate, and they are fitted with a two-way radio set, a seat-pack parachute, and full night-flying gear.

Built of Metal

Like all our machines, the Hurricane is a marvel of aeronautical engineering. With the exception of its outer fabric covering, it is built of metal throughout and is a low-wing monoplane of the cantilever type. By this is meant that the wing is self-supported by its main members and not by external bracing wires and struts.

All three wheels of the landing gear are retractable, and the undercarriage folds back into cavities in the underside of the wings. In the event of an accident, the undercarriage can be raised or lowered by three different methods. The first system, which is the main one, is power-operated and has hydraulic transmission. Next is the auxiliary system which is hand-operated and is also hydraulic, and if both of these systems should fail, then the pilot can release the pressure in the hydraulic gear by means of cocks and free the catches which hold up the wheels. The wheels then fall to the down position by means of their own weight.

When attacking another aircraft, the pilot of the Hurricane points the nose of his machine at the target by sighting along a



The Hawker Hurricane, which was designed by Mr. Sydney Camm, chief designer and a director of Hawker Aircraft, Ltd. It has proved itself to be one of our most formidable fighters. Its armament consists of eight Browning guns mounted in the wings.

single central gunsight and then depresses a button in the cockpit. Instantly the eight guns start pumping out bullets at the combined rate of 12,000 rounds a minute which converge and meet at a given distance in front of the machine. This is officially known as "lethal concentration."

The Spitfire

The Supermarine Spitfire is made by Vickers-Armstrongs, Ltd., and is a single-seater monoplane of exceptionally high performance. It is slightly smaller and faster than the Hurricane, having a maximum speed of 367 m.p.h. It has a wing span of 36 ft. 10 in. is 29 ft. 11 in. in length and 11 ft. 5 in. high. All the experience that this firm gained in building a series of Schneider Trophy winners has been incorporated in the Spitfire. Its armament, equipment and engine are practically identical with that of the Hurricane.

Split flaps are incorporated in the underside of the wing to keep down the landing speed to about 60 m.p.h., and these are lowered hydraulically when coming in to land. Powerful wheel-brakes then come into operation to bring the machine to a standstill.

Vickers Spitfire—8 machine guns.

Defiant—multiple guns in turret.
Bristol Blenheim—"nest" of guns under fuselage, 1 gun in rear turret.

Messerschmitt 109—4 machine guns, 1 cannon.

Messerschmitt 110—4 forward guns, 2 rear guns, 2 cannons.

Despite the formidable appearance of the Me. 110 armament, the smaller British Hurricane and Spitfire fighters have shown themselves a match for these machines, even in superior numbers.

Italian Planes

Foremost among the fighters of the Regia Aeronautica (Royal Italian Air Force) can be reckoned the Fiat G.56 and the Macchi C.200. Both are modern, single-seat monoplane types, with a single radial engine. They each carry 2 heavy machine guns, firing forward. Their wing span of about 35 ft. is two feet less than that of the Spitfire; whilst their speed—305 m.p.h. for the Fiat and 313 m.p.h. for the Macchi—is definitely low as modern fighters go. Against this they are reported to be very manoeuvrable and sturdily built. Another fighter, a biplane, reminiscent of Britain's obsolescent Gloster Gladiator, is the Fiat CR.42.

American Machines

Among the American twin-engined fighters is a single-seat 400 m.p.h.-plus machine with superfine streamlining, the Lockheed P-38. A characteristic feature of this machine is the way in which the two engine-nacelles are extended to form the tail units, and a central fuselage dispensed with. The motors are 1,250 h.p. Allisons, an in-line type of liquid-cooled engine reminiscent of the Rolls-Royce Merlin. Allison is a relatively new name in U.S.A. engines, and the type is now fitted to a number of America's newest fighters.

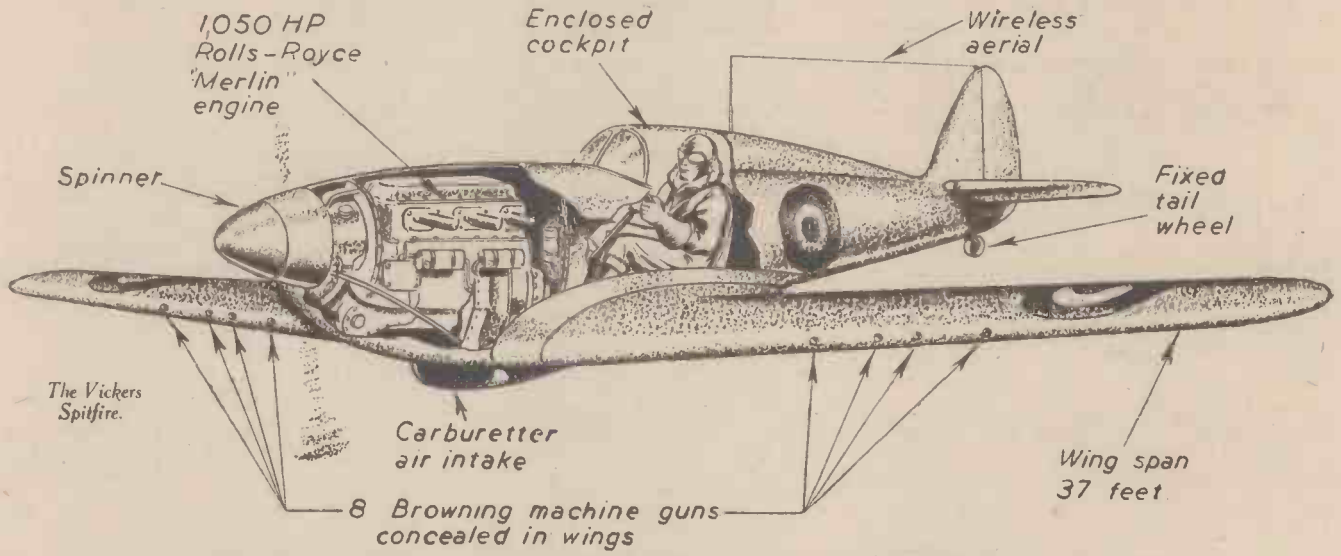
Another interesting machine is the Bell Airacobra—a single-seat fighter for which a speed of over 400 m.p.h. is also claimed. In silhouette not unlike the Spitfire, it is unique among contemporary aircraft in mounting the engine amidships, behind the pilot, and driving the airscrew by a long extension shaft. The twin-engined, multi-seat Airacuda is another Bell product in which the propellers are fitted behind the wings. Forward extensions of the engine nacelles are used to house gunners.

An American Fighter

A more conventional type of single-seat fighter from which a high performance may be expected is the Curtiss P.40. This sturdily-built fighter, designed for the U.S. Army, is also powered with a single 1,250 h.p. Allison motor. The latest version is known as the P.40D. The wing span, 37 ft. 4 in., is just a little more than that of the Spitfire. Another interesting design is the little, high-powered Vultee Vanguard. Although only a single-seater with a wing span of 36 ft., it houses a 1,600 h.p. Pratt and Whitney motor under its cowling.

The Air Ministry are at present considering an offer from the American authorities to release this secret plane to Britain. Its armament consists of 10 machine guns of a new design, and according to experts who have seen the machine, they make it invincible against any plane that Germany can put into the air.

Not much information has been released about the armament of these new fighters. In general, U.S.A. aircraft are less heavily armed than their British counterparts, but it may be remembered that the guns of the Curtiss Hawks supplied to the French Air Force, were increased to meet modern war requirements.



The Supermarine Spitfire is a single-seat monoplane of exceptionally high performance. It is slightly smaller and faster than the Hurricane and its armament, equipment, and engine are practically identical.

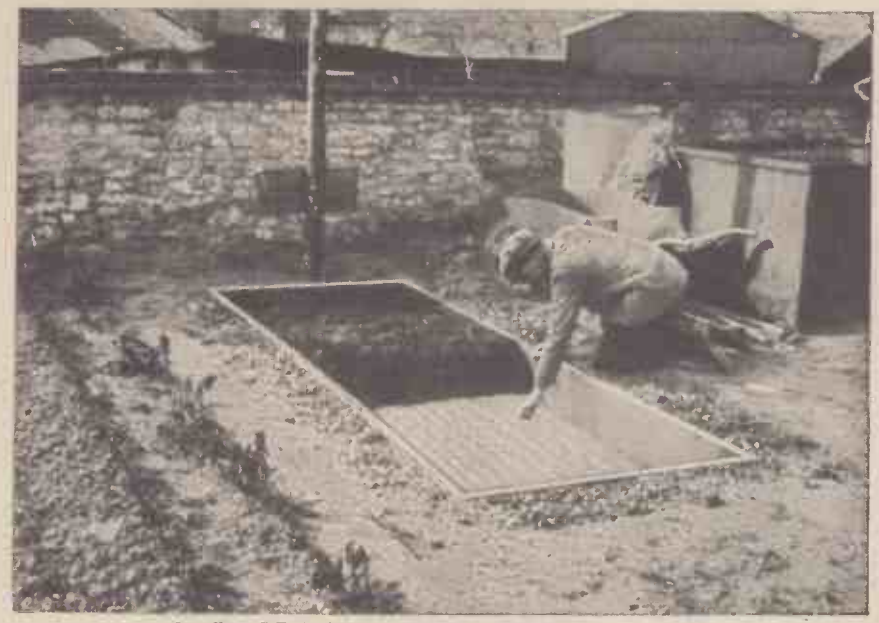
The Bristol Blenheim

Also under the category of a fighter comes the Bristol Blenheim, which is intended primary for both fighting and bombing operations. It is a high-speed all-metal landplane monoplane powered by two Bristol Mercury supercharged engines with variable pitch, and is made by the Bristol Aeroplane Co., Ltd. Its armament consists of a "nest" of guns under the fuselage and a gun mounted in a turret at the rear. It has a wing span of 56 ft. 4 in., and an overall length of 39 ft. 9 in. It is capable of a speed of roughly 285 m.p.h.

It is interesting to see how famous British types compare in armament with similar Nazi types. It will be observed that in current British fighters emphasis is on multiple rifle-calibre machine-guns. Variations in the standard armament, including the use of cannon, have been employed in some types, both British and German. "Cannon," incidentally, is a general term for large bore, shell-firing machine-guns.

British Fighters	*German Fighters*
Hawker Hurricane—8 machine guns.	Heinkel 112 — 2 machine guns, 2 cannons in wings.

Electricity in the Garden



Installing G.E.C. electric soil heating equipment in a garden frame

Methods of Heating the Soil in Garden Frames and Greenhouses

HORTICULTURAL science has developed in many directions during recent years, and various means have been tried for ensuring supplies of vegetables throughout the year. Other experiments have been in connection with the speeding-up of plant growth. In the latter category comes the use of electrical soil heating, which has for some time been used fairly extensively and with marked success in the Scandinavian countries, and parts of Europe. In fact, electric soil heating was used in Sweden as early as 1926, in which year 50,000 lettuces were grown in electrically heated frames.

The principles of electric heating of the soil are perfectly straightforward, for it is necessary only to embed some form of resistance unit in the ground and pass an electric current through it. In practice, however, the matter is by no means as simple as that, for the resistance element has to be insulated. And the insulation must be proof against moisture and various forms of chemical corrosion. Additionally, it must be robust, so that it is not easily damaged when using garden tools.

Heating Cables

A special resistance cable was produced some time ago by the Pirelli-General Co. (an associate company of the General Electric Co.), and this is now widely used, for it has proved to be especially suited to the requirements. It consists of an asbestos core round which is wound a length of resistance wire. Round this there is a lapping of asbestos, and over that a layer of paper tape. Next, there is a lead sheath, this being covered by a layer of specially compounded paper and an outer coating of compounded jute braiding. The ends of the cables are sealed and provided with vulcanised india-rubber tails for making connection to the electric supply. These cables, incidentally, were the first of British manufacture to be placed on the market and they are now used extensively.

The cables cost from 12s. 6d. (for a 25-ft., 125-watt unit), to just under two pounds for a 150-ft., 700-watt unit.

Temperature Control

One of the great advantages of electric soil heating is that the temperature of the soil can be controlled within fine limits; this is, of course, impossible in the case of the ordinary hot-bed made up with horse manure. One method of control is by means of a thermostat, which can be adjusted so that any temperature between 20 and 100 deg. F. is maintained. Additionally, the cables are far more convenient than hot-water pipes, and can be used without the need for a large and special plant. They are ideal when heating is needed for only a few months in the year or when only a few small frames are used. Nevertheless, the electric-heating system can be used successfully and conveniently in a large greenhouse.

The control switch and thermostat with the rod shown exposed

There are two principal methods of employing the heating cables, one of which is to sink them fairly well into the soil, and the other, to lay them on top of the soil and then press them in. In either case a means should be provided for insulating the heated soil from the surrounding earth (in the heat sense, that is) and from the atmosphere.

Installation

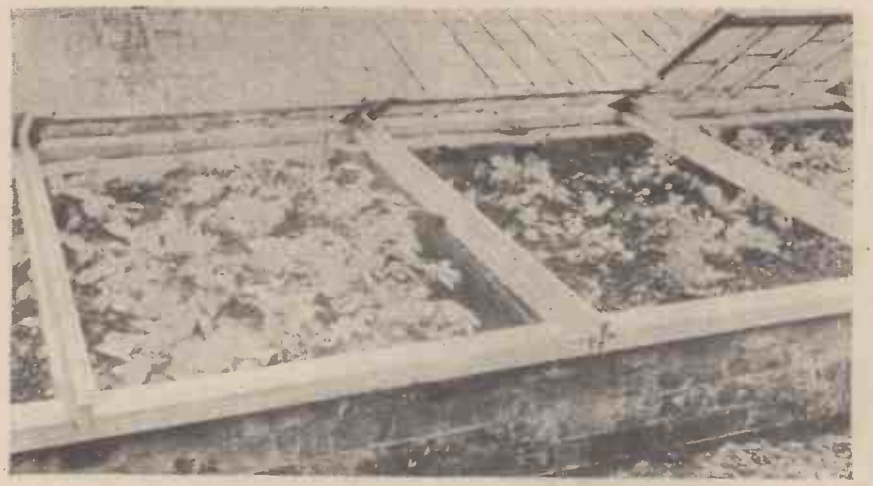
The precise method of installing the equipment will vary slightly, due to the disposition of beds and other local reasons.

The following recommendations are made by the G.E.C., however:—The situation of beds is naturally important, a well-sheltered site with a southern aspect being the most suitable. The bottom and sides of the beds should be well lagged with heat-insulating material to ensure the maximum economy in operation. This is most easily affected by excavating the bottom of the bed to a depth about 12 in. lower than the depth of soil there will be in the bed, and filling this space with coke, clinker, ash or similar material. The sides of the bed should be treated in a similar manner, so that an insulating surround, about 12 in. wide and sufficiently deep to reach the base of the bottom insulation, is furnished. Although 12 in. is recommended, if the cost is excessive this may be reduced. The side insulation may be banked up round the sides of the frame to provide additional protection, particularly when it is exposed to the wind, whilst in excessively windy situations a wind break of boarding or similar material is an advantage, and when placed about a foot away from the frame may be filled in with insulating material. When material such as cork board or insulated sheeting is available, it may be used for lagging or attaching it to the outside of the frame and making it moisture-proof by painting with pitch.

The next operation is to cover the bottom insulation with a layer of sand 1 in. deep. The cable is laid on the sand by running it backward and forward in the bed so as to cover the area as uniformly as possible, the cable ends being brought out to the point where they are to be connected to the electricity supply, after which the cable is covered with a further inch of sand. If desired, the top of the sand may be covered with wire mesh for mechanical protection and as a safeguard and warning when digging. Laying the cable in a bed of sand distributes the heat more uniformly than if it were laid directly in the soil. The bed is completed by filling it with soil to a depth of about 6 to 8 in., according to the plants which it is intended to grow.

Nursery Hot Beds

The method described is for use when plants are grown in soil in frames. When a nursery hot bed is required for starting seeds in pots or trays, or rooting cuttings, construction must be slightly modified. The procedure is the same up to the point where the cable is laid, after which the cable is



Early potatoes with and without G.E.C. electric soil heating equipment

covered with 2 in. of sand, but no soil is added, the pots and boxes being placed directly on the bed of sand.

The usual space between cable runs is about 4 to 12 in., according to the area which the cable has to cover, whilst round the sides of the bed it is recommended that the cable runs should be spaced more closely to maintain the temperature which might otherwise fall, due to heat transference to the surrounding soil.

In small installations one or two cables may be connected directly to a switch, but with larger installations it is preferable to use a connecting box. When a thermostat is used it should be placed with the metal tube in the soil, midway between cable runs and about 3 to 4 in. beneath the soil, the head of the thermostat being left above the surface. A position where the temperature is uniform with the rest of the bed should be selected. Placing the thermostat too close to the cable should be avoided, as this is likely to result in it operating too rapidly owing to the time lag between heat transference from the cable to the soil.

When installing soil-heating cable in greenhouses for supplementary heating it is not as a rule economical to provide heat insulation in view of the large areas involved; consequently, in such cases the cables are laid directly in the soil. In small houses, particularly of the type frequently used by amateurs, this difficulty may not arise, owing to the relatively small size of the beds.

Control

The cheapest form of control is a manually operated switch which, however, necessitates the supervision of the grower to ensure that the current is switched on and off as the temperature fluctuates. During the night this may involve considerable skill in forecasting weather conditions.

When a specific programme is being worked to, such as night heating only, regularity in operation is important, and with manual operation there is a risk that switching on may be overlooked at the beginning of a cold night.

Time switches furnish a more satisfactory method of control when regular programmes are in use, not only eliminating the trouble of manual switching, but also ensuring regularity of operation. The possibility of omission due to carelessness is also removed.

Automatic Switching

The most satisfactory method of control is by means of a thermostat or automatic temperature switch, which maintains the temperature in the bed within predetermined limits, irrespective of outside fluctuations. The soil-heating thermostats may be set at any temperature up to 100 deg. F. and will then keep the temperature constant within a small margin. Not only does a thermostat ensure the maintenance of even temperature under normal conditions, but it also provides a safeguard against unexpected fluctuations in temperature. In fact, the human element is entirely eliminated and the heating installation becomes quite automatic, whilst economical operation is assured, waste being avoided, as the current is switched off immediately the correct temperature is exceeded. Constant temperature cables with built-in controls are particularly suitable for small installations when temperature variation over wide limits is not required. For large installations separate adjustable thermostats are generally more suitable.

Dividing the Load

It is not always necessary to control the cables thermostatically in large installations, and the load may be divided up so that a proportion is permanently on circuit, and part only is thermostatically controlled. One thermostat may be used for controlling up to five 700-watt cables, but care must be exercised to ensure that the proportion of the load which is permanently on circuit is not so great that in mild weather the temperature may rise to a point where damage might be done to the plants.

Suitable Loadings

In general it is most satisfactory to allow generous loadings as a precaution against excessively cold spells. With hand control the temperature can be regulated by varying the time the current is on circuit, whilst with thermostatic control overheating is automatically avoided. For average conditions the approximate loadings required for various running times are roughly as follows:

Running hours per day 8 10 12 16 20 24
Watts per sq ft. ... 14 11 9 7 5.5 4.5

The accompanying table shows the equipment in cable which should be used in various standard sized frames to obtain various loadings

Lights		*Total Area*	*Cables*		*Watts*	
No.	*Size*		*No.*	*Lgth. each*	*Total*	*Per Sq. ft.*
	ft.	*sq. ft.*		*ft.*		*approx.*
1	3 x 4	12	1	25	125	10
2	3 x 4	24	1	25	125	5
2	3 x 4	24	2	25	250	10
1	6 x 4	24	1	25	125	5
1	6 x 4	24	2	25	250	10
2	6 x 4	48	2	25	250	5
2	6 x 4	48	1	100	490	10
3	6 x 4	72	1	100	490	7
3	6 x 4	72	1	150	700	10
4	6 x 4	96	1	100	490	5
4	6 x 4	96	2	100	980	10

The most satisfactory method of applying the loadings is to adopt the higher figure with thermostatic control. This ensures a reserve of heat and automatic control of constant temperature. The higher loadings should also be considered when short-hour operation is employed, to derive the benefit of cheap night tariffs, but in this case thermostatic control is not employed and the lower figure will generally be found more suitable, resulting in more economical operation and reducing the possibility of damage in mild weather.

When cooling beds are available for hardening-off plants before planting out, loadings may be employed about 25 per cent. lower than those shown in the table. Discretion must always be used, and experience taken into account.

Another modern means of stimulating the growth of plants is by the use of special lighting by means of an irradiator fitted with "Osira" floodlighting lamps. It is claimed that growth has been made more rapid, and the yield increased to a marked extent by having an irradiator in operation for eight hours per night.

The treatment has proved especially valuable with cucumber seedlings and strawberries, as well as with such flowers as gloxinia, cineraria and Star of Bethlehem.

Initial cost of the installation is fairly high—from about £15—but running costs are very modest.

The G.E.C. plant irradiator for stimulating and controlling plants by treatment with artificial light

STEREOPHONIC REPRODUCTION FROM FILMS

A New Method of Recording Music on Film

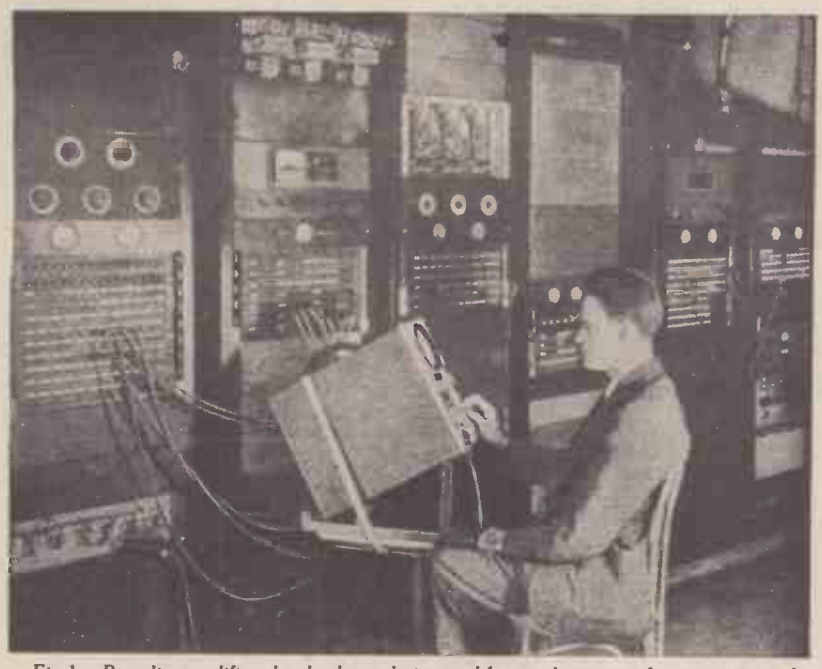


Fig. 1.—Recording amplifiers, low level reproducing amplifiers, and equipment for compressing and expanding the volume range

SYMPHONIC music heard over the radio or the loudspeakers of sound-picture systems, although very satisfactory, fails to produce in several respects the effect received by one listening to the original production in an auditorium. A full symphony orchestra utilises air vibrations at nearly all the frequencies the ear can hear, and it uses volumes of sound from about the lowest that can be heard in an ordinary auditorium to volumes one-hundred million times greater. The frequency range of such an orchestra, in other words, runs from the neighbourhood of 40 cycles per second to perhaps 14,000 cycles, and the volume range extends from about 30 Db above the threshold of hearing to 110 Db, a total range of 80 Db. In contrast with these ranges, radio and sound-picture systems usually have frequency ranges of only 5,000 to 8,000 cycles, and volume ranges from 35 to 50 Db. Moreover a listener in an auditorium receives an added effect from the distribution of the sound in space, a recognition of different sounds coming from different sources.

Limitations Recognised

These limitations have long been recognised by the Bell Laboratories, and some years ago an improved sound-reproducing system was developed. The result of this work was the stereophonic system demonstrated in Washington and Philadelphia in 1933. Besides reproducing practically the complete frequency range of the orchestra and an enhanced volume range, this system went further in interposing frequency and volume control between the pick-up microphones and the loudspeakers to permit the conductor to secure effects unobtainable from the orchestra alone. The music was picked up by three microphones spaced across the front of the stage, and the output from each microphone was carried through its own channel and control equipment to one of three loudspeakers spaced across the stage of the auditorium where the reproduction took place.

In the demonstration seven years ago, the music was reproduced at the same time at which it was being played but at a distance from the orchestra. On April 9 of this year a new stereophonic system was demonstrated in New York city, into which another set of steps has been introduced. The music is recorded on film, and is then available for reproduction from the film at any time. Four sound tracks are placed on a single film : one is used for each of the three programme channels, and the fourth serves for a control signal. A section of the film is shown in Fig. 2.

Recording on Film

This recording on film might seem a simple thing to do. With music and sound so universally recorded on film for sound pictures, there would seem little difficulty to those not technically familiar with

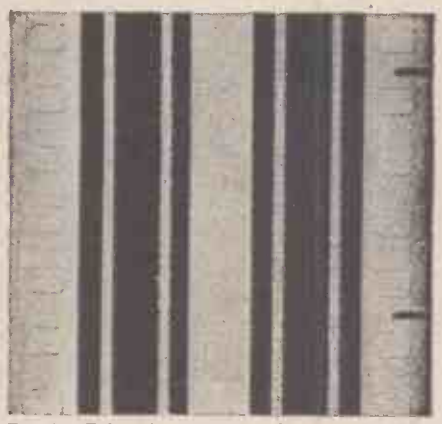


Fig. 2.—Enlarged photograph of the positive film used in the final reproduction.

sound-picture systems in recording and reproducing a three-channel stereophonic programme. The facts are, however, that ordinary recording and reproduction places no such demands on the equipment as does the stereophonic system. Sound-picture systems transmit a frequency range of less than 8,000 cycles, while the stereophonic system employs a band nearly twice as wide. The entire recording and reproducing system had to be designed for this greater range.

In addition much greater precautions had to be taken to reduce noise and distortion. An extremely quiet system is required so that music at very low volumes, much lower than used in sound-picture

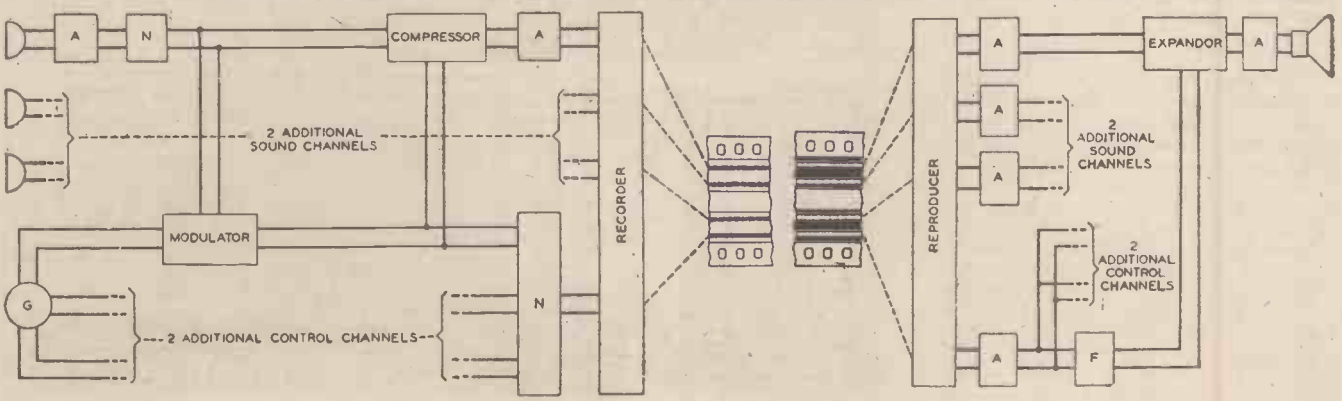


Fig. 3.—Wiring diagram of the stereophonic system.

systems, is not marred by the noise, and this is made more difficult because of the wider frequency range, which gives a wider band for the entrance of noise. In addition there is the matter of increased volume range. The maximum volume range that can be placed on a film is less than 50 Db, while the stereophonic system, with the 10 Db increase and decrease provided by the enhancement control, requires a range of 100 Db. At the very outset, therefore, the recording of music for stereophonic reproduction seems faced with an insuperable obstacle.

A Seemingly Impossible Task

The seemingly impossible task of recording a programme having a volume range of 100 Db on a film that will receive only a 50 Db range was accomplished by use of compression and expansion devices performing functions similar to those used on certain transoceanic radio channels. The music as it is picked up by the microphones is passed through a compressor, one being provided for each channel. These allow the music currents to pass to the recording equipment in their normal volume range if below about 45 Db; higher volumes are reduced by the compressor so that the limit of the film recording is not overstepped. At the same time a record is made on another track on the film of just the time and extent of these reductions. At the reproducing end, the music currents generated in photo-electric cells from a light beam passing through the film are carried through an expander before reaching the loudspeaker. The action of the expander is controlled by a signal obtained from the additional light track. At any point where the original programme was reduced in volume by the compressor, this signal will cause the expander to increase the volume by just the right amount. In this way the full 100 Db range in volume is reproduced by the loudspeakers without exceeding the 50 Db range that is available on the film.

Main Elements

The main elements of the system are indicated in Fig. 3. To control the compressor at the recording end, a small amount of the programme current is taken from the circuit just ahead of the compressor and is rectified. This rectified current modulates a single-frequency current which then controls the compressor and also forms the signal placed on the fourth track on the film. Since there are three channels, and the amount and time of compression will vary from one to another, three control signals must be recorded on the film, one for each of the three channels. These are all recorded on the same track on the film by allowing the three rectified currents to vary independently the strength of three alternating currents of different frequencies. These modulated currents control their respective compressors and are then combined and recorded as the fourth track.

Fig. 4.—The enhancement control unit of the stereophonic system provides both volume and frequency control at the discretion of the conductor

When the Film is Made

After the film has been made, if the music is then to be enhanced, it is reproduced while the original conductor listens and manipulates the enhancement controls to modify the frequency and volume ranges of the three channels and thus to secure an effect that more nearly suits his interpretation. The enhancement control unit is shown in Fig. 4. At the top are six keys used to control the frequency composition—there is one for each channel for adjusting the high frequencies, and one for each channel for the low frequencies. Each key has three positions and gives the control indicated in Fig. 5. The three handles on the front of the control unit are for adjusting the volumes of the three channels. As the handles are moved up from the normal position, the volume is increased, and as they are moved down, the volume is decreased. As the conductor listens to the reproduction of the original recording, he manipulates these controls, and another film record is made of the enhanced programme.

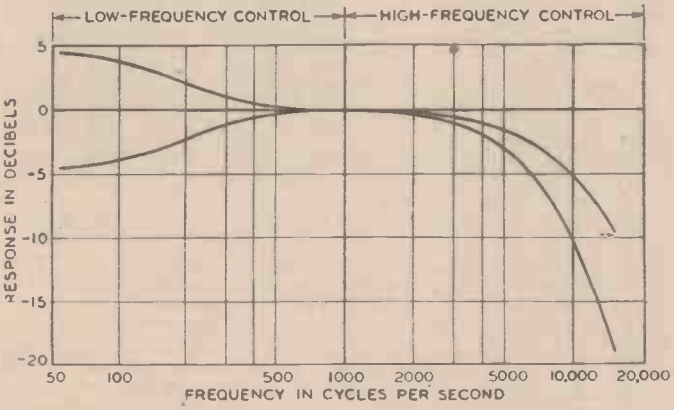


Fig. 5.—Frequency characteristics of the stereophonic system obtainable by manipulating the six keys that are located on the top of the enhancement control unit

Frequency Characteristics

This phase of the operation is shown in Fig. 6, which shows only one channel, however. The changes in frequency characteristics brought about by the enhancement control are secured by the insertion or removal of electrical filters, marked N1 in Fig. 6, in the circuit for each channel. The volume control modifies the current of the auxiliary channel, which is used to control the action of the expanders. Both networks, N1 and N2, are inserted in the circuit ahead of the point where the monitoring circuit is taken off, and thus modify the programme as heard by the conductor as well as the currents used for making the new film. On the new film, the three programme sound tracks are the same as on the original film except for the frequency modifications brought about by the filters. The control track, however, has been modified by the manipulation of the enhancement control so as to cause greater or less expansion when the programme is subsequently reproduced. The new film made as a result of this process thus represents the enhanced programme, and is the one used.

Incidental Development

Besides the compressors, expanders, and filters required for this new system there has been a considerable amount of incidental development of the associated parts. There had to be provided, for example, a carefully designed source for the three signal frequencies used to control the expanders, and narrow band-pass filters to separate the three frequencies at the reproducer so that each would control its own expander. Other developments were required to secure accurate timing. The signals must cause the expanders to act at exactly the same point on the film that the compressors had acted during the original recording. In addition practically every piece of equipment had to be studied and partly re-designed to reduce noise and distortion that in other circumstances would be unobjectionable. *Reproduced from the Bell Laboratories Record.*

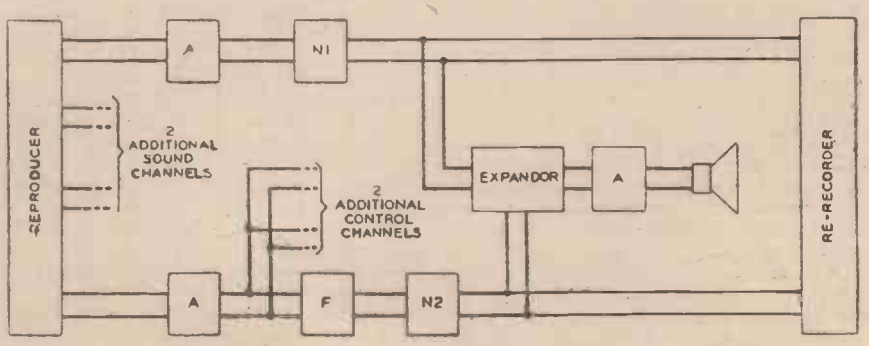


Fig. 6.—Details of the circuit used for enhancing and re-recording.

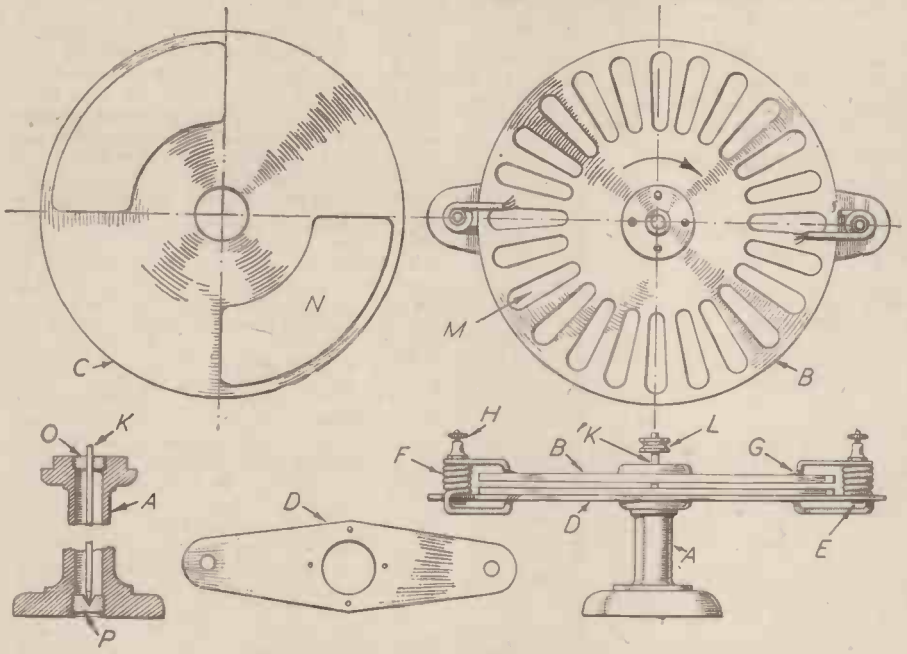
An Electrostatic Motor

By A. H. Avery, A.M.I.E.E.

A Motor that will Run without Current

INSTRUMENTS operating on the electrostatic principle, such as the multicellular voltmeter, are more or less familiar to readers interested in electricity. In this instrument relative motion between the two sets of fixed and movable elements, interleaved but insulated from one another, is occasioned by the well-known law of mutual repulsion existing between static charges of similar electric sign. The movable elements interleaved with and suspended between the fixed elements in the voltmeter take up a rotational movement for a portion of a revolution, until the repulsion effect is balanced against the torsion of a control spring, the deflection being indicated by a pointer on a scale calibrated in volts.

The idea may be developed a little further by suitably designing some of the parts in such a way that continuous instead of partial rotation is secured, resulting in a novel form of electro-static motor apparently able to run without current, merely by maintaining high potential charges at suitable points where they can strongly react on one another.



Constructional details of the motor

Mr. James Wimshurst

Many years ago the late Mr. James Wimshurst, the originator of the famous "Wimshurst High Tension Influence Machine," showed the writer a crude model embodying the functions of an electrostatic motor of such types as above, which ran at high speeds when coupled up to one of his influence machines, and this model somewhat developed is presented here in workable form, being something probably new to most readers, and possessing distinct possibilities.

Any motor that will run without current would appear to be somewhat of an anomaly. The present example is not just another of those constantly-recurring perpetual motion fallacies, nor can it be expected to develop power by itself without a corresponding input of energy in some shape or form from outside sources. Electrical power is measured in "watts," that is volts x amperes, but if this motor will run from static charges of high voltage alone imparted to its sectors, as it does in practice, without any actual flow of current taking place from positive to negative, where does one look for the watts necessary to give it any power output capabilities, since watts in electrical power terminology cannot be represented by either voltage or current alone? Possibly the solution to this problem lies in the fact that there is a minute transference of current taking place all the time to maintain the static charge in the sectors of the rotating element during their rotation, otherwise all laws as to conservation of energy would fall through.

The Motor

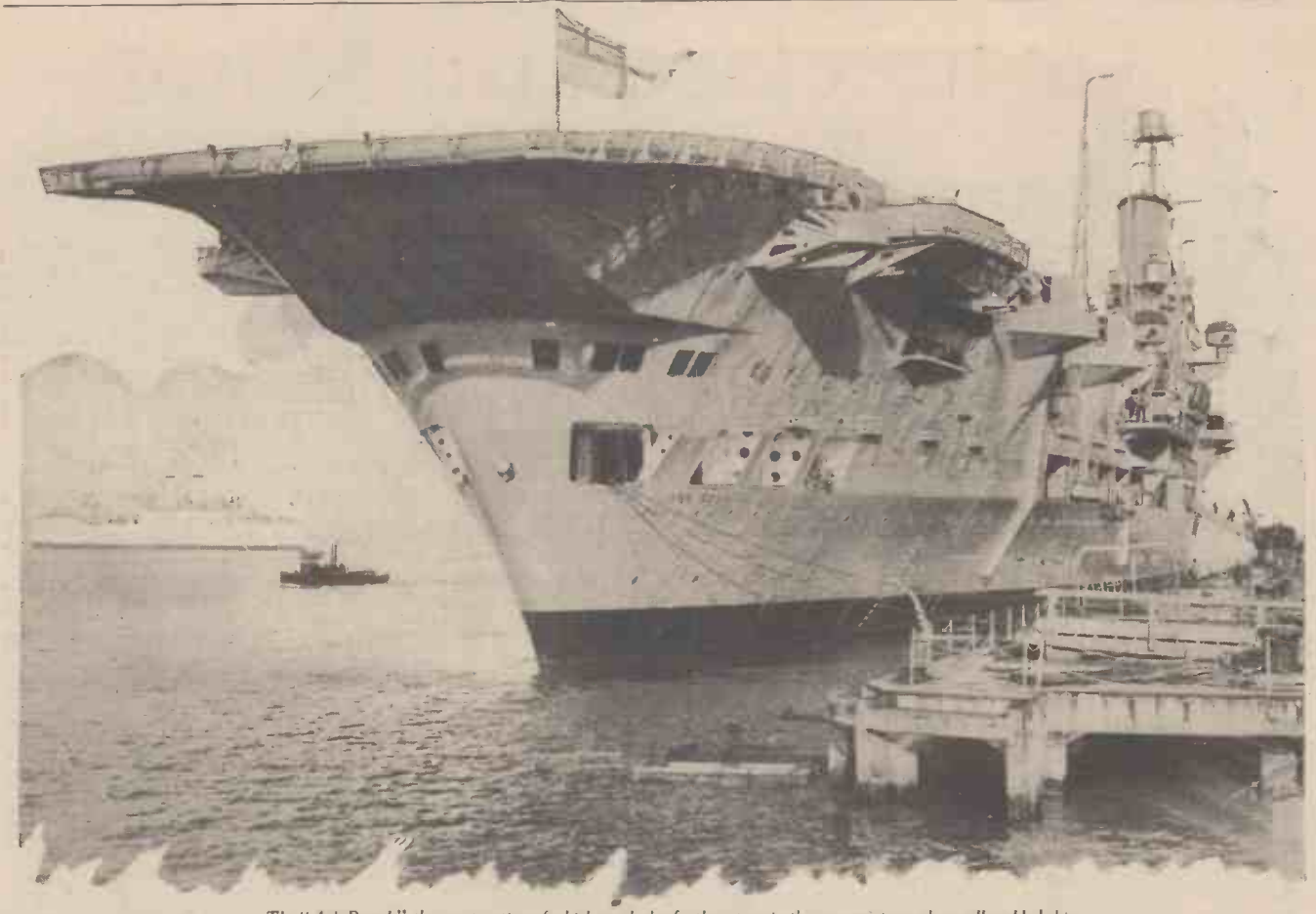
Leaving this rather nice point for the scientists to argue out, and turning to the practical construction, the accompanying illustrations show the motor to consist of two circular plates of insulating material, B and C, the lower one C fixed to a stand A carrying on its under surface two large quadrants of metal foil N, while the upper plate has a larger number of smaller sectors M, on its top face. The upper plate is carefully mounted to run as truly as possible on a silver steel spindle K, supported by a cup and cone bearing P at the lower end and guided by a metal bush O at the upper end. These details are shown enlarged in another portion of the figure, the letter references being the same. On the underside of the lower fixed plate is a brush holder D of insulating material carrying two metal studs E which are finished off with terminal heads at H for connection to the outer circuit or high tension current supply. On each of the studs E will be seen a brush carrier F. This consists of a length of stout brass or copper wire close-coiled and of such diameter as to spring over the studs gripping them tightly. Each end of the wire is drilled up a short distance to take a few strands of fine copper wire (No. 38 or 40g.) or a short length of metal tinsel. These brushes G trail lightly on the sectors under them, both top and bottom.

The Plates

In the choice of material for the two plates B and C, also the brush holder D, one can use either glass, ebonite or one of the various synthetic products now available for high tension insulation. The chief essential is that the material should be quite flat and possess a high specific inductive capacity. The writer's preference is for the material called "Tufnol," as it is light and easy to work, and possesses advantages over the others named. For the sectors M and N, stout tinfoil is preferable. It can be secured to the plates by very thick shellac varnish, pakyderm, armacell varnish, or even certofix. Hardwood makes a suitable material for column A, which requires to be accurately bored, threaded, and fitted with metal bushes at O and P.

Fairly High Speed

When connected to a Wimshurst machine, a Leyden Jar, or a spark coil of reasonable size, the motor will be self-starting and runs up to a fairly high speed. Any two of the top and bottom sectors M and N, being similarly charged, will, of course, be repelled and rotation takes place in their endeavour to mutually separate as far as possible. Every successive sector on the top plate behaves similarly as it follows round, so that there will be a succession of repulsion impulses for the first quarter revolution. These charged sectors then begin to approach the quadrant on the lower plate oppositely electrified, and so experiences a force of attraction, increasing the torque. Once they have touched the opposite brush, however, their charges first become neutralised and then reversed to the same polarity as that of the large sector below with which the brush is in contact. From this point a fresh set of repulsion effects starts up for another quarter revolution, to be followed by attraction as it approaches the starting point once more. Thus there would appear to be six clearly defined cycles taking place during one complete revolution of each top sector: first repulsion, then attraction, then neutralisation; followed by a second set of conditions under opposite conditions of electrification, the process being repeated indefinitely.



The "Ark Royal," the construction of which marked a further stage in the progress towards an all-welded ship.

The Welding Of

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

THE recent naval engagement off the mouth of the River Plate, between three British light cruisers and the welded pocket battleship, quite naturally revived the old controversy as to the suitability of welding for naval construction; it also gave rise to a new discussion as to its influence on the defeat of the German raider in spite of the considerably heavier armament and guns with which she was equipped. Strictly in accordance with the by now famous technique of the anti-welding section of the technical world, the champions of riveting are again pinning their arguments on the time-worn assertions that welding is a " new " process which has not yet been sufficiently mastered to warrant its use in the construction of such important work as naval vessels, that it has the effect of adversely affecting the mechanical properties of the base metal, and that it cannot withstand heavy shock stresses, such as may be caused by explosive forces.

First Great War

In listening to those arguments, one may well imagine oneself back in the days of the first great war, especially if one also takes into account the present international situation. In those far-off days such arguments may admittedly have been well founded, for the process was in its infancy and was not backed by experience except as a rough and ready means of emergency repairs; its effect upon various steels had as yet little or no backing from serious research work, and the then prevalent practice of using bare wire electrodes rendered the strength of the welds doubtful even under the action of static loads, not to mention explosive forces. But in order to delude oneself in this manner to-day it would first be necessary to forget that over twenty years have elapsed since welding was first adopted in the building of new ships (is this period far off the normal " life " of a warship?), that these years have been rich in research in connection with the weldability of steels, and that the progress of electrode manufacture has been such that there can be no comparison between the strength of welds deposited by modern electrodes and those made with bare wire.

Not Evolved Suddenly

It would also be necessary to ignore the fact that the all-welded warship was not evolved suddenly, even in Germany, but by degrees, each of which has presumably been substantiated by experience in the course of its development; to assert the reverse would be tantamount to accusing the naval authorities of most countries (including our own) of hazarding their ships and the lives of their personnel—a charge which no one in his sane and sober senses can possibly make, especially with regard to the British Admiralty.

It is not the purpose of the present article to refute the charges levelled against electric welding by its detractors by quoting the various researches and laboratory tests which substantiate its claims; the quality of ship-building is not ascertained by laboratory experiments, but graduates through the school of experience, so that a brief review of the history of welding in naval construction is the best answer to its critics and is thus the subject of the present article.

Preliminary Applications

The possibilities of electric arc welding were realised by isolated scientists in a number of countries as far back as the beginning of the present century, but the process found no ready application in the age of plenty which preceded the last war, and research work in connection with its development was consequently practically non-existent. The abundance of spare parts retarded progress even for purposes of repair work, in which welding first brought itself to the notice of the technical world, and it was only in such branches of engineering as marine work that it found its first opportunity. Accidents to ships' plant and structure at a considerable distance from home ports, attended by frequently long delays in the obtaining of replacements or the effecting of emergency repairs, by other means, where practicable, created a limited demand for the welding process (at first purely on account of the time factor) as far back as some thirty years ago. The real chance came with the last war, when spare parts became frequently almost unobtainable and the time factor assumed an ever-increasing importance, especially in marine engineering. Welded work soon began to embrace such important items as the

A Brief Review of the History of Welding In Naval Construction

welding of fractured stem and stern-posts; welded boiler repairs became the usual practice and, by the time of the Armistice, welding had already established itself as the standard method of emergency repairs in most countries.

The Beginning of Progress in New Work

The rapid development of the application of the process, attended by its undoubted success, in spite of the poor quality of the then available materials, did not pass unnoticed, and ship designers all over the world became aware of its possibilities as regards new construction. At the same time, the anti-welding arguments already quoted were at that time not without foundation, and the initial stages in the adoption of welding for new work were consequently hesitant and cautious. Nevertheless, pioneers were not lacking and the first welded vessel of any kind to be built by this process under British Government supervision was the cross-Channel barge AC1320, which was constructed at Richborough in 1917-18. She was a vessel of 320 tons displacement on 6 ft. draught, the propelling machinery consisting of an 80 h.p. two-cylinder four-stroke oil engine. The total weight of the barge was 80 tons and the design was a modified form of the conventional transverse frame type with the principal dimensions of 125 ft. 3 in. length between perpendiculars and 16 ft. 5 in. breadth moulded. It was thus only a small and relatively unimportant ship, but it marked the beginning of what might be described as a new era in ship construction in this country.

Warships

All-Welded Target Vessel

In America, shipbuilding circles were likewise awake to the possibilities offered by electric welding as a method of connection, and investigations were proceeding along a similar path. Consequently, in 1920, the United States Government built at the Norfolk Dockyard, by way of trial, an all-welded target vessel whose length was 187 ft. and whose hull weighed 45 tons. It contained some 5,000 ft. of welding, which was carried out with bare wire electrodes in accordance with the then prevalent American practice. In view of this circumstance, it is interesting to note that 425 ft. of this welding were done in the vertical position and 650 ft. in the overhead position, and that, in spite of the use of unsuitable current strength, only 16 ft. of the total welding had to be cut out and rewelded at the end of six months' service, which included a journey from Norfolk to Bermuda. The vessel was destroyed in 1922 and, although this first American attempt could not be described as an entirely conclusive proof of the advantages of welding, the construction costs having proved higher than those for a riveted ship, it nevertheless had the effect of stimulating further investigations by the Navy Department, with the result that a second vessel of the same type was laid down in 1922. The electrodes used were again of the bare wire type and their use must have had a considerable effect on the costs, since the ultimate strength of the welds was taken at only 17.78 tons per square inch (28 kg. per square millimetre). In this connection it may be of interest to note that the United States Navy Department has since issued a specification, the current edition of which is composed of a set of very detailed rules and regulations, whose requirements preclude the use of bare wire.

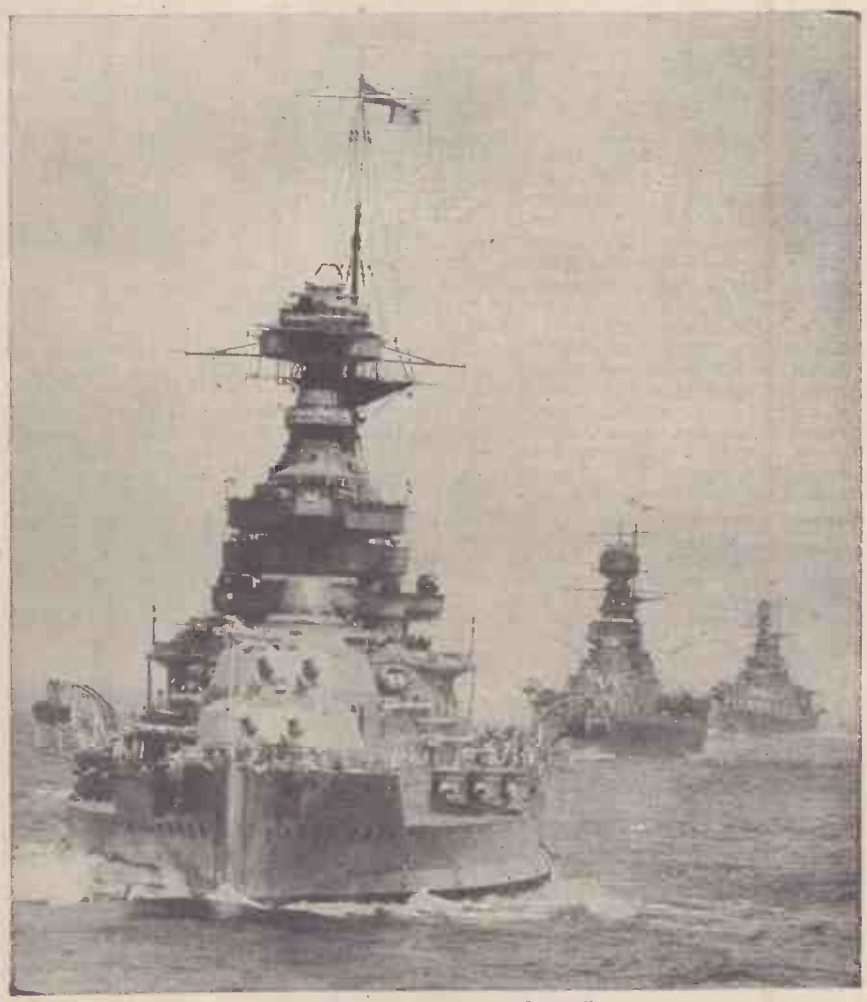
Post-Treaty Construction

The British and American beginnings mentioned above, together with other trial ventures carried out abroad at about the same time, left no doubt that the welding process warranted further notice, and the Treaty of Washington, signed in 1922, had a further and decisive effect on the rate of its future development. The imposed limitations on cruiser tonnage could only be offset by a saving in weight if the maximum characteristics were to be realised on the limited displacement, and the next ten years or so saw a tremendous increase of experimental and research work devoted to the applications of the process (including the question of its effect on the properties of different types of steel) and the development of improved types of electrodes.

Development of Welding Procedure

The practical effect of this sudden impetus was not very apparent in the naval construction of this country for some time, but that the Admiralty were taking a very active part in the development of welding procedure suitable to naval work can be plainly seen from the paper subsequently read by Mr. C. S. Lillicrap, R.C.N.C., M.B.E., at the 1933 Spring Meeting of the Institution of Naval Architects, and from the "Notes on the Welding Practice in British Warships," from the Director of Naval Construction, published in the June, 1935 issue of *The Welder*—not to mention the very detailed current Admiralty regulations relating to welding, which were evolved mostly as a result of their own investigations.

It must also be borne in mind that the use of the welded joint with its inherent rigidity would not necessarily be applicable to the time-honoured standards of riveted ships, thus necessitating certain modifications of the conventional designs. These designs were evolved as a result of actual experience which had long since overcome the practical difficulties encountered at the outset of riveted work, whereas welding was a new method and, as such, was attended by a number of new snags which required solving. Furthermore it was apparent that whilst in small ships welding could possibly be substituted for riveting without any appreciable changes in design, conditions in larger vessels were very different, so that the little experience of all-welded ships available at that time was not necessarily applicable to the latter. Besides this, it was also important to note that the main structural portions of many warships are constructed of "D" quality steel, with a view to effecting the important saving in weight made possible by the



The "Valiant", "Hood" and "Renown".

higher ultimate strength of these steels, and that the welding procedure for the regular production of satisfactory joints on this material had not yet been developed at that time.

Naval Supremacy

It was, therefore, perhaps not very surprising that, in view of Great Britain's unchallenged naval supremacy, the Admiralty should have been satisfied to proceed slowly and systematically until such time as their preliminary work should indicate the safe start of a change-over to welding without the necessity for building ships for the purpose of obtaining experience. In the meantime, the naval constructors of this country were also getting ready for "things to come," and the interest of the profession was evidenced by periodic articles which appeared in the technical press.

In the United States, the effect of the Washington Treaty was somewhat more noticeable and resulted in the immediate extension of the application of welding to the *Omaha* class of cruisers, as well as to the submarine and destroyer tenders. It was, however, at first restricted only to minor fittings, in the same way as in this country, and consisted of the welding of pipe-hangers, certain supports and foundations, shelving, bins and bulk-head boundary bars. The progress of welding research and the success of its practised applications gradually resulted in a growth of confidence in the welding process and its use was progressively extended to structural bulk-heads and hull fittings generally, while in craft such as tugs and lighters riveting was replaced by welding almost completely, and a considerable number of auxiliary Navy Yard craft, ranging from 65 ft. to 120 ft. in length, were constructed entirely by welding.

German Armoured Ships

Nevertheless by far the greatest progress in the application of arc welding to naval construction in the post-Washington Treaty period was undoubtedly made in Germany, on account of the particular conditions obtaining in that country at that time.

The Treaty of Versailles—in limiting the capacity of the German armoured ships and cruisers to 10,000 and 6,000 tons respectively, no doubt with a view to corresponding limitations in the size of armament and the motor power of ships—was in itself a powerful incentive to save weight in order to obtain a higher performance of smaller ships; and, according to Obermarinebauret Burkhardt, in *Die Elektroschweissung*, the occupation of the Ruhr was an indirect starting-point of its development, since the construction of the first new German 5,400 ton cruiser Emden (launched in January, 1925) was nearly brought to a standstill through the impossibility of obtaining Z rolled sections outside the occupied area. The substitution of other profiles would have had an adverse effect on the weight, so the difficulty was overcome by the use of an unequal angle, with the long flange welded to the plating, and the method proved so successful and resulted in such a saving in weight that every endeavour has since been made to utilise welding wherever possible in German naval construction as a whole.

Process Used on Destroyers

As a result, the process was used to a large extent between 1924 and 1929 in the construction of six destroyers of the *Mowe* (800 tons) and six destroyers of the *Wolf* (800 tons) classes as well as in the cruisers *Konigsberg* (6,000 tons), *Karlsruhe* (6,000 tons), and *Koln* (6,000 tons), launched in March, 1927, August, 1927, and May, 1928 respectively, and followed by the 6,000 ton cruiser *Leipzig* in October, 1929. Needless to say these ventures of the German naval authorities did not pass unnoticed by the naval constructors of other countries, and the launching of the first pocket battleship, *Deutschland* (10,000 tons), in May, 1931, aroused the keenest interest not only on account of the creation of a new type of warship as such, but because its very realisation was largely due to the adoption of welded construction. The building of this ship was the starting point of the previously mentioned discussions, which have now been revived by the River Plate action, and a great many rumours as to the behaviour of the welding during her trials were circulating at the time. These assertions were of a very contradictory nature and some of the most extreme went as far as alleging that the ship put back to port with the top strakes tied up with ropes !

Wishful Thinking

It is not the usual practice to publish full details of the trials, so that the occasion was fertile ground for rumours of this kind, most of which were probably merely wishful thinking of the anti-welding community; but the more serious and fair-minded observers did not fail to notice that some years had elapsed between the launching of the destroyers and cruisers and the decision to build the pocket battleship, while those familiar with German methods could hardly doubt that the interval had been spent on observation, with characteristic German thoroughness, of the behaviour of the welded warships already in service.

At the same time, it should be observed in all fairness that some of the less sensational rumours may not have been entirely without foundation, since the practice of using bare wire, which was prevalent in the case of the earlier ships, was subsequently abandoned in favour of coated electrodes; although, on the other hand, this change-over may have been due to the large amount of research work in welding (for which Germany must be given full credit) which was being carried out at the time, as was the case with American practice, with which German practice appears to have had much in common.

Latest Developments

Whatever the reason for this change of welding technique, the laying down of the armoured cruiser *Ersatz Lothringen* in the same year and the launching two years later of a second pocket battleship, the *Admiral Scheer*, of the same class, followed by a third, the *Graf Spee*, in June, 1934, can be taken as an indication that the German authorities were satisfied with the use of welding, whereas the steady growth of its applications to naval work in this country would appear to demonstrate that the Admiralty were of a like opinion. The County class of light cruisers were the first British warships to carry an appreciable amount of welding, and further progress was made in the construction of the Leander class, most of whose superstructure is welded. H.M.S. *Leander*, a light cruiser of 7,000 tons capacity and armed with 6-in. guns, was launched in 1931, and was followed shortly afterwards by H.M.S. *Arethusa* (5,220 tons), launched in 1934, which was, as far as is known, the first British warship to have her hull partially welded.

Submarines

Although little information has been published with regard to the applications of welding in submarine construction, it is known that three of these craft, having all their internal structure and the non-pressure external shell welded, were constructed for the Portuguese Government in the Barrow-in-Furness Naval Construction Works of Messrs. Vickers-Armstrongs, Ltd., as far back as 1934. The pressure hull of these submarines was riveted, but the diving tanks in the external shells were welded and tested to a pressure of 142 lb. per square inch. The welding left nothing to be desired and, although naturally no details of present day construction can be given at present, it can be stated that the use of welding is still practised. *Reproduced by courtesy of "The Welder".*

(To be continued).

New Chlorinated Rubber Product

OF great interest for the engineering, electrical, and other industries is a new chlorinated rubber product, in the form of a soft, flexible black sheeting 0.01-0.04in. thick, that has, after extensive research work, been placed on the market by Detel Products Limited, Greenford (near London).

It may be remembered that Detel is a special form of chlorinated rubber, the invention of F. C. Dyche Teague, the Technical Director of the above company, and the new sheeting is a further important development in the specialised chlorination of rubber. Hitherto the product has been sold in solution in an organic solvent for application, on the same lines as paint, to all kinds of surfaces, not only iron and steel, but also brick, stone, artificial stone, plaster, asbestos board, and wood, as a protection against atmospheric, general acidic, and other corrosion.

For this purpose Detel, now being widely used, possesses remarkable properties since it is completely resistant, at temperatures up to about 150 deg. F., to almost all known acids, inorganic and organic, strong or dilute, such as for example sulphuric, hydrochloric, nitric, mixed acid, acetic, chromic, and even hydrofluoric, and to carbon dioxide, sulphur dioxide, and atmospheric corrosion, as well as all organic acids. Similarly, it is resistant to every known alkali in concentrated or dilute solution, such as caustic soda, caustic potash, ammonia, and salts, and to very many other corrosive and reactive substances, such as sea water, oxygen, ozone, chlorine, bromine, iodine, potassium cyanide, petroleum and tar fractions, alcohol, and methylated spirits.

All that is necessary is to cover the surface with the sheeting, which can be stuck together in the easiest and simplest manner merely by painting a little special solvent cement at the edges, or other part, forming a completely homogeneous joint, resembling the welding of metals. The sheets can be cut with scissors to desired size and shape and attached by the cement in a few minutes.

The sheeting, unlike any form of paint, is also impervious, because in the preparation it is run between heavy rollers, and therefore no pin holes are present. Also, the material is flexible and shock resistant, like rubber, so that dents quickly disappear.

MASTERS OF MECHANICS

No. 59.—John Benjamin Dancer, an Unrecognised Optical Genius of the Last Century

EVEN during Dancer's lifetime, the memory of his many remarkable achievements sank to nothing among his younger contemporaries. For the total blindness which eventually overtook Dancer so crippled him that his business went slowly to ruin and had it not been for the activities of a small group of friends, who financially aided him in his last distressing days, this born inventor and creator of many an optical and electrical device would have ended his days either in the gaunt Victorian poorhouse or as a victim of positive starvation.

Dancer was a genius. In his time he consorted with famous scientific personalities such as John Dalton, James Prescott Joule, Lord Kelvin, and Michael Faraday. But although Dancer was a genius, he was born to a working life. The discoveries which he made, the various inventions which were his had each to bring a direct revenue into the optician's and instrument-maker's business which he presided over during nearly half a century. For Dancer there were no academic honours or discoveries in the attractive yet non-financial realm of theoretical science. Like the renowned Thomas A. Edison, John Benjamin Dancer had more or less to invent for his living. With what success he achieved this requirement and what his precise claims to the status of inventive genius may be, the reader who follows this article to its conclusion will be in a position to judge.

An "Optical" Family

Dancer came of an "optical" family. There were instrument-making Dancers in business in London as early as the 18th century. Michael Dancer, the grandfather of John Benjamin Dancer, had a shop in London in which he sold spectacles, magnifying glasses, microscopes, and telescopes. Josiah Dancer, his son, took up the family instrument-making, but, besides this, he distinguished himself as a classical scholar, linguist, and a scientific lecturer.

Of the several children of the versatile Josiah Dancer, John Benjamin, the subject of our present memoir, is the only one who attained to any eminence. He was born in London on October 8th, 1812, just about the time of Napoleon's historic Retreat from Moscow. It is said that the young John Benjamin needed little schooling, for he had only to be informed once of any given fact or to read a page of a text-book once over to become master of the knowledge therein contained.

The world's first stereoscopic camera, made by Dancer in 1852.

Perhaps, indeed, such a retentive memory was one of the young John Benjamin Dancer's very greatest assets in his early life, for it is certain that he had very little regular schooling during those young years of his. When Dancer was but five years of age, his father, finding business poor in London in consequence of increasing competition from more fashionable opticians, moved his business, together with his numerous family, to the Merseyside, and within a few months settled down at Liverpool, in which city he thrived and attained considerable local renown.

John Benjamin Dancer.

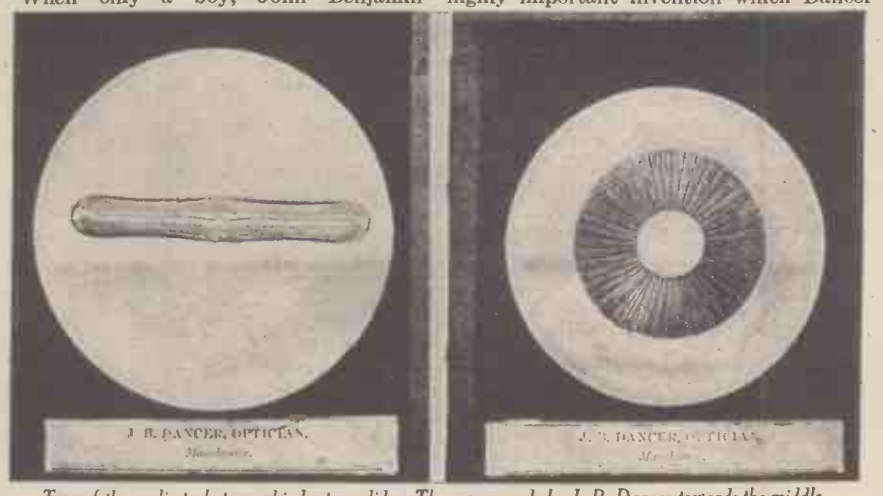
When only a boy, John Benjamin Dancer was put to work in his father's workshops. Here he learned the elements of lens grinding, the construction of spectacle frames, and of various optical instruments. From his father, who was ever an indefatigable and enthusiastic amateur experimenter, he learned some chemistry, some physics, a smattering of electricity, together with a considerable amount of astronomy and natural history. Dancer, in fact, grew up in the atmosphere of utilitarian experiment. Commencing as his father's junior apprentice, he eventually found himself having to shoulder the whole of the responsibilities of the Dancer business in 1835, and at the comparatively early age of 23, owing to the sudden decease of the senior Dancer in that year.

Chained by Circumstances

Perhaps Dancer would have attained a more recognised position in science if he had not been so chained by circumstances and environment to the exacting requirements of business throughout the whole of his lifetime. As things were, however, Dancer seems to have thrown off invention after invention during a period of some forty years. Like Edison in America, Dancer invented as a hobby. His inventions were always strictly utilitarian ones, but each and every one of them had the characteristics of genius about it, they being, for the most part, fundamental conceptions and not mere "improvements."

Dancer's inventive career commenced during his youthful days at Liverpool. He seems to have hit upon the once much-used process of electrotyping, whereby a metal, such as copper or silver, is electrolytically deposited and built up upon another object so as to obtain a duplicate of the same. This invention, it would seem, was intentionally filched from Dancer by an individual to whom he confided the details of his process.

Another creation of Dancer's Liverpool period was the now well-known "porous pot" of Leclanche-type batteries and other primary cells. This important device is never attributed to Dancer, as in mere justice it should be, nor, again, is another highly important invention which Dancer made about this period, to wit, that of the spring make-and-break contact mechanism of the electrical induction or "sparking" coil.



Two of the earliest photographic lantern slides. They were made by J. B. Dancer towards the middle of the last century.

This device, which Dancer first conceived during the course of a number of electrical experiments which he made in his father's workshops, did not ultimately materialise until about 1837—the year of Queen Victoria's ascension to the throne. When it did arrive in practical form, however, the Dancer spring make-and-break

made at once possible the nowadays universal and ubiquitous electric bell, which latter invention was not brought into being by Dancer.

Make-and-break Invention

Dancer appears to have thought little of his make-and-break invention. If, however, he had patented it, he might easily have accumulated sufficient financial backing to render him independent for life.

But Dancer had other things in mind about this period. He had married, and the claims of a growing family had made him realise that his late father's Liverpool business was not doing sufficiently well to provide for the support of the Dancer family. Consequently, after some deliberation, he moved in 1841 to Manchester, at that time the home of the famous John Dalton and of other scientific workers. Here, in conjunction with a financial partner named Abraham, he set up the instrument-making firm of "Abraham and Dancer."

Abraham—whoever he may have been—seems only to have "lasted" for a year or two, for after this time he left the business and we hear of him no more.

Settled in Manchester, Dancer made much of his skill and abilities as a maker of high-class microscopes, and as a scientific instrument maker in general. He had the honour of making a microscope for the aged John Dalton, who died in 1844, and for James Prescott Joule, the wealthy brewer, of Manchester, to whom science is indebted for the discovery of the mechanical equivalent of heat and other fundamental conceptions. Dancer made the now classical Joule apparatus, including a couple of extremely accurate thermometers, which are still in existence and which, even nowadays, are ranged among the world's most delicate temperature-measuring instruments.

Microscopes by the Score

During his early period in Manchester, when that great cotton city was slowly attaining the zenith of its wealth and fame, Dancer made microscopes by the score, putting into each batch of them improvement after improvement until, eventually, the "Dancer" microscope became an instrument of the very highest excellence.

Microscope construction and general instrument-making remained for many a year the "bread and butter" side of the Dancer business at 43, King Street, Manchester, an establishment which was known to all the scientific élite of the North. But there were other matters in which Dancer was interested in besides mere microscope building.

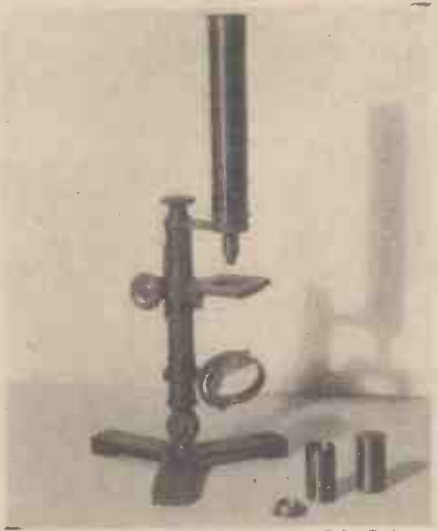
Photography was one of these matters. When the public announcement of Daguerre's discovery of "sun pictures" was first made, Dancer undertook a three-day's stage-coach journey from Liverpool to London in order to look at one of the marvellous "light-delineations" which were on exhibition there. This was in 1839.

Returning to Liverpool, he so accurately imitated the Daguerreotype process that, within a short time, he became master of it, and became the first man to take scientific photographs in England.

Photography

It is very probable that Dancer was the first in the North of England to take even a photographic portrait. This matter, however, cannot be proved. Yet there is no doubt that Dancer was the earliest scientific photographer in our country. He approached the subject of photography with the greatest possible enthusiasm, but his approach to the subject was simply and solely on the scientific side. Had Dancer opened out as a portrait photographer, he would have made his fortune in a few years. But here, again, as the saying is, he "missed the bus" rather badly—if we are to review his career from a strictly commercial and everyday standpoint.

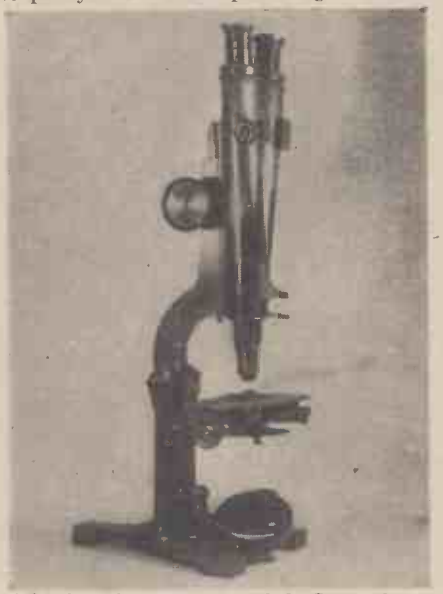
Dancer, after he settled in Manchester.



The microscope which Dancer made for John Dalton.

added to his microscope-making the activities of a camera-maker. He invented and made various types of cameras, all, of course, at that period, of the "daguerreotype" variety.

Perhaps, however, the greatest creation of Dancer's in the photographic sphere was his invention of the stereoscope camera, which invention he first brought out about 1856. The first Dancer stereoscope camera, i.e., a camera taking two side-by-side stereoscope pictures at the same time, was not patented, owing to the professional stupidity of a London patent agent whom



A fine binocular microscope made by Dancer during the early "60's" of the last century.

Dancer approached in the matter. His second, and improved, stereoscope camera, however, received the grant of a patent, and for many years remained the only type of stereo camera in existence.

As a maker of optical lanterns—or "magic lanterns," as they were inevitably and universally dubbed in Dancer's day—Dancer was naturally interested in the subject of "slides." To Dancer is due the invention of the photographic lantern slide, the forerunner of the cinematograph film. This fact is still little known and even more seldom acknowledged. Again, however, in this invention Dancer erred somewhat in making all his lantern slides of scientific and microscope subjects and in not producing the more "popular" types of scenic lantern slide views for the delight of the average audience of those placid mid-Victorian days.

Microphotography

Who remembers the "microphotograph," the tiny collodion photographs, smaller in size than a pin's head, which were produced on microscope slides and which sold by the thousands to our Victorian scientific grandfathers for their amusement, astonishment, and delectation? The microphotograph was Dancer's invention, which he made very early during his career in Manchester. In his later life he devised methods of turning out his microphotographs (for viewing under a microscope) on a semi mass-production scale. His success here was astonishing. Although other makers turned their attentions to the same subject, the "J. B. Dancer" microphotograph reined supreme among amateur microscopists throughout the country, and, strangely enough, few of these photographs have ever been produced since Dancer died.

Yet the invention of the microphotograph, popular though it was, brought little good fortune to Dancer. It spelled for him an enormous amount of work which was without any commensurate profits. Unfortunately, the optical strain of producing such tiny photographs laid the seeds of the blindness which eventually overtook Dancer and thereby created the final tragedy of his life.

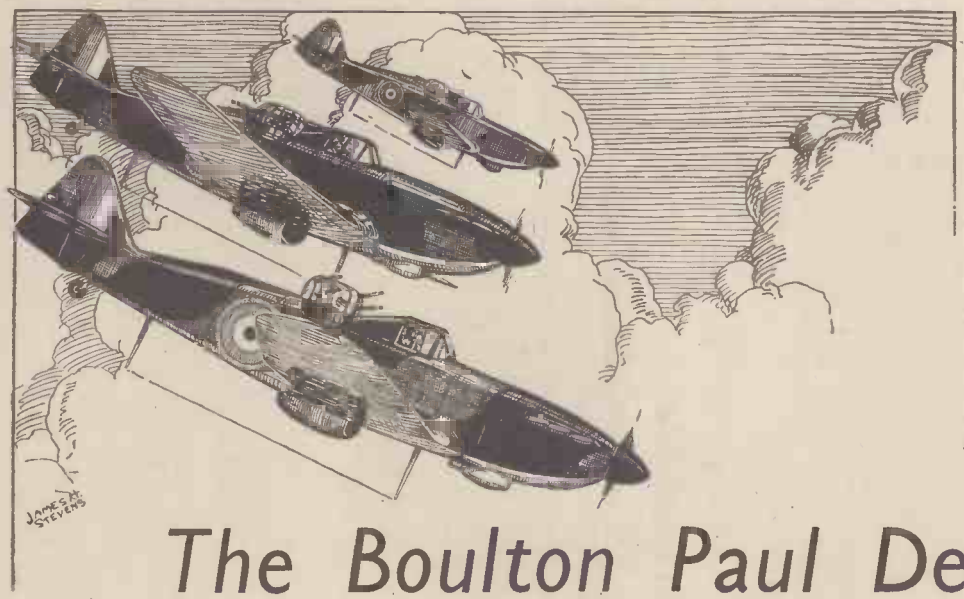
Many microscopical devices and inventions are attributable to Dancer. The "Davis shutter," consisting of an iris diaphragm which is fitted to the microscope, should, in reality, be called the "Dancer shutter," for it was Dancer's own invention. Devices for illuminating microscope objects on the stage of the instrument were invented by Dancer, particularly the "speculum illuminator," which device consists of a semi-circle of silvered metal whose function it is to throw sidewise illumination on to the microscope object under examination.

Binocular Microscope

The binocular microscope, if not Dancer's actual invention, was certainly sponsored and improved by him. So, too, was the formerly much-used "limelight," consisting of a jet of oxy-coal gas impinging upon a cylinder of lime and thereby raising the latter to a dazzling incandescence. But Dancer's name is never nowadays connected with the limelight. He took no patent out on it. It comprised one of his many "incidental" inventions, which he thought little of at the time, but whose value he realised when it was all too late.

Dancer, we have already recorded, fell gradually into total blindness. At first the sight of one eye failed. Despite such a serious handicap to an instrument-making and optical business such as his, Dancer fought bravely on, making the best of his disability. But quickly, the sight of the other eye began to wane. Within a year or two the dread glaucoma supervened, and then Dancer found himself totally blind.

During his remaining years of poverty and of blindness, Dancer dictated an autobiography to his niece, a story in which he gave a detailed account of his long and many-sided career. This document was never published, however, and now, it is to be feared, is irretrievably lost. Dancer died on November 24th, 1887.



SCALE MODEL AIRCRAFT No. 5.

The Boulton Paul Defiant

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

The Fastest Single-Engined Two-Seater Fighter in the World

THE Defiant, whose name so quickly became a household word after its epic first engagements last May, is one of the latest types to be issued to squadrons of the R.A.F. The two-seater fighter as a type has not been given a great deal of attention except by British designers. In the Four Year's War the Sopwith "One-and-a-half Strutter" was perhaps the first machine to be considered in that light, although the fact that it was badly underpowered greatly curtailed its period of success. In 1916 appeared the prototype Bristol Fighter and, from the following year right up to the Armistice, this machine did a very great deal to keep the German single-seaters in check. After the war the two-seater fighter was neglected until about seven years ago, when the ubiquitous Hawker Hart was adapted for such duties. A year or two later the Demon (the Hart development) was fitted with the very first power-operated gun turret. This open turret on the Demon was the ancestor of those on our modern bombers—which have dealt so well by the Messerschmitt that the German technical press had paid them the compliment of trying to belittle them!

Off the Secret List

The Defiant came off the Air Ministry Secret List in January, 1939, and mention of its first action, when a Junkers Ju.88 was vanquished, occurred fifteen months later, during the invasion of Holland. It has been officially stated that speed of production was one of the governing factors in its design, the aim being to turn the machine out quickly and in very large numbers before anything else.

It is, of course, impossible at this date to give any very detailed description of the machine, but it is possible to say that it is of typical modern construction. Wing, fuselage and fixed tail surfaces are the usual stressed-skin light-alloy structures. Particular care has been taken to secure a smooth surface and so reduce boundary-layer drag to the absolute minimum. The controls are metal-framed with fabric covering: all are both mass and aerodynamically balanced. The rudder and elevator have horn balances, while the ailerons have inset hinges. Split trailing-edge flaps are fitted between the inner ends of the ailerons and the radiator fairing.

Armaments

Detailed notes on armament cannot be given, but the turret is a Boulton Paul four-gun design. The guns are mounted in pairs, one above the other, on each side of the gunner. The turret is hydraulically operated and can be traversed through 360 degs.; the guns can also be elevated. It will be seen that, by setting the guns near the perimeter of the turret, the blind spot behind the rudder is eliminated. Part of the fairing between the pilot and the gunner and a portion of the top decking of the fuselage are retractable—this is shown in the heading sketch. The wireless aerial is carried beneath the fuselage to further clear the field of fire.

In the absence of reliable information at the time of writing it is impossible to say definitely whether the aerial on the production machines is as shown in the drawings, or whether the rear mast is extensible in flight to the same length as the forward one.

The undercarriage retracts inwards, the wheels lying in the belly of the fuselage. The curious fairing plates, which overlap when the undercarriage is extended, allow for the extension of the legs when not under load.

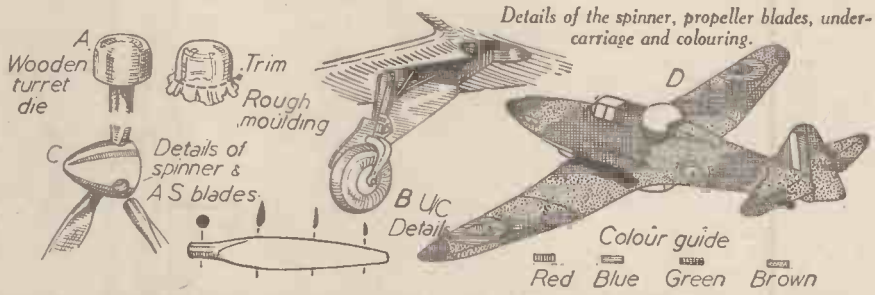
The engine of the Defiant is the 1,050 h.p. Rolls Royce Merlin. It is fitted with ejector exhaust pipes and drives a D.H. controllable-pitch airscrew.

Although no official performance figures have been issued for the Defiant, a deal of arrant nonsense has been written in the press, both of this country and the U.S.A.—the maximum speed being given as anything from 400 m.p.h. up to 550 m.p.h.! Without in any way belittling the Defiant's first major engagement when, operating as a squadron of 12, at least 37 Messerschmitts, Junkers Ju.87's and a Ju.88 were shot down, it can be said that these estimates are absurd and do not do full justice to the pilots and air gunners concerned. The Defiant has the same engine as the Hurricane I.

The Model

The choice of scale for a model aeroplane is largely one of individual preference; there are, however, one or two general considerations worth taking into account. First, there is the problem of space; any fair sized collection does occupy a lot of room unless the scale is small. On the other hand, if too small a scale is chosen, a great deal of detail has to be omitted, or else included in an incongruously clumsy fashion. The two limits can roughly be set by 1/36 and 1/72 full size. The writer originally adopted the former because of the range of accessories in the form of lead soldiers, etc., which could be bought from toy shops. It is an admirable scale for those who like detail, as it is possible to incorporate every item in accurate miniature, but suffers because the space occupied by the larger machines is considerable. The 1/72 scale was adopted by myself when lack of storage space prohibited the continuance of the 1/36 scale collection—the choice of 1/72 made it possible to adapt my large library of 1/36 scale drawings with the minimum of trouble. The 1/72 scale is convenient to store and is not too small for the inclusion of most details. It now has the advantage that almost every conceivable accessory—from figures of pilots and mechanics to guns and bombs—can be bought from almost any local toy shop.

Details of the spinner, propeller blades, undercarriage and colouring.



So much for scale. The most convenient method of making the 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 tail surfaces, as it is easily cut and shaped.

Difficult to Model

Only three parts of the Defiant present any difficulty to the modeller; cockpit cover, undercarriage and airscrew. Taking these in order, the cockpit cover consists of two parts, one for the pilot and one for the gun turret. The former is shaped from celluloid, or some acetate sheet, the three-piece front screen being fixed to the fuselage with a cellulose glue and the sliding door and roof section runs in slits cut in the top decking of the fuselage. The gun turret is easily made from transparent sheet by an elementary form of press tool. A wooden male die is carved and is painted to make it waterproof before use. The female die (platen) consists of a small tin filled with fairly tightly-packed sorbo rubber, a tin of plastic wood, or any similar substance. The cellulose sheet, die and, if possible, the platen should be heated in very hot water and the turret pressed to shape. Once formed satisfactorily the lower edges of the turret should be trimmed with a razor blade. As this is rather a "deep draw," the first attempt may not be satisfactory. The main rule is to get all the parts as hot as possible and to do the job as quickly as possible.

The Undercarriage

The undercarriage arrangement is shown in the detail sketch B. If a retracting unit is made, it should be remembered that the legs extend when retracted and therefore take up more space than as shown on the drawing, where they are under load. The overlapping fairing plates take up this extra length when folded into wing.

The airscrew is simple if a lathe is available, for it is then possible to turn the spinner. If recourse has to be made to cruder methods, a short length of wood can be roughly shaped, mounted in the chuck of a hand drill (not a brace) and, after fixing the body of the drill in a vice, the part can be turned up, using a file and glass-paper as "tools." The blades are easily filed from fibre and set into holes drilled in the spinner.

Painting

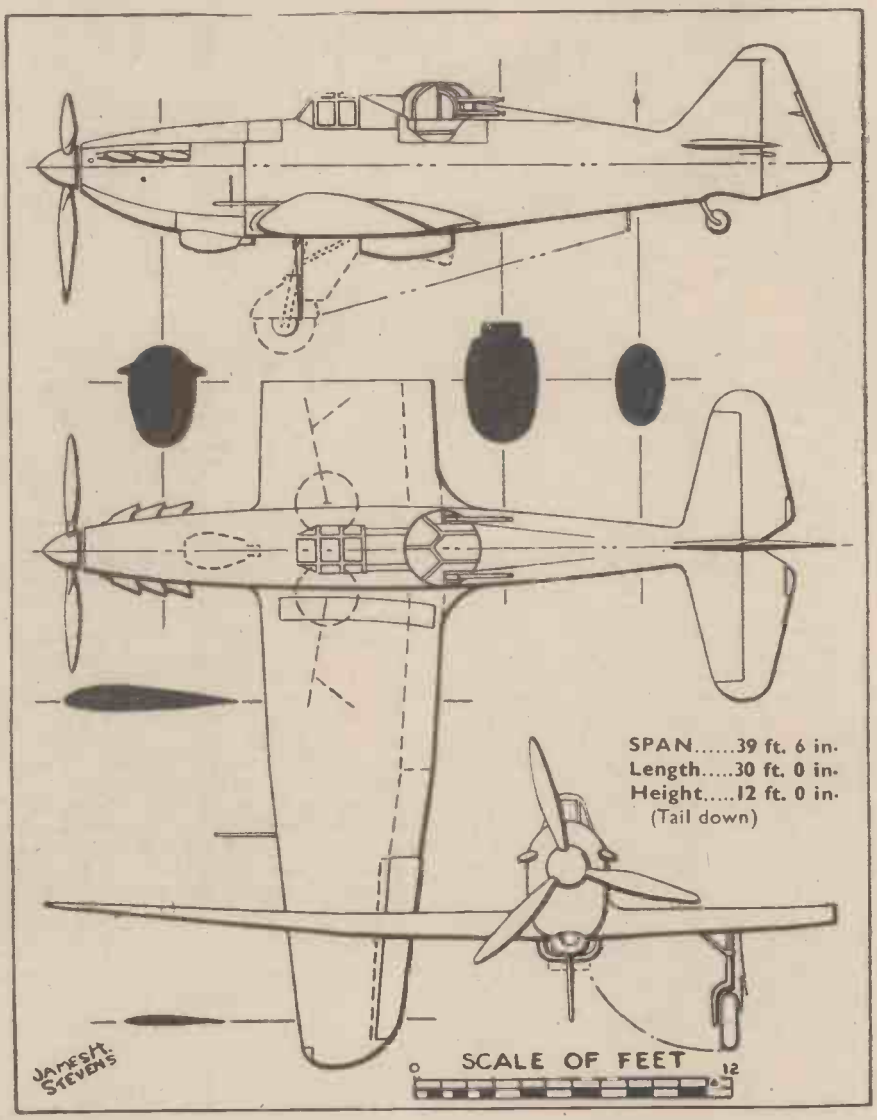
The paint to be used is a matter of personal choice, matt poster paint, oil "art" enamel or cellulose paint all being suitable. For ease of working and general finish, the writer prefers art enamel, as it does not dry too quickly when doing intricate parts, as does cellulose, and it is not easily finger-marked like the poster colour. A good filler should be used on all wooden parts and they should be thoroughly rubbed down with OO glass paper.

It might be as well to mention here a very simple method of suggesting the slight ridge that is formed by the ribs on the fabric-covered control surfaces. The positions of these parts should be marked in pencil and then, after the final undercoat, a narrow line should be painted with a fine liner's brush.

The prototype Defiant was first painted entirely silver, save for a black top decking in front of the pilot, and black spinner and airscrew. Large red, white and blue cockades were carried on wings and fuselage and the black machine number K 8310 was painted on the sides of the fuselage and under each plane. Later (midsummer, 1939) the black top decking was painted silver and only the *backs* of the airscrew blades were black.

Production machines are shadow-shaded and are subject to the latest (at the time of writing) regulations for the markings of fighters. Undersurfaces are pale bluish-white, without cockades; rings on top of wing are red and blue only, those on sides of fuselage red, white and blue with a yellow outline; the fin is painted red, white and blue; grey squadron and machine letters are painted on the sides of the fuselage, two letters for the squadron, one for the machine. The airscrew is black with yellow blade tips. The exhausts are brownish-grey.

SIDE, PLAN AND FRONT VIEW OF THE BOULTON PAUL DEFIANT



BOOK RECEIVED

"The Way It Works." By Professor A. M. Low. Published by Peter Davies, London. 222 pages. Price 8s. 6d. net.

WRITTEN in non-technical language, this book, which is intended for the layman, explains the working of various machines and apparatus with which we come in contact in everyday life. For instance, the operation of such things as escalators, radio beams for landing 'planes, traffic signals, gramophone recording, gas masks, vacuum cleaners, the autogyro and helicopter are clearly explained with the aid of many illustrations. Altogether, there are over eighty different machines and processes explained in this interesting book, which also includes an index.

Printing Technique In Analytical Chemistry

A Method of Contact Printing, Long Known but Little Used Until Recently

ONE of the simplest and most familiar ways of identifying an unknown substance is by the formation of a coloured product at the end of a prescribed chemical routine. The substance is dissolved in a suitable medium, the necessary intermediate treatments are carried through, and finally the colour of the liquid in the test tube is characteristically transformed by the addition of a specific reagent.

Colour reactions have great versatility, but the relatively crude technique by which they are employed often curtails their advantages, especially where speed and delicacy are essential. Thus, in order to obtain sufficient material for test, the specimen often has to be destroyed or damaged beyond further usefulness. Much time may be consumed in the solution of the specimen, removal of excess dissolving agent, and the intermediate transformations necessary before the final test is applied. Where many tests are to be made daily, the analyst's performance is limited.

Testing Chromium

For example, an engineer may wish to know if a small proportion of chromium is contained in a steel specimen. Following one of the time-honoured schemes of qualitative analysis, the analyst files off a portion, say, a tenth of a gram, dissolves it in nitric acid, and evaporates away most of the excess. Then he makes the solution strongly alkaline with caustic soda, adds sodium peroxide, and boils. After this the precipitated iron hydroxide is filtered off and the filtrate is acidified and tested for the chromate ion by any of a number of standard tests. All this may take from a half to three-quarters of an hour, and it requires a rather fully equipped laboratory. Further, the finer details of structure rarely can be differentiated chemically. If such an analysis is attempted, the only approach is a repetition of tedious local treatments with the dissolving agent in minute quantities. Success then is largely a matter of the manipulative skill of the operator.

Contact Printing

A partial answer to the desire for simplification with increased sensitivity and delicacy is found in the method of contact printing, long known but little used until recently. In principle this technique differs from others essentially in that the initial solution, intermediate reactions, and final formation of the coloured end product are all carried on within the tiny cells formed by the pores of paper or other inert medium which is pressed into close contact with the specimen surface. These little cells limit lateral diffusion, so that each contains only the end product derived from the corresponding small area of the specimen. A print of the surface is produced in which any variations in composition are mapped on the paper by corresponding differences of colour or of colour intensity. Since the products are concentrated in a thin layer and observed against a favourable background, very little of the sample need be used. In many cases the damage is so slight that the specimen is still usable.

Two Processes

Printing methods usually involve two processes; first, material is transferred in its original configuration from the specimen surface to the paper. There it is converted to a coloured product, recognition of which

Adjusting the voltage used to make the electrographic print.

follows from the conditions of the test. Sometimes this process occurs simultaneously with the transfer, but more often it is necessary to remove certain substances which would interfere, as well as to convert

Washing out the excess reagent after the print has been developed.

the remaining material to a form suitable for the final colour reaction. To this end, the paper containing the undeveloped print is immersed in various liquid reagents and washing media, but the process must be so devised that throughout these treatments, the material under test remains "fixed" on the paper fibres in the form of a mildly insoluble compound. Otherwise it would diffuse or wash out and the distributive pattern would be lost. The details of the method vary greatly with the kind of information desired and the nature of the surface to be examined.

A Superficial Deposit

The surface material may exist as a superficial deposit, distributed either at random or according to some significant pattern on a substratum of entirely different composition. Dust, salt spray, fingerprints, residues of spilled liquids, blood stains, sublimates, or exudations of various sorts or metal transferred by friction, might occur on almost any kind of surface and would represent this class of deposit. Continuous coatings, purposefully applied, such as metal platings, lacquers and other finishes, would form another class. Then there are films formed on a surface by chemical interaction between that surface and atmospheric agents which contain the original surface components in combination with new elements; tarnish and corrosion belong to this class. Lastly, if the condition of the interior of a specimen is to be studied, suitable abrasive treatment may be employed to expose a surface which will yield information concerning its composition and homogeneity.

Transfer of the material to the paper is accomplished by methods based on physical, chemical or electro-chemical solution. When the material is water-soluble, intimate contact with the moistened reagent paper suffices for the test. Thus the sodium chloride normally on the finger ridges is easily made to reproduce those ridges as a print on silver chromate paper. Physical solvents other than water may be used similarly, although the examples are fewer.

Chemical Transformation

In most cases, however, the surface must be brought into solution through chemical transformation. The choice of dissolving agent then calls for more critical consideration than in ordinary analysis. The excess cannot be removed easily. Solution should be rapid and yet uniform to insure against loss of print detail through lateral diffusion. It must be so controlled that only a very thin layer of the surface is attacked. Often the action is required to be selective so that only certain substances are brought into solution, leaving the base material inact. Finally, the agent has to be selected to avoid a condition inimical to the full development of the colour producing reaction.

Such requirements are often met by using certain salt solutions of slight acidity or alkalinity or by employing other salts having properties which make them highly

selective in their dissolving action on certain substances. Thus, sulphide tarnish films on silver and copper are not readily attacked, even by relatively strong acids—the use of which would be prohibitive anyway, because of the impairment of the lead-sulphide printing reaction. Potassium cyanide, however, dissolves these substances readily, liberating the sulphide ion for reaction with the lead carbonate reagent where excess cyanide does not interfere in the slightest degree.

Most metallic surfaces, on the other hand, lend themselves to a simpler and more effective method of solution which has the outstanding advantages of rapidity and perfect control. Electrolytic solution is the basis of the process, first used by Glazunov in 1929 to obtain prints of steel specimens.

The Glazunov Process

Paper containing a suitable electrolyte is sandwiched between the surfaces of the specimen and an inert metal such as platinum. The specimen is connected through a rheostat to the positive pole of a 2-6 volt battery; the inert plate, to the negative pole. When connection is made, metal ions pass from the specimen into the paper at a rate controlled by the current and in quantity proportional to the time. Solution is uniform and rapid and the electrical field maintained helps to prevent lateral diffusion, giving very sharp prints. The paper may contain the colour-producing reagent, but if this is impracticable because of interfering effects, the ions entering the paper may be fixed there by a suitable precipitant in the form of basic or other insoluble salts, and the coloured print obtained later by development with suitable reagents.

Illustrative of the step-by-step printing technique is the detection of lead in brass. Leaded brass is a common commercial grade which occasionally needs to be differentiated from the non-leaded variety. To do this quickly, a print of the surface is made electrolytically with paper dipped in sodium carbonate-sodium nitrate solution. Copper, zinc, lead, and traces of iron and manganese are fixed as insoluble basic carbonates where the metal touches the paper. The excess electrolyte is washed out with water and there is left the undeveloped print containing these salts. The paper is then dipped into a potassium cyanide-potassium carbonate solution and again washed. This removes the copper and zinc salts. It is dried and dipped into a solution of potassium dichromate in acetic acid, then washed thoroughly. This final treatment converts the basic lead carbonate to yellow, insoluble lead chromate, while the iron and manganese are dissolved and washed out. The yellow colour is characteristic enough for most purposes, but its nature may be confirmed by treatment with sodium sulphide which converts it to brown-black lead sulphide. Tin does not interfere in these reactions.

Electrolytic Printing

Detection of chromium by electrolytic printing is simple and rapid, in contrast to the cumbersome process described in an earlier paragraph. The specimen surface is brought into contact with paper soaked in sodium nitrate-phosphate solution and a positive potential of 4 volts is impressed for a few seconds. Chromium is indicated by a deep yellow colour and is confirmed by adding to the print a drop of diphenyl carbazide solution in acetic acid, when a magenta colour shows the presence of the chromate ion. Thus, in a single operation solution of the specimen, oxidation of the chromium to chromate, and its separation and detection are accomplished in one or two minutes.

The "electrographic" method, as it has been called by Glazunov, has come into much use in the Microchemical Laboratory of the Bell Laboratories in the past three years. It has provided the answer to numerous requests for rapid qualitative tests and has become a valuable diagnostic and research tool. *Reproduced from Bell Laboratories Record.*

Fractional H.P. Motors for A.C. Supply

An Interesting New Range of G.E.C. Motors

THE increasing use of small electric motors for driving industrial, commercial, and scientific machines of all types has resulted in many developments in the design both of standard motors and special motors to suit particular applications.

An entirely new range of G.E.C. fractional h.p. motors for single-phase and three-phase A.C. supplies is of interest. The range covers outputs from ⅛ h.p. to ⅞ h.p. Single-phase motors are available with "split phase start" or "capacitor-start" characteristics, while the already well-known range of "repulsion-start" motors is included. Three-phase motors are of the squirrel-cage induction type.

Repulsion-start induction motors are designed for applications where high-starting torque combined with minimum starting current and a high accelerating capacity are required. There are no separate condensers or switches. Details are shown in the illustration below.

Two Main Types

In the brush-lifting type, the motor starts as a high-torque repulsion machine with brushes in contact with a radial commutator. As it approaches full speed the brushes are automatically withdrawn from the commutator, which is at the same time short-circuited.

This type is most suitable where silent running is important, owing to the absence of brush noise; for example, for certain domestic appliances.

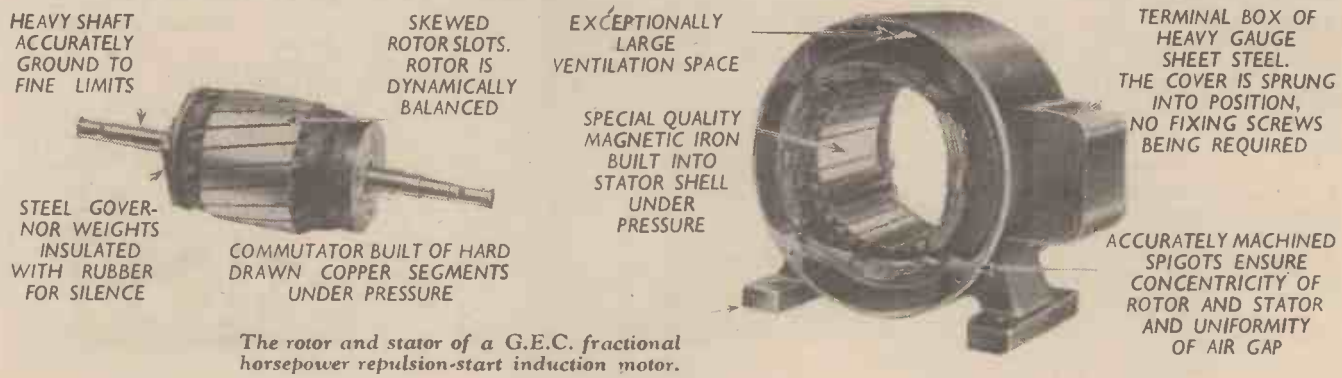
In the case of the brush-trailing type the motor starts as a high-torque repulsion machine with brushes in contact with an axial commutator. As it approaches full speed the commutator is short circuited, the brushes remaining in contact.

It has a higher starting torque and is more suitable for industrial and commercial applications, particularly for such loads as compressors (where the torque required at start and running-up fluctuates considerably) and for loads with a heavy flywheel effect.

Four leads are brought out to provide series-parallel connections, enabling two separate voltage ranges to be covered by one winding.

Refrigerator Motors

The refrigerator motors, ¼ h.p. and ⅛ h.p. resiliently mounted capacitor-start induction types, have been specially developed for the purpose and have the advantage of being silent. This is due to the absence of magnetic and mechanical noise, achieved by liberal rating, special bearings, resilient mounting and other features. There is overload protection by means of a thermal cut-out which automatically stops the motor should it be overloaded to a dangerous extent.



The rotor and stator of a G.E.C. fractional horsepower repulsion-start induction motor.

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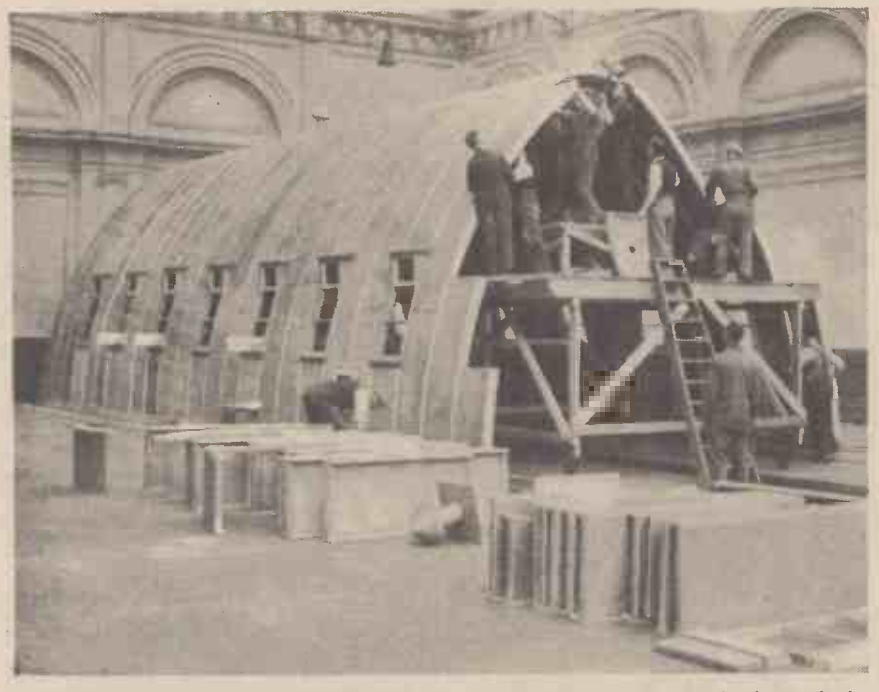


The military hut shown here is built of lightweight concrete units, made from cement, sand and mineralised sawdust. This new building material will carry pins, nails and screws as easily as timber. The amount of steel used in this structure was only ½ cwt.

THE MONTH IN SCIENCE AND

World's Largest Plane

A NEW Douglas bomber, which is considered to be the largest plane in the world, is now under construction by the Douglas Company. Previously the United States Army and the Douglas Company denied that they were building such a plane. The machine will have a wing span of over 110 ft., which is larger than the spans of the Boeing and Consolidated bombers, originally the largest bombing planes. Four 1,500 h.p. engines will be housed in four barrel-shaped projections in the top of the motor cowlings. They are the most powerful aviation engines now built. It will be an all-metal machine and have retractable tricycle landing gear and nose wheel and all-metal wing flaps which either assist the plane's take-off or retard its landing speed.

Automatic Electric Glue Pots

THE Westinghouse Electric & Manufacturing Company of America have produced an automatic, dry-type electric glue pot, incorporating a snap-action thermostat which maintains a temperature of between 150 and 160 degrees F., the most efficient temperature for keeping glue at a working consistency. A 2-quart container can be heated to 150 degrees F. in the short space of between 30 and 50 minutes, the time being determined by the type of glue used.

New Type Engines

AMERICAN engineers appear to be concentrating their attention on the development of new engines. The Packard motor car company have recently produced an engine which is expected to become increasingly important to the United States defence. It is especially adaptable to mosquito boats, and a number have been ordered by the U.S. War Department.

Henry Ford, another car firm, have also produced a new aeroplane engine which resembles in principle the Rolls-Royce unit used in R.A.F. machines. No further details are available.

Yet another engine, this time of a revolutionary type, has been produced by the Aviation Manufacturing Corporation in co-operation with the Army Air Corps. This engine, which is described as "flat as a pancake," will add at least 10 per cent. to the speed of warplanes, and increase their operational radius by 15 per cent.

It has a horsepower of 1,200 and can be "submerged" completely within the wing of an aeroplane, thereby reducing wind resistance.

Wonders Of Mercury

THE author of a recent article in the *Evening News* states that there are over 500 varieties of thermometer and kindred scientific instruments in essential everyday use. These vary from the clinical, whose purpose is obvious, to the pyrometer, which is capable of recording temperatures up to 3,000 degrees Fahrenheit.

Yet without that little mercury-filled tube in its many shapes and forms every ship would rock helplessly at her moorings, the huge steel-forging furnaces would cease to function, bombers and fighters would be forced to remain in their hangars, and, in the last resort, an island country like ours would be faced with starvation. Not even the vast stocks of food already in storage would be eatable after the first few days of such a disaster.

A New Plastic

MR. S. C. RAE CHOUDHURY has recently invented a new type of plastic called "Pulpo." The process consists of various waste pulps and fibres which are converted into a homogeneous pasty substance which when hardened practically becomes a new substance like wood, having all its qualities without defects but light as celluloid. This extreme lightness gives it a further advantage over wood and other plastics. This paste can be used for making numerous articles.

A.R.P. Shelter

THE unit system of the well-known pressed steel tank is being used as a basis for a new type of A.R.P. shelter which is now being constructed. It will have all the advantages which are a feature of the tank, including simplicity of construction, interchangeability of parts, great strength, and simple and speedy erection. Even in the most adverse conditions this shelter can be made completely watertight by means of pump plates, since the plastic joint compound used in the construction of storage tanks will be used for sealing the joints.

Plastic Pile-Driving Dollies

NORMALLY, steel helmets in pile-drivers have a hardwood dolly, but recently a contractor found that the dolly crushed badly and collapsed in a few minutes whilst endeavouring to drive steel piling to a pre-determined depth. A block of phenolresinoid laminated plastic was substituted for the wooden dolly, and this successfully withstood a driving force of 15,800 ft. lb. per blow at the rate of 120 blows per minute. The block stood up to six hours of continuous work, when charring occurred due to the heat set up by the friction caused by the very uneven surface.

New Case-Hardening Process

A NEW surface-hardening process has been originated by America. The process is intended for plain and alloy steels, such as nickel steel and nickel chromium steel, and is known as "dry cyaniding." Continuous nitriding and continuous gas carburising are the essentials embodied in the process. The case is similar to that given by normal cyaniding. The principle of the method is the use of ammonia combined with other gas carbonising mixtures.

Parachute Training Device

A NEW machine which reproduces all the sensations and experiences of a parachute jump, has been designed by Mr. W. A. Kerr, holder of the Empire parachute descent record of 22,395 ft. The invention consists of a tower from which runs a steel rail. The airman is suspended from a trolley which runs on this rail and is launched from the tower, and plunges to earth at an angle of 40 degrees. After a drop of 50 ft. the bottom of the trolley drops out and the airman is caught with a jerk in harness similar to that of a parachute, thus giving the sensation of pulling the ripcord. The airman is swung about to give him the sensations of floating down in air currents. Finally when he is over a sand-pit the trolley is automatically released at a height of 10 to 15 feet from the ground to give him the sensation of landing.

An Electrical Dog

SPARKO, the world's first electrical dog is being exhibited at the New York World's Fair. He is an attraction at the Westinghouse building, and he walks, barks, wags his tail and sits up to beg. The dog is a creation of Mr. J. M. Barnett, Westinghouse engineer, of Mansfield, Ohio.

THE WORLD OF INVENTION

Magnesium From The Sea

AN American chemical firm is planning to spend £1,000,000 on the construction of plant for the recovery of magnesium from sea-water. The plant will be at Texas, and will be the first large-scale attempt to use the ocean as a source of chemical raw materials.

The Modern Tank

THERE are 6,200 detail parts employed in the production of a modern tank, entailing some 50,000 different machining and assembling operations. In some operations accuracy of measurement to two ten-thousandths of an inch is necessary. In order to prevent vibration when the powerful engines of the tank are at work, revolving parts have to be balanced with virtual exactitude. To the man in the street these feats seem impossible, but they are achieved, and with relative ease and speed.

But when these formidable and clumsy-looking iron robots are turned out of the workshop ready for action, it seems hard to believe that so much delicate workmanship has been put into their construction. In a large factory somewhere in England a considerable number of these "land battleships" are being produced, but there is need for many more, and it is learned that plans have already been completed for greatly increasing the size and output capacity of this particular factory.

Magnet Steels

ATTEMPTS have been made in Russia to improve the Alnico magnet materials. It is claimed that alloys containing 20-33 per cent. nickel, 9-12 per cent. aluminium, 5-12 per cent. cobalt, give better magnetic properties in section of 5-20 sq. cm. than the ordinary Alnico 28/11 type.

Tiny Engines For Giant Cars

DR. GUSTAV EGLOFF, a Chicago fuel expert, envisages an era of giant road vehicles propelled by engines the size of a suitcase. He told the American Petroleum Institute that laboratories have produced a new motor fuel which will enable car and lorry manufacturers to halve the size of their engine. It is called triptan, a fuel of 125 octane rating and possessing twice the combustive power of regular grade petrol of 75 octane.

It is stated that the laboratory cost for this new fuel has been reduced from £720 a gallon to £10 and research workers hope eventually to bring it down near the present popular price levels of petrol. Dr. Egloff, discussing crude oil and its competitive fuels, said that the United States had hydrocarbon resources in the form of natural gas and crude oil sufficient to provide transportation for a long period. He described how natural gas could be compressed into tanks at a pressure of 5,000 pounds per square inch, and used in car engines.

New Type Of Plating

A METHOD of soft semi-bright nickel plating has been developed which is midway between the standard and the fully bright. An electrolyte is employed consisting of a slightly altered type of Weisberg and Stoddard cobalt-nickel solution, obtained by eliminating the sodium salts and reducing the percentage of cobalt in the anode. Cast carbon type of nickel anodes are used possessing a small cobalt percentage. The solution is operated at a pH of 2-4 and at temperatures ranging from 60-82 degrees C.

An "Aerial Fortress"

AN interesting description of a new "aerial fortress" was recently given from an American radio station. The fortress is armed with cannon and lighter guns, and it was said could climb 16,000 feet in an incredibly short time or hover over the ground and open terrific fire at low range. It was also stated that this new type of bomber had passed tests and was already in production.

Metal "Skin" Airship

AMERICA has revived interest in the airship by developing a metal-class dirigible designed to resist storm conditions. It has been produced by the Goodyear-Zeppelin Corporation. A "skin" of metal of a certain tension is used to cover the airship and it is claimed that this absorbs forces which otherwise would twist and break the airship in rough weather. The cover is also designed to act as a gas container, dispensing with the need for the separate gas cells usually employed. The framework is built on orthodox lines.

The method of manufacture is to place the metal cover in position over the girders, which are then expanded, stretching the covering into place. It is possible that a new system may be employed whereby the metal cover is made bullet proof.

Pliable Steel

MR. R. E. ZIMMERMAN, vice-president in charge of research of the United States Steel Corporation, states that they have developed a steel that will bend and not break and is hard enough to scratch glass.

Hearing The Northern Lights

ALTHOUGH it may seem hard to believe, the colourful beauty of the Northern Lights can be heard! Writing in the current issue of the magazine *Natural History*, Dr. Clyde Fisher states that many reliable observers have heard this mysterious sound that accompanies certain auroral displays. It is described as a hissing, crackly, rushing sound, similar to that of burning grass.

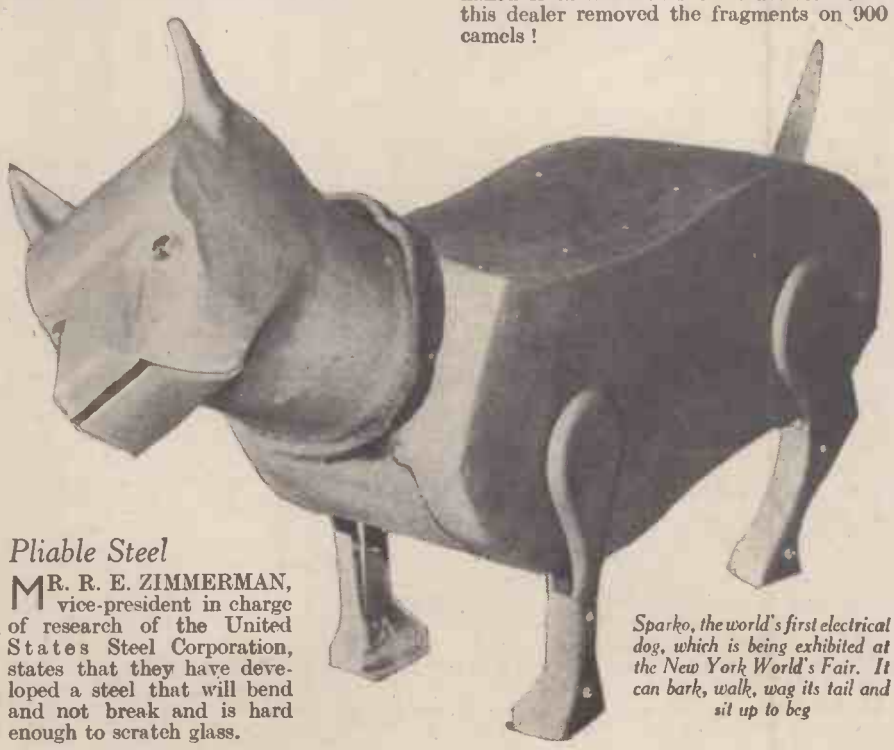
Detecting Submarines

THE fitting of an ultra-sensitive echo-sounding set as part of the standard equipment of submarine chaser ships, has been advocated by American scientists for the detection of submarines. They are also considering, as an alternative, a more complicated method. It consists of the setting up of two electro-magnet ships, which would steam line ahead. In this way, any enemy submarine below the surface would be indicated by disturbance of the lines of magnetic force as recorded on instruments carried in a third wholly-wooden ship.

A Lying Wonder

THE almost cloud-capped twin towers of the Crystal Palace are to be demolished in order that the metal they contain may be used in the manufacture of munitions. In this connection, it is interesting to note that certain huge fragments of bronze for eight centuries lay scattered on the ground in the island of Rhodes—an island in the extreme right of the Mediterranean, belonging to Italy—at present.

These fragments were the disintegrated relics of one of the Seven Wonders of the World. Originally, they formed the Colossus of Rhodes, a gigantic bronze statue of Apollo, the Sun-God, executed by a Greek sculptor named Chares. It is said to have been 120 feet in height and was ascended by an interior spiral staircase somewhat like the Monument in London. The Colossus was overthrown by the tremor of an earthquake. When the Saracens conquered the island they sold the remnants of the famous statue for old metal. The purchaser hailed from Palestine. It is asserted that this dealer removed the fragments on 900 camels!



Sparko, the world's first electrical dog, which is being exhibited at the New York World's Fair. It can bark, walk, wag its tail and sit up to beg

Our Busy Inventors

By "Dynamo"

Baby's Milk Bar

WHEN the baby is taking its nourishment from a feeding bottle, it is usual for the mother or nurse to hold the bottle at an angle convenient to the infant. To relieve the lady of the necessity for this act, a bottle support has been patented in the United States. The device comprises a bar —I almost styled it a milk bar—and means for supporting it above and across the body of the child. There is an aperture and an arrangement for holding the bottle in the aperture in the correct nursing position.

Watertight Safe for Ships

GALLEONS laden with gold have in the past sailed from the Spanish Main to the Old World. And now in our hectic times many tons of the precious metal have "gone west." They have been shipped from the danger zone in Europe to that huge safe deposit—America. The perils of the sea have been increased by the submarine which infests Old Father Neptune's fathoms. Therefore, to guard treasure which has to be transported to foreign climes, there has been contrived a special strong room which is incorporated within a vessel. A ship may now be constructed with a watertight safe, leading to which is an equally watertight passage. One end of this passage opens into the safe and the other end is accessible from the outside of the hull or deck. The latter opening is provided with means for the attachment of a diving bell. This would enable bullion and brilliants to be salved from a submerged liner.

Paper's Proxy

THE passing of the news poster has moved the street paper vendors to place miniature blackboards upon the pavement, and there is a demand for chalk and caligraphy. The newspaper salesman has to be an amateur signwriter. The ability to write clear captions is an asset. In the last war, the late Horatio Bottomley solved the problem by starring the leading feature in his paper in bold, black type on the whole of the front cover. Exhibited on a bookstall it answered the purpose of at least a miniature poster.

I note that a writing surface has just been patented in the United States. It consists of a plate of aluminium having a smooth, satin surface and includes an adherent film of aluminium oxide. This surface is capable of receiving chalk marks which can easily be erased.

Probably, as a result of the scarcity of paper, the old school slate will be revived.

To Prevent Holes in Stockings

A PROCESS devised to add to the durability of stockings is the subject of an application for a patent in this country. This is embodied in a composition of paraffin wax combined with an antiseptic substance such as salicylic acid, zinc oxide, or talcum. The idea is to apply the composition at the points exposed to the most friction—the soles, the toes and the heels.

I wonder whether this process will prove an antidote to "laddering." A really effective preventive of this besetting sin of silk stockings would be hailed with a paean from a myriad dulcet throats. And the inventor would make a fortune almost beyond the dreams of avarice.

Interesting to Ladies

THE mysteries of permanent hair waving do not come within the ken of "mere man." However, I have heard that, to obtain a more or less permanent effect, the heads of the fair are made temporarily to resemble those of the Furies, avenging goddesses whose tresses consisted of snakes, and I am told that heat is a necessary condition.

A new method of permanent hair waving has been patented in America. Into a tubular container adapted to hold a lock of hair are placed two chemical substances. Normally these substances are separated by a wall. A manually operated arrangement breaks the partition. When these chemicals make one another's acquaintance a considerable amount of heat is generated, and the sequel is a series of undulating locks.

Plates for Cups

THE ancient Greeks rewarded the victor in the Olympic games with a wreath of wild olives and a palm. The modern triumphant athlete receives a more substantial trophy. This often takes the form of a cup having upon it the name of the winner or the team. There has just appeared an invention, the object of which is to provide means for readily attaching an inscription plate to a trophy. The plate has at its back an attachment which fits into a hole in the plinth. This invention is especially adapted for attaching plates with names of players to replica cups, when the original cup is presented to a team of players, each of whom is given a smaller cup which is a copy of the original.

Compact Parachute

A PARACHUTE which will go in the waistcoat pocket is not yet a fact. But a step in this direction has been effected by an inventor who has applied to the British Patent Office for a patent for his device. This new parachute has a canopy internally provided with springs which lengthen and open the parachute. It is held open independently of the action of the air. The springs, which allow the parachute to be folded into a small volume, are characterised by spring blades capable of being rolled up in a spiral manner. This device is the invention of a Rumanian living in Paris.

Musical Shoes

IT used to be said that shoes which squeak were not paid for. A slipper designed to squawk has been accepted by the United States Patent Office. This is a novelty intended for the young. It is what is known as the bunny-shoe type, which resembles a juvenile rabbit. The characteristic feature is the addition of a squawker, whistle or other sounding device.

Dogs' Neckwear

IN Germany there has recently been a wholesale destruction of dogs. Happily our own canine pets have not shared this fate. As a consequence, there may be a demand in this country for an improved dog collar, in relation to which an application has lately been made to the British Patent Office. The leather parts of a dog collar have usually been stitched or riveted. Should the animal outgrow this neck band, it must be replaced by a larger one. Also, should the leather part of the collar become worn or broken, or the metal fittings be damaged or require renewal, a new collar is necessary. At least the old one has to be taken to a saddler.

Bearing these facts in mind, an inventor has contrived a collar having, in addition to buckle or other fastening, means for expanding the girth of the collar. If any of the parts require renewing, the owner of the dog can himself perform the work; and should a change of address occur, a new engraved plate can be affixed without skilled assistance.

The parts of this new collar, instead of being stitched or riveted, are screwed together by bolts and nuts of a special type. Ornamental studs with threaded stems are socketed and engage the stem of the nut.

Pocket Post Office

METHODICAL folk are accustomed to carry a supply of postage stamps. This is a convenient practice which, however, renders one liable to be applied to for a stamp by the unsystematic people.

A new pocket holder for stamps is the subject of an application for a patent in this country. It consists of a four-sided box whose bottom is at an acute angle with the front wall. On this wall the lid presses resiliently to grip a projecting stamp. As this stamp is pulled, it causes its successor to curl over into the place of that separated from a strip of stamps folded concertina-wise. The box has more than one compartment in order to accommodate stamps of different value.

Rest for the Weary

IT is stated that a sleeper remains in one position as long as he is comfortable. But when discomfort is experienced, a readjustment of the body is made to regain an easy position.

This fact is remarked by an inventor who has submitted to the British Patent Office a proposal for an improved mattress. He adds that the change of attitude on the part of the recumbent sleeper usually involves the act of turning over partially or completely. If any of these movements do not necessitate too much effort, it is made unconsciously without interrupting sleep. However, should the discomfort be exceptional, the sleeper awakes.

The inventor in question has devised a mattress with a number of upright spiral springs arranged in parallel rows in a well-known fashion. But the characteristic feature is that the springs are divided transversely into sections differing in their resistance to deflection. The middle section, upon which the heavier part of the body, including the hips, rests, is qualified to support a greater load than the sections upon which the shoulders are supported. And this, the inventor contends, enhances the repose of the sleeper.

Watch Repairing and Adjusting—9

The Cylinder Escapement, Jewel Sizes, etc.

THE cylinder escapement must not be despised even though it is not to be found in the high-grade watch. This type of escapement is still popular with the cheaper movement, where it often gives a considerably better performance than some lever escapements.

As its name implies, the main unit of this escapement consists of a cylinder. The pivoted cylinder, to which is attached the balance wheel, occupies the same place as the balance staff in the lever escapement. The escape wheel, which is of peculiar design, works directly into the cylinder; there is no intermediate connection like the lever or pallets. Brass escape wheels and jewelled cylinders were used by the early makers, but the best results have been obtained by using steel wheels and cylinders.

The Escape Wheel

Unlike the lever, which is a detached escapement, the cylinder is essentially frictional, for the escape wheel teeth rub the edge of the cylinder for a considerable part of the balance vibration. Fig. 1 shows the

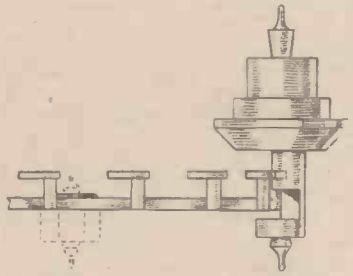


Fig. 1.—The escape wheel and cylinder, whilst the action of the escapement is shown in the centre column.

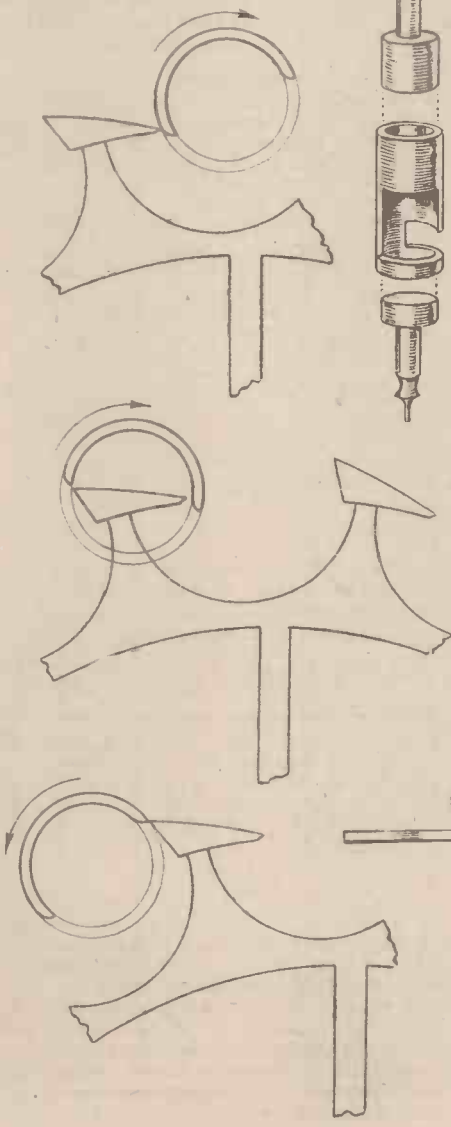
escape wheel and cylinder. From the sketch it will be seen that the teeth are mounted upon stalks, whilst the plan view reveals the wedge-shaped tooth.

In the action of the escapement, a point of an escape wheel tooth rests on the outside of the cylinder, and as the balance revolves, the tooth forces its way into the cylinder, at the same time giving impulse to the balance. The cylinder, which is, of course, cut away to allow the teeth to enter, now receives the tooth on its inside. There is a little drop as the heel of the tooth leaves the lip of the cylinder.

Cylinder Escapement

The tooth remains inside the cylinder until the balance reaches the end of its vibration. When the balance returns it allows the tooth inside the cylinder to escape, and the point of the next tooth to drop on to the outside of the cylinder. In a cylinder escapement, the banking is provided by the balance and the balance bridge. A short pin is fitted into the edge of the balance wheel whilst the banking stud usually consists of a pin attached to the underside of the bridge. Fig. 2 shows the arrangement. Unless the banking stud is close to the rim of the wheel, excessive vibration is likely to cause the banking pin to lock itself on the banking stud.

High quality escapements are provided with a series of dots to assist in setting the balance in beat. Three dots on the bottom plate and one dot on the balance. When the balance is at rest, its dot should be opposite the middle dot. To test the beat, turn the balance until a tooth drops, note the position of the balance dot in relation to one of the outer dots. Reverse the balance and note its position. If the dots coincide or bear the same relative position to each other, the escapement will be in beat. If the positions are unequal, the hairspring will have to be moved until they become equal.



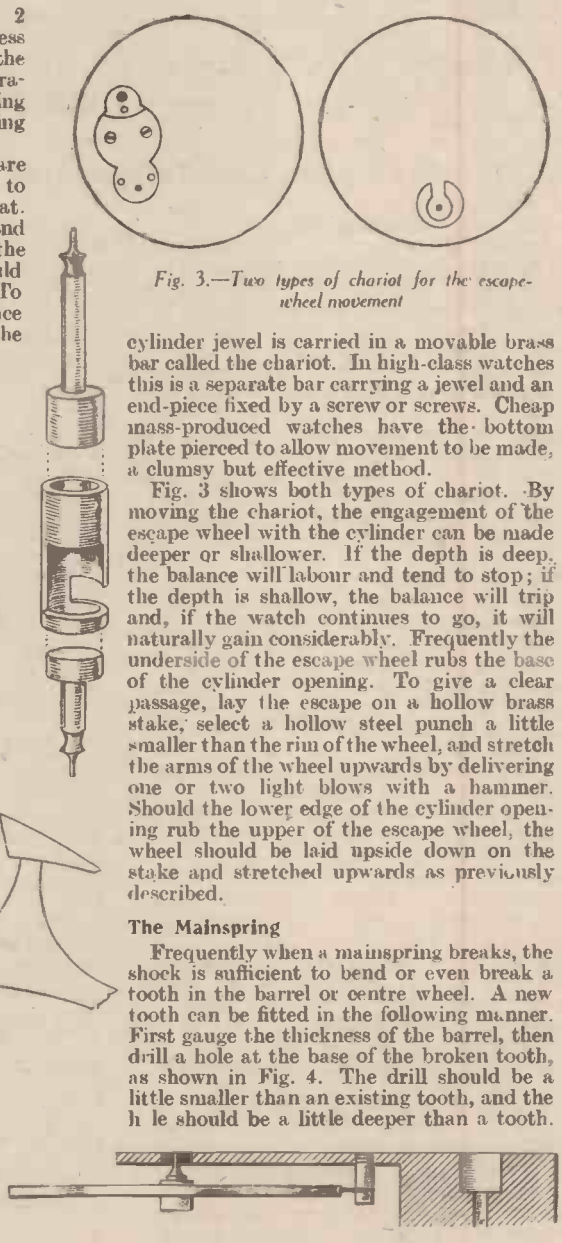


Fig. 2.—The balance wheel and banking stud.

Drop

Should the escape wheel have drop outside the cylinder, but no drop inside, the cylinder will be too small; if the conditions are reversed, the cylinder will be too large. These faults can only be remedied by fitting a new cylinder. Unequal escape wheel teeth can be equalised by filing the tips of the teeth with a diamond file. The lower

Fig. 3.—Two types of chariot for the escape-wheel movement

cylinder jewel is carried in a movable brass bar called the chariot. In high-class watches this is a separate bar carrying a jewel and an end-piece fixed by a screw or screws. Cheap mass-produced watches have the bottom plate pierced to allow movement to be made, a clumsy but effective method.

Fig. 3 shows both types of chariot. By moving the chariot, the engagement of the escape wheel with the cylinder can be made deeper or shallower. If the depth is deep, the balance will labour and tend to stop; if the depth is shallow, the balance will trip and, if the watch continues to go, it will naturally gain considerably. Frequently the underside of the escape wheel rubs the base of the cylinder opening. To give a clear passage, lay the escape on a hollow brass stake, select a hollow steel punch a little smaller than the rim of the wheel, and stretch the arms of the wheel upwards by delivering one or two light blows with a hammer. Should the lower edge of the cylinder opening rub the upper of the escape wheel, the wheel should be laid upside down on the stake and stretched upwards as previously described.

The Mainspring

Frequently when a mainspring breaks, the shock is sufficient to bend or even break a tooth in the barrel or centre wheel. A new tooth can be fitted in the following manner. First gauge the thickness of the barrel, then drill a hole at the base of the broken tooth, as shown in Fig. 4. The drill should be a little smaller than an existing tooth, and the hole should be a little deeper than a tooth.

The depth of the hole can be tested with a piece of pegwood.

When repairing a large barrel, file up a piece of steel wire until it partly enters the hole, draw file it and drive it home, carefully, to avoid bulging the barrel face. If there is any doubt about the grip of the new tooth, fuse a minute piece of solder about the tooth before dressing it to the shape of

the existing teeth with a needle file. A piece of brass wire will be strong enough for a small size barrel. The barrel and the centre wheel should be put between the plates to test the gearing before reassembling the movement.

Fitting Teeth

Fitting teeth to either the centre, third or fourth wheels is an even more delicate operation. The holes should be drilled right through the rim. A piece of brass wire held in a pin vice or pin tong, and filed to a very gradual taper, should be forced in. Any surplus wire should be cut off and the new tooth filed to shape. If necessary, a little solder can be applied to the inside of the rim. Should the wheel be too thin to drill, a new tooth can be fitted in another way. Select a broken wheel of similar size, cut out a block of about three teeth, and break off the end teeth. Clean the rim of the wheel and the new tooth in readiness for soldering. Lay the new tooth upon the rim of the wheel, and solder it in the correct position.

When fixed the new tooth should be filed to the exact shape and finally faced off with an emery buff. The tooth should be fixed to that side of the centre wheel which has most clearance. A new tooth can be fitted to a cylinder escape wheel by a similar method if the cylinder has a fairly large opening. Procure an old escape wheel of the same size and break off one tooth from the rim. The new tooth is then laid in position and soldered to the escape wheel rim. Place the wheel on a small brass plate or blueing pan which has been previously warmed. It is essential that the heel of the new tooth does not project beyond the diameter of the wheel teeth.

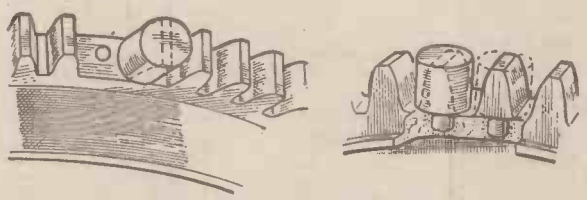


Fig. 4.—The method of fitting a new tooth in the barrel or centre wheel.

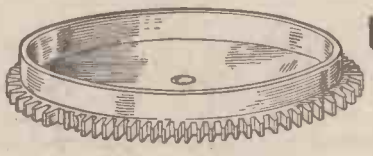


Fig. 5.—The barrel or centre wheel.

Fig. 6.—Section of a jewel hole.

Fig. 7.—A gauge for reading the size of the hour wheel socket or cannon pinion. It is similar to a pivot or mainspring gauge.

Jewel Holes

The brass set jewel hole and the jewel hole retained by a burnished flange were both described in an earlier article. Modern watches, however, use a different method of jewel retention. The jewel holes have perfectly straight sides. Early type jewels needed only an opening and closing tool, but to fit the latest type a small press as supplied with a jewel outfit, is necessary to ensure correct fit.

Small glass bottles similar to those used for ordinary jewel holes contain the graduated plug-type jewels—often called friction jewels—whose size ranges from 0.70 m.m. to 3.00 m.m., each size varying by 1/100 m.m The press has a stop divided into 1/100 m.m. which regulates the depth to which the plunger may be depressed. A number of fittings include stakes, pushers, clampers and broaches. The broaches are actually tapered half-round cutters, unlike an ordinary broach the taper ends in perfectly cylindrical formation in order that the sides of the finished hole may be straight.

As the amount of end-shake varies, the face of a jewel hole may be above or below the surface of the watch plate. Before pushing out the old jewel, measure the position on the press. This is done by depressing the pusher until it touches the jewel and then adjusting the finely divided stop. A reading should be taken to ensure a correct fit with the new jewel. The old jewel should be pushed out from the outside. First select a broach which will only slightly enlarge the existing hole. The hole is broached from the inside with a gentle turning action, a little pressure being applied until the cylindrical part of the broach passes through the plate.

Broaching

After broaching, slightly chamfer the edge to remove any burrs. The chamfered edge will also act as a guide for the jewel hole which has one edge bevelled as shown in Fig. 6. Choose a jewel with a suitable pivot hole which is 1/100 m.m. larger than the broach—a broach which measures 1.99 m.m. will need a jewel which measures 2.00 m.m. If the face of the jewel is to be flush with the plate, use a pusher larger than the jewel. Lay the jewel in position on the watch plate which should be resting on one of the solid stakes, and depress the plunger until it touches the plate. The previously recorded setting should be used for jewels which have to be above or below the surface.

The type of jewelling need not be confined to modern watches as the old-fashioned burnished-in settings can be broached out to receive a larger jewel hole. Brass set jewels and bushes can be efficiently fitted with this press.

Watch hands are too often regarded as an odd pair of fingers which point to the time. They should, however, be chosen and fitted with care. Many stoppages are due to the hour hand being too long, its point either catching in the seconds hand or the underside of the minute hand. In many instances the hour hand is as long as the minute hand. The size of the socket is most important and to obtain a correct fit certain gauges are essential. One gauge for reading the size of the hour wheel socket or cannon pinion resembles a pivot or mainspring gauge. Fig. 7 shows this gauge.

Broken Hands

Graduated in 1/10 m.m., two gauges are necessary to cover the whole range. The smaller of the two records from 25/100 to 100/100 m.m., whilst the larger reads from 100/100.m.m. to 200/100 m.m. Frequently the sockets of broken hands are still in position. When these are available a different kind of gauge can be used which consists of three tapered steel needles. The socket is pushed over the needle where its size is indicated on the scale. These needle gauges also have a scale which indicates the length of hand required. Cards of broach-less hands are obtainable for use with these gauges. As the name implies, fitting can be carried out without the use of broaches.

NEW INVENTIONS

Mobile Air-Raid Shelter

AN improved guard to protect cars from flying debris, shrapnel or nearly spent bullets is the subject of an application for a patent made to the British Patent Office. The device includes a flexible guard comprising a number of chains having interconnected links and one or more metal slats, strips or the like threaded along the aligned links of the chains.

Fortunately, up to the moment of writing, there has been practically no reason to employ such a guard. But, in the case of an air raid, to be able to use one's car as a mobile shelter would afford protection at least against minor missiles.

Mackintosh For Gloves

A KID glove exposed to rain or snow is apt to lose its pliability. I have seen one, through being saturated by a shower, as rigid as a Tommy standing at attention. What may be termed a glove mackintosh has made its debut. It is composed of regenerated cellulose film, such as Cellophane, and is provided with ventilation apertures in the palm. This shield will prevent the oil in the kid glove from being soaked out by moisture.

Umbrella Roller

TO make an umbrella attain the desired slimness is something of an art. One secret is that the cover must be well ironed, so that the folds lie close together.

A self-rolling umbrella has been patented in the United States. It is adapted to roll up the cover on axes located lengthwise in relation to the stick of the umbrella. This invention will be welcome to the smart, well dressed man who is tempted not to open his new umbrella, even when it rains because he has not the knack of folding it.

For Washing Up

WASHING up in the home is sometimes regarded by the housewife as not the most attractive of domestic duties. In hotels, restaurants, hospitals and factory canteens, where a large quantity of cups and plates have to be cleansed, I understand that machines are usually employed for washing the crockery.

There has been applied for at the British Patent Office a patent for an invention of the above description. Its object generally is twofold : to enable the cups, etc., to be washed and dried in considerable quantities in a more effective manner than hitherto, and with the possibility of complete sterilisation without undue loss of time.

According to the new invention the cups and other articles are so constructed that, when they are nested or stacked, there are spaces for the admission and escape of washing or sterilising fluid.

"MOTILUS" PEEPS INTO THE MODEL WORLD

Mr. Hilder starting one of his own yachts off at a local regatta

Our Model Expert Reviews The War-Time Position Of Model Makers

THERE is humour to be had out of models, and I had to smile to myself when I came across a sketch the other day made by a friend of mine several years ago, which was supposed to indicate the impression made on some African natives by a 2½ inch gauge steam locomotive. The Baro Kano Railway of Nigeria was at that time under construction and a concession was required from the Emir of Zaria and the Emir of Katsena to allow it to pass through their territory. So a firm of model makers was entrusted with the task of building a steam model of the locomotive and track, which was sent out to Nigeria for the edification of the chiefs. I have no record as to how the model was really received, but suffice it to say that the railway was built through the territory and ultimately the model locomotives were presented to the native chiefs as a recognition of their assistance given to the railway authorities. Let us hope the natives lived happily ever afterwards!

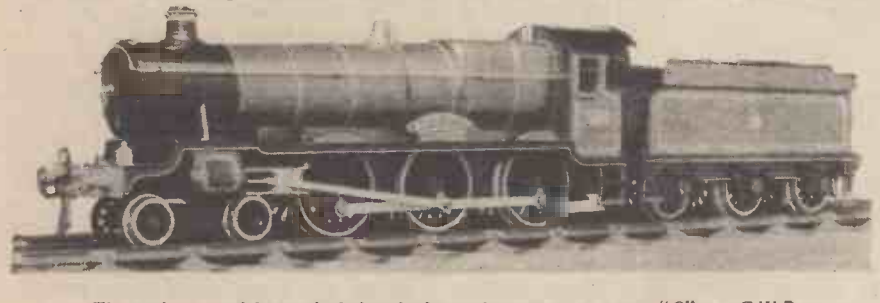
The "Llanvair Grange"

Here is a model of the "Llanvair Grange," the prototype of which belongs to the "Grange" 6800 class, introduced in 1936, and designed to replace the older 4300 class 2-6-0 type for working mixed traffic. The "Grange" class followed the "Hall" class being 4-6-0 type, but with 5 ft. 8 in. diameter driving wheels. It is a G.W.R. class built for dealing expeditiously with fast freight services, such as the broccoli trains from Cornwall, the fruit trains from Worcestershire, and heavy excursion trains.

The owner of this fine scale model, Mr. Gilbert Thomas of Teignmouth, is probably known to many readers as an author and well-known book critic. He writes both prose and verse and in his works often makes reference to railways and model railways. He is also a keen G.W.R. enthusiast and has always collected West of England locomotives for his extensive gauge "O" railway. Now that he lives at Teignmouth they pass his front door so to speak! This model is beautifully constructed to scale and is fitted with the latest type of all British clockwork mechanism.

An American Model Maker

When I was in America some ten years ago I came aeross Ernest S. MacGowan of Minneapolis, a really enthusiastic model-maker. I heard from him the other day and he tells me he is a regular reader of the model engineering papers of Great Britain, but he finds a lot of material which does not interest him such as petrol engines and aeroplanes. He mentions, by the way, that there are millions of model aeroplanes being made in the U.S.—mostly by boys or young men, and many are powered with excellent petrol engines. The picture illustrated was sent by him and shows a model threshing engine that was exhibited at the County Fair at Owatonna, Minnesota. The engine was made by three brothers, who run a garage and car repair shop and this engine was made for advertising purposes. They made the necessary patterns and had the castings made at a local foundry and built the engine in their own machine shop. I should say the scale is about ⅛ full size. The engine is fired with soft coal and the exhaust is up the chimney as in loco. practice. Mr. MacGowan says "It seems strange that the making of models is such an unimportant activity in the United States. Here we are with at least three times the population of Great Britain and yet the number of men who make models for their own amusement is very small indeed. There is however an increasing number of those who are making small locos. that run by steam." He praises the miniature reproductions of the streamliners which the railroads are using to try to get back some of the business they have lost to the motor bus lines and the private car. The firms who put them out are absolutely up to the minute.



The modern possibilities of clockwork driven locomotives in gauge "O"—a G.W.R. "Llanvair Grange" special model

Mr. Hilder surrounded with examples of his work, including a model of the Hastings Lifeboat.

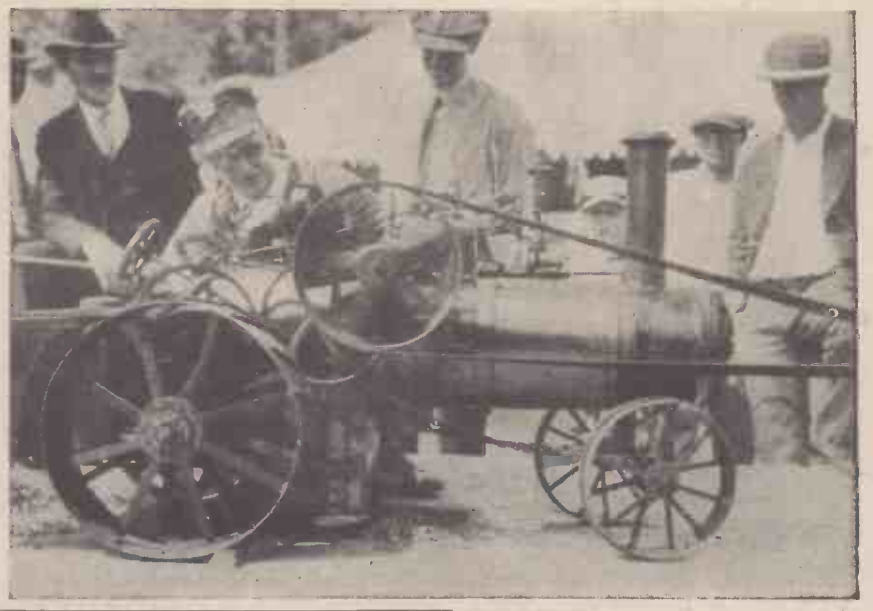
Model Yachts

Spending a day or two at Hastings recently I came across my old friend, Mr. W. R. Hilder, who is a well-known model maker, beside being in charge of the Hastings Lifeboat. His speciality is model yachts, which he builds in his spare time. The illustration at the top of the page shows him surrounded by several of his models, the central feature of which is a 1 inch to the foot model of the

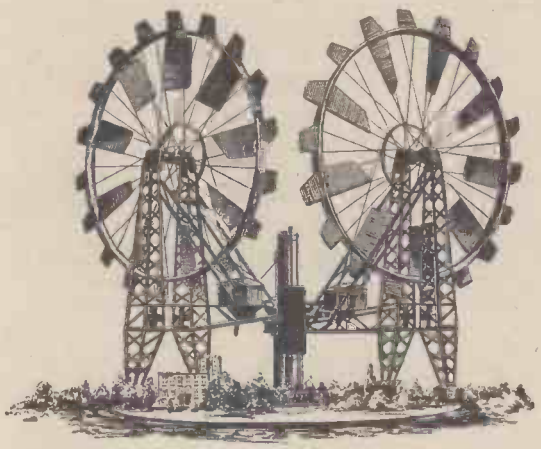
Hastings Lifeboat. Also on view is the Hastings Luggar (dark sails in right background). This represents the largest type of fishing boat used off Hastings. It is very wide in the beam with a bluff bow and a lute stern. Some of Mr. Hilder's work is to be seen in the South Kensington Museum, while at places like the Eastbourne Museum he has several models, and has modelled the Blackpool Lifeboat.

Model of a Lifeboat

At his shop in Courthouse Street, I saw several examples of yacht work, and he had also a model of one of the large 46 ft. motor lifeboats (the Hastings Lifeboat is 35 ft.) and when he obtained the drawings for this model there were only three of this modern type lifeboat in existence. His yachts are fitted with the Bermuda rig and are good racers, and in the illustration on the previous page will see him starting one of them at a local regatta.



American model enthusiasts in Owatonna, Minnesota, building a working model of a steam threshing engine. The scale is about ⅓ full size.



Proposed design of wind generator: driving wheels would be 1,000 ft. in diameter.

Power For The Future

This Article Describes Alternative Sources of Power which Have not Yet been Tried on a Commercial Scale.

IT is seldom realised that electricity itself is not a source of power, but a convenient method of transmitting and storing the power itself. At present, no method has been devised of harnessing nature's electricity, which must be produced by generation, using some form of prime mover.

Alternative sources of power beyond coal and oil are water storage, tidal movement, wind, and the heat of the sun. Of these, water power would only be sufficient for 10 per cent. of world demand, the cost of erection is prohibitive, and the sources of water supply are in remote places where power transmission is costly.

Tidal movement has been used for several schemes, including the well-known Shannon installation, but again the cost of installation and maintenance is very high. Other ingenious arrangements include floats which generate current as they move with the waves, and one which operates turbines through the difference of temperature of the sea on the surface as compared with the water 4,000 ft. below. The difficulty in both cases being that the results obtained were meagre compared with the cost of the plant.

Thermal Power

The sun is a very effective source of power and its rays are equivalent to two horse power per square yard. The best results are obtained by a parabolic bowl of mirrors reflecting on to a central water tube boiler. This produced one horse power for three square yards, or approximately 20 per cent. of radiated energy.

Wind Power

Considerable experiments have been undertaken on the Continent and in Asia, based on the established fact that there is always a wind blowing at 2,000 feet above the earth. The scheme, although an ambitious one, is certainly capable of immense output if the mechanical difficulties can be overcome.

The proposed wind generators would be mounted on towers 2,000 ft. high and would have vanes at a diameter of 500 ft. The maximum speed would be 50 r.p.m., and the wind vanes would themselves carry high-tension three-phase alternators. Ingenious arrangements keep the vanes at the right direction and angle to obtain the maximum power from prevailing winds, and also to eliminate overspeeding if the wind velocity reaches gale force.

Alcohol

Finally, there is nature's own power product, alcohol. With the aid of recent discoveries, alcohol 99.9 per cent. pure can now be obtained from decaying vegetation and has the advantage that it can replace oil and petrol for many purposes, although it remains to be seen whether sufficient quantities can be produced to meet world requirements. Meanwhile there has yet to be produced a power source equal in cost and effectiveness to the ever diminishing stocks of coal and oil.

Reproduced from "The Brook."

The International Brotherhood of Scale Model R.R. Builders

NO doubt many of our readers are conversant with the enormous strides America is making in the model railway hobby and the firm of Scale-Models of Chicago, manufacturers of "Scale-Craft" working models—have inaugurated an International Brotherhood of Scale-Craft Model Railroad Engineers, whereby members are given useful assistance in making the very most of their hobby.

The International Brotherhood has not been long in existence and Mr. W. J. Bassett-Lowke, managing director of Bassett-Lowke, Ltd., was recently elected the first British member of the organisation. An amusing part of the scheme is that the badge of membership is accompanied by an American type regulation engineer's cap. We cannot imagine Mr. Bassett-Lowke wearing this at the next Model Engineer or Model Railway Club Exhibition.

Elliott Donnelley, head of the American concern, writes to Mr. Lowke, "Incidentally, I have you to blame for my getting into the model railroad business! About 13 years ago I took up the hobby and, at that time, as there were no real model manufacturers in this country, my first equipment was made by you—some of which I sent for by mail, and some of which I picked up at your stores in London and Northampton during two of my visits to England. In fact I was in England in 1924, and almost cut my trip short because you had in one of your branches a secondhand 1½ in. scale locomotive that was for sale at $1500.00, which was just about the amount I had for my European trip. For almost a week I debated whether I should buy this locomotive and go home, or whether I should continue my so-called education!" Mr. Donnelley has in his file practically every Bassett-Lowke catalogue ever published.

Facts About Metals

(*Continued from page 455 of July issue*)

Masurium.—Metallic element.—Chemical symbol, Ma; At. No. 43.

Discovered (along with the more plentiful rhenium) in 1925 in platinum ores by Noddack and Tacke.

Although the element is a metallic one, practically nothing is known about it at the present time.

Mercury.—Metallic element.—Chemical symbol Hg (from the Latin, *hydrargyrum*, meaning "liquid silver"); At. No. 80; At. Wt. 200; Freezing Point, -38.85° C.; B.P. 357.25° C.; Sp. Grav. 13.596; Sp. Ht. .03312; Coef. Exp. .000018216; Therm. Cond. (Silver=100) 5.3; Elec. Cond. (Copper=100) 1.96.

Chief ore: Cinnabar, HgS.

Mercury or Quicksilver was known to the ancients on account of the ease with which it is extracted from its ore, cinnabar. The alchemists were especially attracted by it, and considered it to be a constituent of all metals. On account of the peculiar nimbleness of its globules, they named it "Mercury" after the mythological Mercury who was the fleet-footed messenger of the gods.

Mercury is a silvery-white metal. It is the only metal known which is liquid at ordinary temperatures, although the metal gallium makes a close second to it. Mercury remains unchanged in dry or moist air. It is not very volatile except when heated. Alkalis have no action upon it, but it dissolves in many mineral acids, as, for instance, nitric acid. All soluble mercury salts and compounds are very highly poisonous, as is, also, mercury vapour itself. In very thin films, mercury appears violet by transmitted light.

Mercury has very many uses in science and industry and also in the arts. It readily dissolves and/or alloys with most metals, such alloys being called "amalgams."

Mercury-with-Chalk.—Name given to a preparation containing chalk and mercury which is used in medicine. Known, also, as "Grey Powder." It is prepared by grinding up mercury with chalk and consists merely of very fine globules of metallic mercury which are prevented from coalescing together by the presence of the chalk particles. Its pharmaceutical name is "*Hydrargyrum cum Creta*," which means literally "Mercury with Chalk."

"Metallic" Selenium.—The light-sensitive variety of the element, Selenium, obtained by quickly cooling molten selenium to 210° C., and then by keeping it at that temperature for some time. M.P. 217° C.; Sp. Grav. 4.5.

"Metallic" selenium is a black, shining material, whose electrical conductivity in daylight is about twice that of its conductivity in the dark. Strictly speaking, the material is more or less entirely non-metallic in nature.

Mild Steel.—This is ordinary carbon steel containing not more than .5% of carbon. It is malleable and can readily be welded. For ordinary "day-by-day and everyday" uses, mild steel is indispensable.

Mischmetal.—An alloy of cerium metals obtained by the electrolytic reduction of crude cerium chloride. It contains cerium and lanthanum, together with small quantities of praseodymium, neodymium and samarium. Alloyed with iron, to increase its hardness, mischmetal is much used in the preparation of pyrophoric alloys for lighting and sparking devices.

See Pyrophoric Alloys.

Moirée Metallique.—Name given to the surface of sheet tin or tinplate which has been treated with hydrochloric or sulphuric acids, under which treatment the metal surface acquires a peculiar crystalline or "watered silk" appearance. This is sometimes made permanent by being coated with coloured varnishes.

(From the French, *moiré*, "watered.")

Molybdenum.—Metallic element.—Chemical symbol, Mo; At. No. 42; At. Wt. 96; M.P. 2450° C.; B.P. 3200° C.; Sp. Grav. 10.3; Sp. Ht. .0659. Chief ores; Molybdenite, MoS_2; Wulfenite, $PbMoO_4$.

Molybdenum was first prepared (in the form of a metallic powder) in 1790 by P. J. Hjelm. Its name was derived from the Greek, *molybdos*, signifying "lead-like," this being a name which the Greeks applied to galena and all lead ores.

Molybdenum, when pure, is a greyish metal, having a bluish cast, and capable of taking a high polish. It is closely related to chromium in properties. It does not readily oxidise or tarnish in air, and its melting point is even considerably higher than that of platinum. For this latter reason, the pure metal has been extensively employed in the making of the electrodes of transmitting valves, cathode ray tubes and other high-vacuum devices.

Molybdenum has the property of rendering iron and steel hard without, at the same time, making them too brittle. For this reason, molybdenum is nowadays being increasingly used. Molybdenum steels are employed for making ships' propeller shafts, rifle barrels, and, also, as high-speed tool steels, it being found that such steels do not lose their temper when heated. Molybdenum steels may contain up to 10% of the metal, molybdenum.

Compounds of molybdenum are used in dyeing and in pigment making.

Molybdenum Nickel.—A nickel-molybdenum alloy containing from 20% to 50% nickel and from 45% to 75% of molybdenum. Used in the manufacture of nickel-molybdenum steels.

Molybdenum Steel.—Introduced in 1904 by the French metallurgist, Professor Guillet. Such steels may contain up to 10% of molybdenum. They are as hard but less brittle than tungsten steels, and, being particularly shock-proof, are employed for making rifle barrels, propeller shafts, etc. They are also used as high-speed steels, i.e., for the making of tools running at very high speeds. Steels containing molybdenum have also been employed for bullet-proofing purposes.

Monel Metal.—Primarily a nickel-copper alloy containing iron, manganese and other elements. Derived from the smelting of a nickel ore containing copper. It was first introduced in 1905 by the International Nickel Company, and it takes its name from Ambrose Monell, the then President of that organisation.

Monel contains approximately two-thirds of its weight of nickel. A typical analysis of this alloy is: nickel, 68.41%; copper, 29.14%; iron, 1.19%; manganese, 1.02%; silicon, 0.06%; carbon, 0.12%; sulphur, 0.008%.

The metal has a specific gravity of 8.8. Coef. Exp. .000015. It is sufficiently magnetic to be attracted to a hand magnet.

Monel is a tough alloy whose mechanical properties can be improved by cold working. It cannot be heat treated. It has a Specific Heat of .127. It is claimed to be between 10 and 15% stronger than mild steel.

Monel is used at the present time on account of its high oxidisation and corrosion-resisting properties. It is employed frequently in the construction of machinery for the handling of foods and chemical substances. Also for dyehouse, laundry and hospital equipment and the like.

Mosaic Gold.—One of the "imitation golds." A variety of brass. Composition varies, but the following is typical: copper, 65.3%; zinc, 34.7%.

This must not be confused with the variety of "mosaic gold" which is used as a pigment and which consists of scales of tin sulphide.

Moss Copper.—Name given by copper refiners to the fine, green, velvety filaments of impure copper which sometimes line cavities in lumps of the smelted copper.

Mumetal.—A nickel-iron alloy containing, also, about 6% of copper in order to facilitate its heat-treatment. Was developed by The Telegraph Construction and Maintenance Co., Ltd. Has similar properties to the "Permalloy" series of high magnetic permeability alloys.

Muntz's Metal.—A variety of brass containing 60% copper and 40% zinc. It is plastic when hot and, in the absence of tin and other hardening metals, can be extruded through a die when red hot. When used for this purpose, about 1% of its contained zinc is replaced by lead.

The metal was originally devised and patented in 1832 by Mr. George Frederick Muntz, of Birmingham.

Mushet's Steel.—Tungsten steel. A type of steel containing upwards of 3% of tungsten. It is difficult to forge and cannot be welded. It can be cast into the form of tools which can be ground to a very sharp edge.

Musiv Silver.—An amalgam which has at times been used for the spurious silvering of brass and copper, the amalgam being mixed with 6 times its weight of bone ash and applied to the metal surface with a rubbing action.

The "musiv silver" amalgam consists of: tin, 3 parts; bismuth, 3 parts; mercury, 1.5 parts.

(*To be continued*)

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

A Spot Welder For Use On A.C.

The Construction of a Battery Operated Spot Welder was Described in the May 1940 Issue of "Practical Mechanics"

Reprinted at the request of many readers, from an issue now out of print.

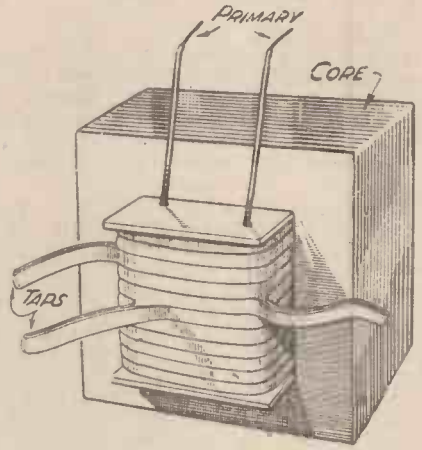


Fig. 1.—The finished transformer

THIS article actually describes the method of making the battery-operated spot welder, described recently in these pages, suitable for use on A.C., because the welder itself remains virtually unchanged. Briefly the differences are that this machine is operated from a transformer and the finger push switch dispensed with. A foot switch is used leaving both hands free to hold the work, etc.

Start the work by removing the contact switch and then drill another hole through the bottom arm so that the whole may be bolted down to the bench or a large wooden base.

The Transformer

The transformer is the heart of the machine and must be made with care. A 500 watt transformer can be operated from a light socket and is heavy enough for most work, but a 1,000 watt requires a 5 amp. plug and this wattage is too great for the lighting wiring. If possible, try to obtain a second-hand transformer with an open casing rated for your supply and with an output of over 500 watts. On conversion, it will be as efficient as a commercial 500 watt transformer and the work of conversion will be easy. The output required is a maximum of 100 to 200 amps. at 1, 1.5, 2, 3 and 5 volts. In watts this is 500 or 1,000 depending on the current required. Five volts is not often required in the home shop. To carry over 100 amps., large cables are necessary, and as the resistance has to be kept very low we are using sections on the heavy side to allow for drops in voltage across joints, etc. On a core of this size, which must not be less than 3.5 square inches, we can allow 5 turns per volt; thus, one needs a total of 25 complete turns with taps at the 5th, 7½, 10th and 15th turn respectively.

The length of strip of suitable section is obtained, and if hard drawn, is annealed. The section must not be less than 0.7 in. x 0.1 in. Now it must be cleaned and then insulated from end to end with good quality tape. Do not try to economise by scraping off the tape from the section required for taps, but leave this until finished and scrape off afterwards.

The Tappings

The taps are brought out as double lengths of wire to avoid soldering, etc., they should be hammered flat so as to lie neatly together. The starting end is connected directly to the bottom bar as before while the top bar has the flexible connector for use with the taps. In making a tap, bring out the wire for 6 in., bend it over on itself, and take it back and continue winding to the next tap. Remove the insulation from the bent end, clean the copper and press together, and then run solder between the two to make a solid bar. Drill the bar and tap ¼ in. fine, and fit with a cheese headed screw.

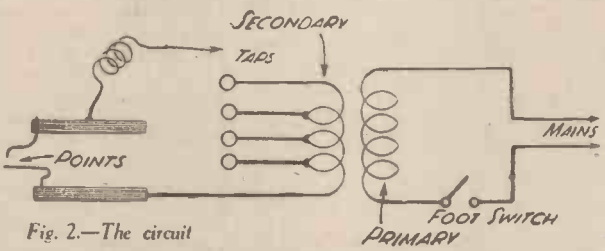


Fig. 2.—The circuit

When the transformer is mounted on the base, the taps also are screwed down to the wood by two small wood screws, countersunk and passing through the copper, one in front and one behind the tapped hole. The top surface of the copper is dead flat. A suitable washer must be used under the screw in order to make good contact. When different tappings are often required, the screws are fitted with an easily turning head. Do this by drilling a $\frac{3}{32}$ in. hole diagonally through the head and then hammer a 2 in. length of $\frac{3}{32}$ in. silver steel rod through it. The spade end of the connector is made to suit the taps. Arrange the five taps in a neat row behind the welder. Keep the leads as short as possible. See Fig. 4 for details of the taps, etc.

The Primary and Secondary

If a second-hand transformer is used, do not dismantle it but thread the secondary through the spaces; this may sound tedious but remember you are dealing with only 25 turns. It is a matter of minutes with the core clamped in a vice. The reason for this is that we cannot reassemble the core and clamp it as tightly as the maker does. Several that we have made are only about 25 per cent. efficient when tried out again. We have assumed that the primary was suitable for your supply. If not, rewind to suit. This means 1,150 turns to take 5 amps. As the transformer is short rated we can cut the wire size down a little to economise. Winding 1,150 turns on a fixed core when the wire is passed through and through is no joke, we have done it, but would advise

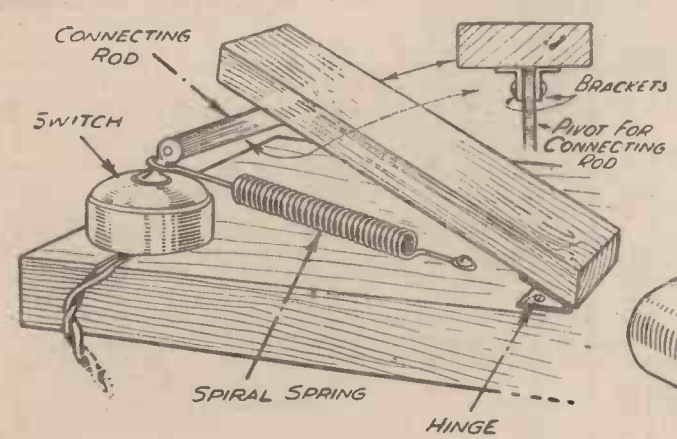


Fig. 3.—Details of the foot switch

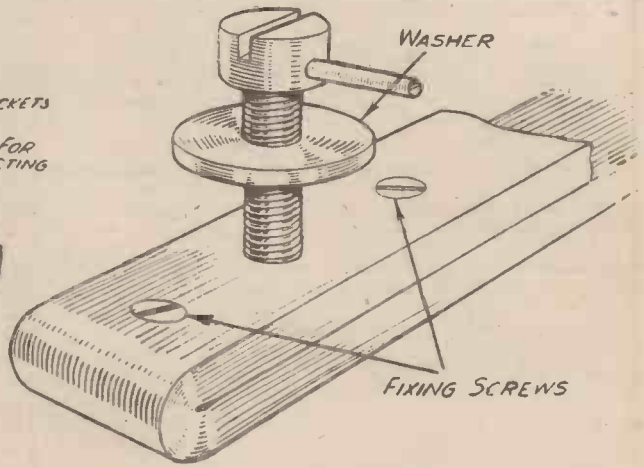


Fig. 4.—The method of making the taps

dismantling the core and winding in the ordinary manner.

A 500-watt transformer of this type will cost from £7 10s. to make, and so we do not think it necessary to deal with the construction of a new instrument.

The Foot Switch

The foot switch will now be considered. Here we have the same idea as that used for closing the points. Mount both the Bowden Control to the points and the switch on the same base. The switch is a piece of wood 3 in. wide and 9 in. long, and is hinged, at the end nearest the operator, to the base. The switch proper is a tumble switch with a brass knob. It should be capable of carrying 5 amps. with a quick make and break. A 6d. one will do quite well. This is mounted under the pedals and is connected to it through a brass connecting rod. Make a saw cut at right angles to the pivot in the knob, open it out with a file until it will take a $\frac{1}{16}$ in. hole through the knob. The connecting rod, which is a simple strip drilled with $\frac{3}{16}$ in. holes at each end, is cut from sheet brass $\frac{1}{16}$ in. thick. Put the switch in the off position, place the connecting rod in the knob and push the pin in, now

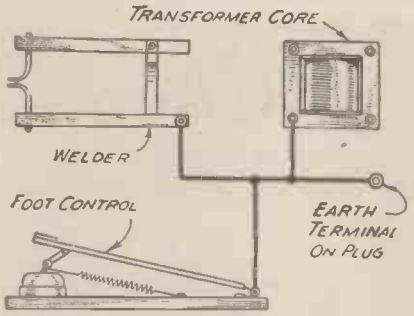


Fig. 5—The connections for earthing the welder and the foot pedal

work the switch by manipulating the knob. The pedal must work the switch, and for this, mount two small brackets on the under side of the wood, drill and put in the rod. The best position for the brackets and switch will be found by experiment, but we use it with the bracket on the end of the wood and the switch about 2 in. from the end, the rod being 3 in. from centres. A powerful spring is hooked round the knob and round a screw in the base so that the switch is always OFF. It should take quite a lot of pressure to close the switch and on removing the foot it should fly open. Fig. 3 shows the finished switch. With this means, it is possible to get very accurate time control and good work can be done. Twin flex from the switch is taken up with the Bowden wire to the welder base and there connected to a porcelain junction box. This gives a neat and workmanlike finish. Fig. 2 shows the circuit.

A Press Switch

A simple press switch can be made from bits of brass similar to a bell push, but we do not recommend this because of the difficulty of protection, etc. The whole welder *must be* earthed and so must the foot pedals, etc. (See Fig. 5.)

Since the transformer is worked off the mains, and the little extra electricity used is not noticed, it is a good plan to arrange a small light just by the points. This should be a six volt car side lamp with switch on the base and is run from the 5 volt tapping. Mount it on a small flexible arm, and cut a tin shade so that the light is exactly as required. It will dim a little when the 5 volt tap is used.

Looking into the Future

Steam Cars

THE construction of the first steam-driven car dates back many years, and since that time many designs of steam car have been produced and sold. About forty years ago an American produced a steam-driven car which was capable of a speed of 140 m.p.h., in fact it was the first car in the world to reach such a speed. Now there seems to be a possibility of a revival of this type of car.

A Yorkshire firm have recently been experimenting with a steam power plant which can be installed in petrol engined chassis at minimum cost in place of the normal petrol engine. The remarkable feature of this steam car plant is that it has been designed to fit under the bonnet of a car as small as the 8 h.p. Morris, and its weight is such as not to overload the chassis, in spite of the slender scantlings of such a small car. The engine is a two-cylinder double-acting compound 90 degree V type unit equipped with piston valve steam control, and fitted with ball or roller bearings both on crankshaft and eccentric sheave, the big end of the connecting rod being similarly mounted. A stroke of 1½ in., with bores of h.p. and l.p. cylinders respectively of 1¼ in. and 2½ in., enables this engine to develop according to the makers an output of 30 h.p. at 2,000 r.p.m. working on steam supplied at a mean pressure of 1,500 lb. per sq. in.

Synthetic Rubber

IT has been suggested that before many years the United States will become independent of natural rubber supplies. Mr. John L. Collyer, president of the Goodrich Rubber Co., has said that they are now using Ameripol—a synthetic rubber made from petroleum—in proportions varying from 50 to 100 per cent. in the production of tyres. Ameripol costs more than natural rubber at the moment, but expanding production is expected to bring the price down.

World's Longest Tunnel

A TUNNEL 85 miles long, which, when completed, will be the longest in the world, is now under construction in America. Six thousand men have for the past two years been boring their way through solid masses of rock extending from the Catskill Mountains to the Hudson River. It is hoped to complete the tunnel by 1945 at a cost of £70,000,000.

Storehouse of Energy

DR. H. K. KINGDON and Dr. H. C. Pollock, two New York scientists, have succeeded in isolating a minute quantity of Uranium, one of the hardest substances in the world to isolate. The amount was one hundred millionth of a gram, or one thirty-billionth of a pound. Dr. Kingdon said the isolation was a "step towards the goal of tapping the storehouse of energy known to exist in atomic nuclei."

Smallest Electric Motor

AN American electrical engineer has just completed an electric motor the size of a pin's head. The windings are of specially prepared enamelled wire and the motor is stated to develop one millionth horse power. It weighs less than one hundredth of an ounce and runs off a one-volt dry battery.

Coal by Pipeline

UTAH coal production engineers are considering a plan to transport coal in suspension through pipelines. Investigations which they have carried out show there is no technical basis on which it could fail. Coal of fine sizes, especially pulverised coal, for which the demand is increasing steadily, could be transported in this manner, they believe.

The plan is to use water for the carrying liquid, with quick-drying operations at the various terminals of the pipelines.

Television and Aeroplanes

QUITE a lot has been said recently concerning the application of television in one form or another in connection with aeroplanes. It is quite common knowledge that the reception of television signals in an aeroplane while in flight, even when at a high altitude, is not a difficult matter. Over five years ago 180 line pictures radiated from the station at Crystal Palace were shown in a machine while flying forty miles away, and three years ago during the Radiolympia Exhibition the experiment was again repeated before a party of newspaper press men using the standard Alexandra Palace transmissions. On various occasions it has been suggested that since there are but few difficulties of reception, schemes could be devised whereby the principles of television could be made to guide the pilot of a machine when the approach to his ground objective is obscured by fog. If this could be undertaken successfully there is no doubt that it would prove a boon to blind flying, but so far no equipment seems to have been put into practical service on a commercial basis, although there is every hope that it will eventually materialise. Of more recent date, however, a discussion has been going on concerning the possibility of installing actual television transmitting apparatus in aeroplanes with the idea of transmitting aerial views direct to one or more ground stations. A few weeks ago due prominence was given in a leading American paper to the fact that a squadron of Italian machines had been fitted out in this way, and that a satisfactory signal range up to 100 miles had been achieved successfully. The main problem for any work of this character would undoubtedly be the reduction of the weight of the apparatus to a figure which comes within that possible for carrying in aeroplanes and, if the report is true, then a good deal of research work must have been undertaken to achieve this state of affairs. It is obvious that any country experimenting on these lines will not release technical information while the present emergency exists, but just as the last war produced very fundamental improvements in radio technique, so it is conceivable that similar steps may be taken in the field of television which will have commercial application on the termination of hostilities.

A NEW SERIES

The Story of Chemical Discovery

No. 1—The Dawn of Chemical Knowledge

MANY attempts have been made to trace the earliest origins of chemistry, but all have ended in failure. And, indeed, when we reflect upon the universal nature of chemistry, both as applied to arts and manufactures and also from its theoretical viewpoints, we should really be little surprised at the non-success of efforts to discover the first chemical practitioner. For the desire to exploit the material things which we have around us is inherent in every thinking and energetic mind. From our childhood days we have all, at one time or another, been impelled to manipulate certain materials, to mix them together in order to produce a product of required properties. The schoolboy who mixes coloured water in a bottle for no other object than mere curiosity is acting upon an elementary chemical impulse. So, too, is he who dabbles in the mixing of mud, sand, mortar, or any other miscellaneous material with the object of seeing what will happen as a result of his operations.

Old as Mankind

And so we may confidently assume that chemistry, as a general system of acquired (yet frequently unexplained) knowledge, is as old as mankind itself. Indeed, the alchemists of old used to single out Adam himself as the first of their brethren, and, on the basis of this claim, some of the alchemical "adepts" proceed to tell us that Adam was created "on the sixth day, being the fifteenth of March of the first year of the world!"

There is little doubt, however, that the first glimmerings of practical chemical knowledge came to mankind contemporaneously with its acquirement of the arts of fire-making, cooking, painting, and dyeing. Men found that fire had the property of changing certain materials very profoundly. Clay, for instance, could be converted into a hard, brick-red material when it was baked. Certain earthy matters could be mixed with water to form "daubs" or paints. The juices of plants could be used as stains for wood and skins and even for the colouring of the human body. Last, but not least, the discovery of metal smelting enabled mankind to tower enormously above the brute creation and to fashion for itself tools of protection and, alas, of warfare which made the possessor of them virtual master of his surroundings.

Metals of the Ancients

Six metals and two non-metals are mentioned in the Hebrew record of the Old Testament. They are: gold, silver, copper, lead, iron, tin, diamond (carbon), and brimstone (sulphur). If to this list we add the metal mercury, we have a fairly comprehensive catalogue of the materials which the ancients considered to be more or less peculiar and elementary and which formed the raw materials of their manufacturing arts, particularly on the metallurgical side.

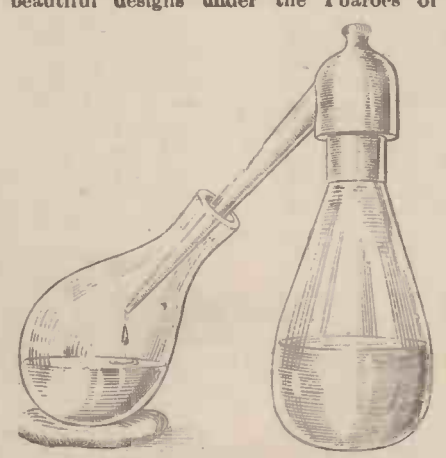
Iron is a very commonplace metal nowadays, yet in those early times it was considered to be a metal of great value and rarity, owing no doubt to the difficulty which the ancients experienced in smelting it from its ores. Since gold and silver frequently occur in the native or metallic condition and because copper, tin and lead are readily smeltable, these metals were known at a very early stage in the world's record of manufacture.

Glass

Glass, too, is another material which was known to the ancients, particularly to the Egyptians. Its original discovery is ascribed by Pliny, the Roman historian, to a number of Phœnician sailors who were

Hippocrates (of Cos), 470-375 B.C., an early practitioner of medical chemistry.

wrecked on the coast of Syria during a particularly bad storm. They kindled a fire on the sand of the shore, using plants as a fuel. After the fire had been raked out, beads of transparent material were discovered—produced by the soda in the plant ashes combining with the silica of the sand under the heat of the fire. Whether this story is true, there is no doubting the fact that glass was known and worked into many beautiful designs under the Pharoes of Egypt, and also that these now unknown ancient technicians had discovered for themselves various methods of colouring and tinting their glasses.



A very ancient representation of a distillation apparatus

Soap manufacture, too, is another chemical art which dates from very early times, although perhaps not so early as glass-making. The very early mentions of soap which occur in the Old Testament and other records in all probability refer not to soap as we know it but to carbonate of soda and to the "pot-ashes" resulting from the calcining of plants in iron pots. This compound, which the Hebrews termed *nether*, had grease-dissolving rather than detergent properties, and when, about the time of the Romans, it was discovered that pot-ashes could be chemically combined with various greases to make a new compound, the latter—the world's first soap—was used more as a cosmetic than as a washing agent. And it comes as a curious commentary upon those ancient times when we learn that such cosmetics and pomades were used more by the male population of the Roman cities than by the female members of that ancient civilisation.

Only One Acid

The ancients, despite their manufacturing knowledge, knew only one acid—vinegar. They knew that it is formed when wine turns sour, and they were also acquainted with the fact that sugar and starches can be fermented into alcoholic liquors in certain conditions.

Probably the Chinese in the dim ages of the earliest Oriental civilisations were acquainted with sulphuric and nitric acids, but, if so, this knowledge must have died with them, for, as we have just mentioned, acetic acid (in the guise of vinegar) was the one sour liquid which the world knew in the days immediately preceding the dawn of the Christian era.

The dissolving powers of vinegar seem to have been known, since certain materials, such as verdigris, were made by allowing vinegar to act upon copper. Cleopatra must have possessed some chemical knowledge when she boasted to Anthony that she would consume an incredible value of food at a single meal, and when she subsequently, at her repast, produced two of her finest pearls and dropped them into a goblet of vinegar, wherein they dissolved. This famed story, however, appears as one of the numerous legends which are not very credible when examined in the cold light of actual fact, for, in this instance, the fact of the matter is that true pearls are not soluble in vinegar of the strength which Cleopatra could have had available.

Fermentation

Fermentation, we have seen, too, is a chemical process which has been worked since civilisation's beginnings. For, as one writer has rather quaintly put it, "among the earliest records of all kinds of men you find a time recorded when they got drunk!"

Another chemical process which was carried on by the ancients, particularly by the Greeks, was starch manufacture, the

material being prepared by washing wheaten flour in a manner very similar to our modern methods.

Pottery-making, of course, was an industry well known to the ancients of all races, and even the art of making porcelain was known to the Eastern empires centuries upon centuries before its secret was rediscovered in 1709 by Bötticher, in Saxony.

The ancients could manufacture gold leaf by precisely the same methods of patient hand-hammering which we ourselves employ in modern days. Paints, colours, pigments and various dyestuffs extracted from woods, barks, lichens and marine organisms all appeared in the chemical repertoir of the pre-Christian nations, while the disinfectant and corruption-retarding properties of various balsams and natural resins were well recognised and utilised for embalming purposes in those now far-off centuries.

The Philosopher's Stone

Can we say, then, in the light of these facts, and of many others which space does not permit us to set down here, that practical chemical knowledge is merely a modern acquisition, a thing of a couple of centuries growth? Indeed we cannot, for if we possessed the leisure and the inclination to delve still more deeply into the technical knowledge of ancient civilisations, we should find that a number of the world's most famous thinkers had evolved a very fair conception of the atom centuries before the wretched and deluded alchemists, with their fantastic and involved notions of the Elixir of Life, the Universal Solvent, and the Philosopher's Stone, had so contaminated theoretical reasoning as to render it impossible of comprehension.

John Dalton, the pioneer of our modern Atomic Theory, is usually considered to be the "originator of atoms." Such, however, is by no means the case. Many thinkers before Dalton's time had visualised matter as being made up of ultimate particles which they termed "atoms" (the word itself comes from the Greek *a*, "not"; *temno*, "I cut," i.e., a thing which cannot be divided), and which they conjectured as forming the basis of all material things.

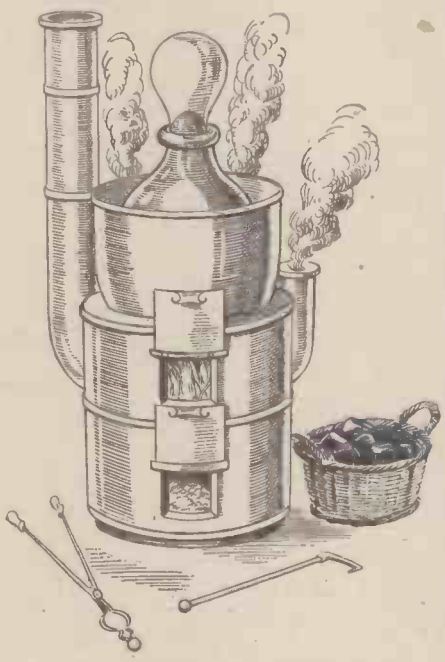
Greek Philosophers

Thus the Greek philosophers Thales, Anaximenes and Heraclitus, who lived in the sixth century B.C., all considered material things to be made up of innumerable little balls of hard, impenetrable substance which formed the basic or primary stuff of the Universe. It would seem that their notions were derived from certain Hindu ideas which had existed before their time and that the Hindus, in their turn, had taken these ideas of the "grained" or atomic constitution of material things from the earliest Chinese. Whatever may be the true facts concerning this historical sequence of chemical reasoning, there is no doubting the fact that the Greek philosopher, Empedocles (490-430 B.C.) placed on record his idea of all matter being in theory divisible into minute and ultimate particles which were governed by forces and which could be acted upon by heat as an active principle.

Leucippus (*c.* 495-428 B.C.), his pupil, Democritus (470-361 B.C.), and the Roman poet Lucretius (99-55 B.C.) form a trio whose combined thought consolidated the earliest "chemical" theory of atomic structure, for these philosophers taught not only that matter is made up of atoms, but that the atoms are separated from one another by void spaces and that these atoms are in constant and perpetual motion. Modern physical research has done nothing to destroy such assumptions. Indeed, present-day investigations have confirmed the essential truth of these old physical philosophies, in consequence of which fact it becomes a matter for amazement when we reflect upon the precision with which these ancient criticial thinkers, entirely unaided by any instruments, penetrated by their reason alone into the dark obscurity in which the atom has its essential being.

Elements

The ancient philosophers, when dealing with chemical subjects, had their own notions of elements. We know nowadays that by the term *element* (used in a chemical sense) we imply something which is singular in itself, something fundamental from which more complex materials may be built up. Common salt, for instance, we do not call an element, because salt consists of a chemical compound of the metal sodium and the gas chlorine. But sodium and chlorine we do regard as elements or elementary bodies, for they are not resolvable by chemical means into any simpler substances.



An early alchemical furnace.

The ancients had pretty much the same inward conception of an element as we ourselves possess, to wit, that such a body is one which cannot be split up into any simpler material. But, somehow or other, even the shrewdest of these ancient thinkers, came sadly to grief when they began to frame their practical notions of what were and what were not elements.

According, for instance, to Empedocles, who is, perhaps, the most famed of the early philosophers for his theory of the elements, everything which existed in the world was composed of a mixture of two or more of four elements. The *four elements* of Empedocles became famous. They were: earth, air, fire, and water. Thus, all liquids contained water. Combustible materials embodied fire within them, air was the principle of all vapours, and earth of all gross and inert substances.

Centuries afterwards, Aristotle (384-322 B.C.), perhaps the most famous "scientific" philosopher of the ancients, modified and transformed Empedocles' "Four Element" theory into a more nebulous hypothesis. The four elements became four "qualities," of heat, cold, damp and dryness. Combinations of these "qualities" formed "elements."

Thus, according to Aristotle, heat plus damp denotes the element air. Cold plus damp denotes water. Heat plus dryness indicates fire; whilst cold plus dryness signifies earth.

A farrago of nonsense, without a doubt, yet unfortunately Aristotle's practical ideas, and in particular his "method" held sway over Europe for centuries and was directly responsible for the almost complete stagnation of experimental knowledge which characterised the first sixteen hundred years of our own era.

To the four elements some of the ancient Greek theorists added a *fifth*, the *quinta essentia*. This was considered to be a subtle, imponderable extract, perhaps the essential material of which the other four elements were composed. In this respect the old *quinta essentia* (from which name, of course, we derive our modern term "quintessence") resembles our modern theory of an Ether of Space, out of which all things, material and sub-material, may be composed.

Primal Element

Later, a number of Greek philosophers postulated a *protyle* or primal element out of which all other materials were made. This conception, a modification of the *quinta essentia* theory, had its ups and downs. The philosopher, Anaximenes, for instance, considered air to be the primal element or *protyle*. Thales of Miletus, who lived in the sixth century B.C., thought that water was the first principle of matter, whilst another Greek thinker, Herakleitos, held that only fire could constitute such a primal matter. Finally, to complete the series, as it were, Pherekides, another Greek, considered earth to be the primal matter, since "all things comes from earth."

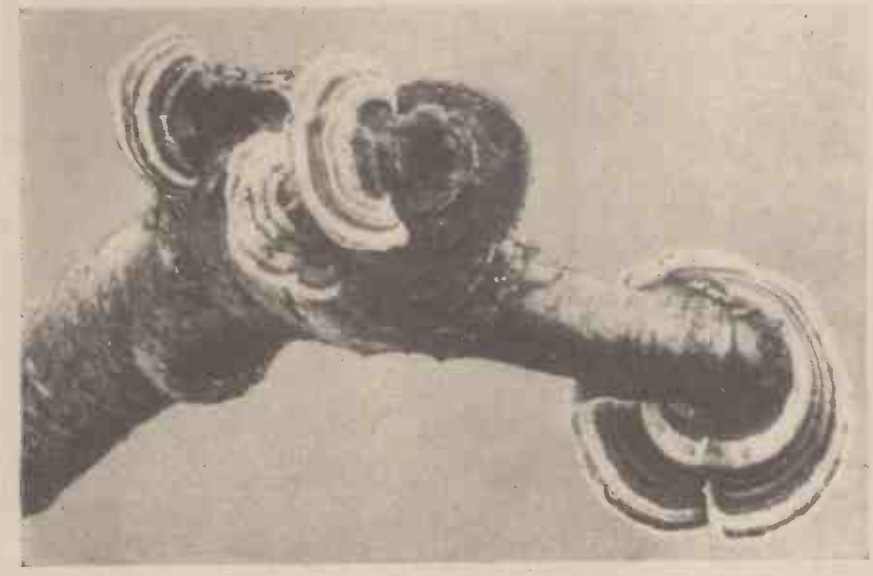
Idea Still Exists

Curiously enough, this idea of a primal matter still haunts us, and modern chemists and physicists are, for the most part, firm believers in a theory of this sort. We know now, of course, that matter is resolvable into positive and negative particles of electricity, protons and electrons, and we feel intuitively that even these minute and, indeed, sub-material bodies must be composed of some other universal entity. But what such a thing is we cannot say. We cannot, indeed, even with the enormous aid of our present-day experimental knowledge, hazard more than a dim guess. As one noted chemical writer of the day has put it, referring to our modern assault on the mystery of matter, "The target appears to recede with increasing knowledge, and Science might well confess with Tennyson:

So runs my dream! But what am I?
An infant crying in the night;
An infant crying for the light;
And with no language but a cry."

Modern chemical science, therefore, rests fundamentally upon a number of conclusions arrived at by the ancient Greeks. Many other nations exceeded these old wiseacres as regards skill in the practical manufacturing arts, but for pure knowledge and abstract reasoning the Greeks were unexcelled, and, in all truth, we interested adherents of modern science, chemical and otherwise, owe them a debt of acknowledgment which at all times we should be willing to pay.

"Corpse Candles" and Will-o-the-Wisps



One of the several species of luminous fungi in Britain. It has been considered that the clouds of luminous spores cast off by such fungi may give rise to the phenomenon of the ignis fatuus.

Some Strange Superstitions Examined in a Scientific Light

THE notion of the "Will-o'-the-Wisp" is one which is deeply ingrained in English folklore. This mysterious light, which, it was said, purposely played over country pathways and meadow-tracks in order to lead travellers astray on dark nights, had sometimes demoniac attributes attached to it. In the hilly parts of Wales, for, instance, the Will-o'-the-Wisp becomes the dreaded "Corpse Candle," such as is noted by George Borrow in his "Wild Wales." Here its province is to lead travellers into the bog and the mire and, if possible, by means of its evil intelligence thereby to lure them to their doom.

In Lancashire, the "Jack-o'-Lantern" is a well-known visitant of country districts and, also, of burial grounds and low-lying regions near rivers. The northern counties of England used not to attach over much significance to the occasional visitations of these mysterious lights. They were not usually considered in these districts to be of evil import, but sometimes when one of unusual size was noted it was the occasion of much local astonishment and perplexity.

Mystic Visitations

There is, of course, no denying the actual existence of these mystic visitations of ghostly light which our rural forefathers were well aware of, and which the learned writers and scientific men of a now departed age dubbed *ignis fatuus*, or the "foolish fire." In various country records, in a number of scientific dissertations, in the transactions of local learned societies and among other varied writings accounts of the appearance of the *ignis fatuus* are to be come across with fair frequency. Dr. Priestley, the famous English chemist, actually describes an *ignis fatuus* which was observed "between two rocky hills on a dark and calm night" by an individual who "got by degrees within two or three yards of it and thereby had an opportunity of viewing it to the greatest advantage."

"It kept skipping about a dead thistle," goes on the worthy Doctor, "until a slight motion of the air made it jump to another place and, as the observer advanced it kept flying before him. He was so near it, however, that had it been the shining of glow-worms he was satisfied that he could have distinguished the separate lights of which it must have consisted; whereas it was one uniform body of light. He, therefore, thought that it must have been an ignited vapour."

Ignited Vapour

In this last sentence, of course, Dr. Priestley s observer hits upon the truth of the matter. The *ignis fatuus*, will-o'-the-wisp, Jack-o'-Lantern, corpse candle, or whatever other fanciful designation such a manifestation may appear under, is, in actual fact, a ghostly globule of phosphorescent flame which hovers over wet and marshy ground in many country districts. Sometimes the pale-burning flame may be noticed only a few inches above the ground level. At other times, it may be more than six feet above the level of the ground and it may, in size, occasionally attain the dimensions of a football.

The catalytic combustion of alcohol by means of a fragment of platinised asbestos placed above the wick of a spirit lamp. The asbestos continues to glow until all the spirit has been used up.

The *ignis fatuus*, as all observers agree, does not remain stationary in one position. It hovers curiously and hesitatingly over certain areas of the ground, sometimes rising, sometimes falling, and frequently taking a leap or a jump for a distance or a foot or two.

In most instances, the ignis fatuus or Will-o'-the-Wisp becomes extinguished on the approach of any observer, particularly if the manifestation be only a small one. In any case, however, the phosphorescent flame never remains in the one area when approached by an observer. When, under such circumstances, it does not become extinguished, it invariably flits erratically to one side of or in front of the observer, this characteristic motion clearly giving rise in the past to the superstition of the Will-o'-the-Wisp's role in the luring of belated travellers to their doom in country bogs, ponds and mires.

Nothing Mythical

To this day, the *ignis fatuus* may still be seen in country districts, usually on autumn nights, although it has been observed all the year round. There is, therefore, nothing mythical about the Will-o'-the-Wisp, except, of course, the evil and ridiculous functions which most rural superstitions have attributed to it. But to this day, also, the precise nature of this curious manifestation of mystic fire and light is not known with any real certainty.

We may rule out of the question the possibility of any flying luminous insect being responsible for the apparition, for there are no true fireflies in England, and even if there were, such creatures would be readily distinguishable by competent observers. Nor, again, can we attribute the light to glowworms, luminous centipedes or other ground creatures.

As Dr. Priestley's shrewd observer remarked more than a century and a half ago, the secret of the Will-o'-the-Wisp is "an ignited vapour," and, so far as we are able to ascertain, that vapour is actually phosphine or phosphuretted hydrogen.

A Ready Explanation

Phosphuretted hydrogen can be generated by dropping pieces of calcium phosphide in water. Produced in this manner, the gas immediately takes fire when it makes contact with the air. Indeed, a marine distress signal working on this principle—the *Holmes signal*—was once employed by ships, a canister of calcium phosphide being thrown out into the sea and setting up a conflagration immediately it touched the water.

The same spontaneously-inflammable gas is generated by the decomposition of animal

and vegetable matter containing phosphorus. Here, of course, is the ready explanation of the appearance of Corpse Candles and the like, since if any dead animal becomes covered over with soil (as is frequently the case), the slow decomposition of its body, particularly in damp surroundings, will occasion the generation of spontaneously-inflammable phosphuretted hydrogen. When first produced, this gas or vapour will tend to be retained by the soil. Later, however, when the soil becomes saturated with the vapour, the latter will begin to ooze out here and there. In some instances it will travel a good distance under the surface of the ground, coming up to the air a long way from its originating source. And, naturally, the foot of a traveller or observer walking across such "phosphuretted" land will either cause the gas to be ejected with such velocity that the resulting globule of phosphorescent flame will "dance" in front of the approaching individual, or the footfall may result in it becoming extinguished altogether, the local accumulation of gas being suddenly ejected and used up.

Silicon hydride, another gas, exists in a form which, like phosphuretted hydrogen, is spontaneously inflammable. This, too, is generated by the decomposition of vegetable matter and may, therefore, have something to do with the appearance of the *ignus fatuus*

Some of the higher fungi in this country are strongly luminous. It has been supposed, on occasion, that these growths occurring on the barks of damp tree trunks and decaying logs, may give rise to luminous spores or seeds which, being blown away by a gentle gust of wind, would create the appearance of a miniature cloud of luminous vapour. Whether there is any essential truth in this assertion is difficult to say. At any rate, the explanation is by no means an impossible one.

Organic Chemistry

Organic chemistry has brought to our knowledge a large number of compounds which are spontaneously inflammable. Zinc ethyl, for instance, which is made synthetically by heating powdered zinc with ethyl iodide, is a liquid which is spontaneously inflammable to a very high degree. Brought in contact with the air, it at once inflames, burning vigorously until it has completely combusted itself. Certain chlorides of silicon and phosphides of sulphur and fluorine are spontaneously inflammable also. To the presence of such substances in even minute amounts has been attributed the occurrence of mysterious fires which have taken place in the countryside from time to time.

Hayricks, for instance, have broken into unquenchable flame in the middle of a cold night without the slightest forewarning of such a happening. Here, however, an explanation is not difficult to find, for, owing to the generation of ammoniacal compounds, the hayrick may have been slowly heating up for weeks, until, at last, fanned by a gentle breeze, and perhaps, aided by the presence of an *ignis fatuus* or a trace of some naturally-generated spontaneously-inflammable compound, a flame has been brought into existence which has at once raised its surroundings to the condition of open fire before the alarming discovery has been made.

Sudden Conflagration

Upon such a basis must rest our explanations of the many recorded instances of the sudden conflagration of thatched-roofs in the wintertime, the straw of piggeries and shippons, hayricks and barns.

But, according to widespread local legend, even men have spontaneously combusted!

A case of spontaneous combustion purposely brought about by inoculating a can of dry hay with a phosphorus compound.

In Ireland there are legends galore concerning individuals who, after making too merry at nights, have, during their return home by lonely ways across bog and mire, been suddenly confronted with the Evil One and more or less incinerated on the spot.

Ridiculous Legends

Ridiculous as many such legends are, they nevertheless occur persistently. Some even get into print, as, for example, the account given in Leroux's *Journal de Medicine* of a very fat woman, aged 28, who was found on fire in her room when nothing else was burning. After her clothing was removed, a layer of black, partially-carbonised grease was revealed and the doctors came to the conclusion that the combustion began, in some strange manner, internally, and that her clothes were only burnt secondarily.

Most of the stories concerning the spontaneous combustion of living bodies concern men and women who were very fat and who were excessive drinkers of alcohol in one form or another. If such stories be true—and there is often some truthful basis underlying all persistent stories—it would seem that bodily fat which has become degraded with alcohol can, at times and under some unknown conditions, become liable to spontaneous combustion.

We know in our laboratories, of course, that if alcohol be sprayed over "platinum black," or very finely-divided metallic platinum, the platinum will become red hot and will ignite the alcohol. Also we know that if above the wick of an ordinary spirit lamp we fix a little wad of platinised asbestos (asbestos carrying finely-divided platinum) by means of a pin and, after having lighted the wick and blown out the flame, the platinised asbestos will continue to glow red hot until all the spirit has been used up.

Chemical Actions

Such chemical actions, whose essential cause is as yet unknown, are termed "catalytic actions," the platinum causing the combustion in some strange way, yet not actually taking part in it itself. Now, by means of traces of nickel, platinum and other metals, it is possible, and, indeed, very practicable, to effect profound changes in fats and greases. If, in the laboratory and on the manufacturing scale, such things are readily brought about, we cannot wholly deny the possibility of the *living* fat in the human or animal body, particularly when strongly animated with such a combustible and reactive substance as alcohol, taking fire under certain rare and obscure conditions.

There is, indeed, much of the chemistry of the human body which is still very obscure to us. In the light of a careful examination of recorded facts it does really seem to have been the case that in a few rare instances, human fat tissue which has become enormously bloated up with strong alcohol, has actually physically inflamed itself, with the consequent death of the victim.

Phosphorus

People who have eaten phosphorus and died from its consequent poisoning have been observed to manifest luminous breaths. The two cases of phosphorus poisoning and alcoholic inflammation are, of course, by no means comparable. The former instance, however, renders the fact clear that highly combustible substances may be taken into the body, perhaps unknowingly. And, naturally, in such an instance, it would not be difficult for spontaneous combustion to be set up in an alcohol-ridden interior. It is, also, very possible that other and as yet unknown materials, may have a similar effect in the presence of fat and alcohol, and such a reaction may very well underlie the several seemingly recognised instances of spontaneous combustion of the living human body which are to be come across in the annals of medicine as well as of folklore.

BIGGEST VERTICAL STATIONARY OIL ENGINE

ONE of the biggest vertical stationary oil engines ever built in this country has recently been completed by the English Electric Co. It has an output of 3,500 b.h.p. and is of Fullagar design. The engine is to be installed in the station of the Bermuda Electric Light, Power and Traction Co., Ltd. It is of unusual design and is built up with a bedplate in two parts. The overall length of the engine is 33 ft. 6 in. and the alternator which it drives increases the total length by about 14 ft. Engine speed is 200 r.p.m. and the regular output of the unit in daily service will be 3,275 b.h.p.

It is an eight-cylinder engine of the opposed-piston type with a bore and stroke of 19 in. and 22 in. respectively. In each cylinder two fuel-injection valves are arranged horizontally and fuel is injected into the combustion chamber just before the two pistons reach their nearest point of approach. Upon ignition the gases expand and the two pistons then move away from one another. At the top of each cylinder are ports through which the gases are exhausted as the ports are uncovered by the upper piston, and at the same time, the lower piston uncovers ports in the lower part of the piston to admit scavenging air. The result is that the scavenging of the cylinder is carried out from bottom to top.

The fuel for each cylinder is supplied from a separate fuel-injection pump at a pressure of about 5,000 lb. per sq. in. The pumps are arranged in pairs and are driven from an enclosed camshaft, the drive for which is transmitted through worm gearing.

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.

Testing A.C. Windings

CAN you supply me with details for making a "growler" for testing A.C. windings.—E. P. (Guildford).

A "GROWLER" for testing A.C. windings can be made of stampings 1¼ by 1¼ in. sectional area in U-form with limbs 3 inches long, and to work on 230 volts 50 cycles a suitable winding will consist of two coils each containing 600 turns of No. 28 SWG d.c.c. copper, joined in series with one another, one coil on each limb. The ends of the stampings carrying the coils are usually shaped or chamfered to fit as nearly as possible to the surface of the armature or stator core under test, to avoid too big an airgap.

Refractories for Electric Heaters

WHAT is the composition of the "formers" used for electric heating apparatus, and is it possible for me to make them at home ? W. T. (Lancaster).

THE manufacture of "formers" or refractories for electric heating appliances is not one that can be successfully carried out on a small scale, as it calls for extensive plant for grinding, moulding and heat treatment. The various kinds of refractory materials used include aluminous porcelain, sillimanite, fused alumina, silicon carbide, alumina, various grades of fireclay, plumbago and magnesite. Each one of these has a peculiar characteristic of its own, and the kind of material selected has a definite relation to the purpose for which it is used, such as resistance to various temperature limits, mechanical strength, thermal conductivity, electrical resistance, and resistance to fracture from thermal expansion. Chemical reaction with the wire resistance elements with which they are wound has also to be taken into consideration, also porosity to molten metals when used as crucibles.

Nicotine from Tobacco

IS it possible to extract nicotine from tobacco ? Is nicotine soluble in alcohol? If so can it be precipitated in a form by some suitable reagent?—J. B. (S. Rhodesia).

IT is possible to extract nicotine from tobacco leaves in the following manner. The crude, dry tobacco leaves are extracted with boiling water. The dark brown extract is concentrated, mixed with an equal bulk of milk of lime and then distilled. The distillate is then just acidified with oxalic acid and evaporated to a small bulk. It is then carefully treated with caustic potash solution, which treatment liberates free nicotine. The nicotine is finally extracted with ether, and is (if required) purified by distillation in a stream of hydrogen.

For most commercial purpose, it is only necessary to extract tobacco leaves with boiling water in order to produce a toxic nicotine extract.

Nicotine is extremely poisonous, and great care must be taken in working with it. When pure, it is a colourless liquid, but it rapidly darkens on exposure to light, air and moisture. It boils at 241° C. It is readily soluble in water and in alcohol. With hydrochloric acid, it forms nicotine hydrochloride.

Isolating Enzymes

IS there any practical laboratory method of isolating any of the enzymes, particularly diastase, the active enzyme in flour?—A. L. (Birmingham).

THE enzymes are very difficult to prepare in an even approximately pure state, and some of them have never been prepared in such a condition at all. This difficulty is due to the fact that enzymes are used up by their essential activity in chemical reactions.

In the case of the enzyme diastase, however, you may prepare a fairly pure product in the following manner:—

Digest green barley malt with 20 per cent. dilute alcohol for 24 hours. Add to the

resulting extract 2½ times its volume of absolute alcohol. This will precipitate the diastase, which may then be filtered off and finally washed first with absolute alcohol and then with ether. The diastase prepared in this manner will take the form of an amorphous powder, which can be further purified to some extent by repeated solution in distilled water and reprecipitation with absolute alcohol.

Diastase, as you are probably aware, is the active substance existing in malt extract which enables the malt to convert starch into dextrine and sugar. Hence its part in the fermentation of starch extracts.

Absolute Alcohol

CAN I get absolute alcohol by distilling rectified spirit with calcium oxide. If not, could you please suggest a method? B. L. (Bristol).

YOU cannot satisfactorily obtain absolute alcohol from ordinary rectified spirit by repeated distillation over quicklime, since such industrial alcohols frequently contain substances, such as methylamine, which are difficult to remove and which have been purposely added in order to render the spirit undrinkable. If, however, the spirit is free from such adulterants, you can obtain absolute alcohol from it by allowing it to stand over fresh quicklime for a week or more and afterwards distilling the liquid. After three distillations in this manner, a few pieces of clean metallic sodium should be added and allowed to remain in contact with the alcohol for a week. The sodium will absorb practically all the last traces of water from the alcohol, so that by a final redistillation an alcohol of 100 per cent. purity can be obtained.

Cereal Chemistry

I AM at present working in a cereal laboratory. Unfortunately, I cannot supplement the knowledge I acquire there by private study as no technical schools or correspondence courses are available on this subject in Rhodesia. Can you, therefore, recommend a correspondence course on cereal chemistry, and give me particulars of any examinations I can sit in order to qualify myself as a cereal chemist?—G. H. (Bulawayo).

THERE are, in England, no special correspondence courses dealing exclusively with cereal chemistry, nor are there any special examinations in this subject. Since you do not give us any idea of the standard of your proficiency in general chemistry, it is difficult for us to advise you definitely upon the course of action you should take in connection with your aim at becoming a cereal chemist. The only official body capable of registering qualified chemists in this country is The Institute of Chemistry 30, Russell Square, London, W.C.2. This Institute, which is of world-wide renown, has a South African Corresponding Secretary in the person of Dr. Chas. F. Juritz, M.A. Since it is useless for you to attempt to study with any possible correspondence emanating from England, we suggest that you get into touch with Dr. Juritz, outlining your position and ambitions, and seeking his advice, which, of course, will be freely given. We may add that the Fellowship examination of the Institute of Chemistry may be obtained in the special subject of "Foods and Drugs" which subject includes cereal chemistry. The examination, however, is a very stiff one, and years of hard practical study are necessary in order to pass it.

There is no special examination conferring recognition as a cereal chemist. If, therefore, you have worked for a number of years in a cereal factory and have studied the subject intensively, both theoretically and practically, you are entitled to regard yourself as a cereal chemist.

Sulphuric Acid

HOW can I make a strong solution of sulphuric acid in a home laboratory?—A. C. (Manchester).

SULPHURIC acid may be made on a small scale by dissolving sulphur trioxide in water, but as sulphur trioxide is very expensive, this process is economically prohibitive.

Economically speaking, it is impossible to make sulphuric acid in a small laboratory and on the small scale. There is no successful practical method available. The classical textbook method which consists of mixing oxides of nitrogen, sulphur dioxide and steam in a large enclosed vessel is rarely satisfactory in practice, and we would not recommend you to embark upon it.

Sulphuric acid is still fairly cheap, and, if we were in your position, we should purchase our supplies from Messrs. Frederick Jackson & Co., Ltd. Chapel Street, Salford.

Renewing Used Files

IS there an acid I can use for renovating used files?—L. B. (Middlesex).

YOU can, to a certain extent, renovate used files by dipping them in crude hydrochloric acid (spirits of salts) or in a mixture of this crude acid and hydrofluoric acid (contained in a lead vat), but such acids are exceedingly potent and they generally dissolve away some of the teeth of the file as well as the clogging particles. Hence, we hesitate to recommend any such treatments.

You will get a satisfactory result if you make up a fairly strong solution of caustic soda and, having soaked the files in this for a few hours, scrub the file teeth with a wire brush and subsequently rinse thoroughly in water. By allowing a paste of lime and water to remain in contact with the files for a few hours, a similar effect will be obtained.

Stimulating Muscles

I REQUIRE a drug which will stimulate the muscles of the body. I have tried caffeine, but it was not very effective. Is theobromine any use?—E. T., Sheffield.

QUININE sulphate dissolved in dilute phosphoric acid and taken a teaspoonful at a time is probably the "drug" you are seeking. Caffeine is quite a good stimulant, but all other similar drugs are dangerous and should be avoided. Theobromine is useless for your purpose.

BARGAINS FOR MODEL MAKERS

MESSRS. BASSETT LOWKE, LTD., Northampton, are offering a high-class engine and boiler fittings at less than pre-war prices. This selection of fittings, which consists of water gauges, syphons, block-off cocks, union cocks, drain cocks, crosspieces, sockets, oil cups, valves, cylinders, eccentrics, etc., is surplus stock made during slack times in past years and for which there is a reduced demand during war-time. These fittings are described in A.B.12 Model Engineers' List, price 8d., obtainable from the above address.

THE Cyclist
Editor : F. J. CAMM

VOL. IX AUGUST, 1940 No. 222

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.

Women's Records

MISS WILSON, on Sunday, July 7, confounded the critics who have suggested that she was only good for long-distance events, by returning a time of 1 hr. 6 mins. 16 secs. for the W.R.R.A. 25-mile record. She started at eight o'clock in the evening, using the Pangbourne Lane-Bath Road course. Thus, Madge Ball's figures, which were on the books at 1 hr. 9 mins. 29 secs., have gone. Miss Wilson now has only two further records to break. Her time at the turn was 33 mins. 50 secs., which coincided with her time at the turn during a private time trial.

On the same day Mrs. Billie Dovey obtained the 25-mile tricycle record, beating Mrs. Pearl Wellington's figure of 1 hr. 26 mins. 40 secs., returning a time of 1 hr. 21 mins. 49 secs. The W.R.R.A. thus has been kept extremely busy this season and the lady record breakers have kept cycling in the news at a time when R.R.A. record attempts for understandable reasons have been abandoned.

It seems inevitable that within a short time Miss Wilson will place to her credit the whole of the W.R.R.A. records for two-wheelers; whether she will then turn her attention to tricycle records is a matter of conjecture, but we should not be surprised if she does so.

Time Trials

THE war proceeds, iconoclastic fashion, to skittle over important events. The classic Bath Road "100" has been abandoned and many other clubs have followed suit. The difficulties of running even club events, apart from opens and classics, are enormous. The parashooters and all of the other voluntary organisations who patriotically patrol the roads at night, as well as the assiduity of the police in asking for identification cards, present difficulties which are almost insuperable. And this apart from other considerations, such as convoys and the closure of certain roads adjacent to places of strategic importance. Then there is the question of overtime and week-end work, which is severely depleting the entries, even of club events. Fields of five and six are common, and clubs are finding it extremely difficult to muster the prize money. The R.T.T.C. is wisely leaving the matter in the hands of the District Councils, feeling, and rightly, that each District Council is better able to understand the road conditions which rule locally. And thus it is that cycle sport is in for a bad time.

The Bath Road Club, not wishing to disappoint all those members and helpers who regard their classic "100" as providing an occasion when they may fraternise on a social platform, have arranged a dinner for them at the Clarendon Restaurant on August 3.

Track Sport

CERTAIN of the events which take place at Paddington Track have similarly been cancelled, although it has been decided to continue with the Junior Sprint Championship.

We think the decision to discontinue track sport wise, in view of the fact that it does attract a congregation of people which is unwise at the present time. Although the country is at war tempo, it does not eschew all sport, and acknowledges that a certain amount of competitive recreation is necessary. Government spokesmen have already said so. Those responsible for controlling the various aspects of the sport have given serious thought to the provision of some alternative which will circumvent existing onerous conditions, so far without success. Evening meetings have been suggested, but even here the possibilities dwindle when we remember that most of the men not in the Army are working overtime and have little occasion to train. War has, indeed, delivered its metaphorical torpedoes into the bulwark of our pastime. They have not, however, sunk it and the movement is kept afloat by the undying spirit and love of the game which activates all those who take part in it.

More Women Cyclists

WHILST the demand for bicycles has gone up, the supply has gone down and, according to our estimates, the numbers being supplied are 70 per-cent short of what could be sold. Normally, there are three men's machines sold to every ladies', and it is somewhat astonishing, therefore, to learn that at present the demand for each style of machine is in about equal proportions. As manufacturers have laid down their programmes on the three-to-one basis, there is thus, at the present time, a greater shortage of ladies' machines. A manufacturer, discussing the point with us, suggested that women are turning to the two-wheeler because present road conditions are safer than they were in the halcyon days of peace. It is our view that the publicity afforded to cycling by recent W.R.R.A. record attempts has also had something to do with it.

The "Spitfire Fund"

THE National Cyclists' Union has launched a Spitfire Fund and invites every cyclist to contribute to it. It is their intention to raise sufficient money to purchase a Spitfire and present it to the Government as a slight appreciation of the great effort by which this country intends to bring the war to successful fruition, not the least part of this being the defence of this country. Cyclists, perhaps more than any other section of the community, appreciate the charm of the British countryside and the need for it to be preserved. Cyclists who wish to contribute to this effort should send their donations direct to the N.C.U., 35, Doughty Street, London, W.C.1.

The suggestion is ambitious, and £10,000 is a lot of money. If, however, cyclists demonstrate their ability to raise this large sum, it raises interesting possibilities for a post-war programme.

Cyclists for National Service

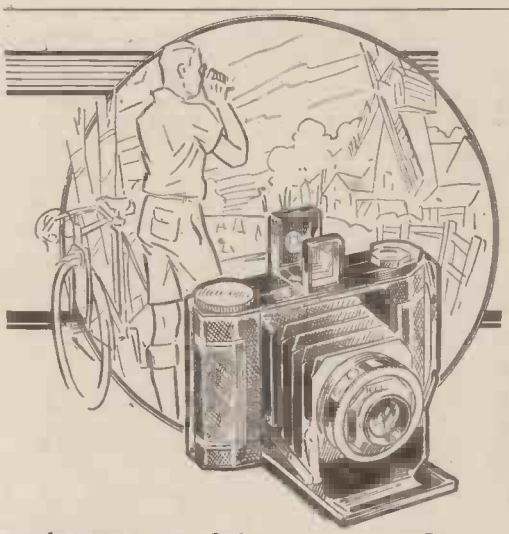
THE Cyclists' Touring Club informs us that they have received from a number of national bodies, including the Ministries of Information and Food, Local Defence Volunteer Force, Women's Voluntary Services for Civil Defence, the A.R.P., and others, urgent requests for aid in raising cyclist messenger corps. They point out that the membership of the club is distributed throughout the country in an unequal and haphazard manner, and it is not always possible to respond immediately to these demands. Mr. G. H. Stancer, Secretary of the C.T.C., therefore appeals to all cyclists who are willing and able to undertake messenger work to send him their names and addresses so that he can register these for reference as soon as there is a call for assistance in their locality.

The Fellowship of Old-time Cyclists

THE Fellowship of Old-time Cyclists this year have abandoned their meeting and it was substituted by another meeting organised by the members themselves. The reason given was that they did not think that such a meeting would be well supported or representative. I know that among certain members of the F.O.T.C. some resentment was felt at this decision, which, they say, was taken without a referendum of the members, which alone would have decided whether the meeting would be well attended or representative. It seems a great pity that this event was cancelled for there was no particular reason for it. It would not have been unpatriotic, for most of the members are beyond the age where they would be using up time better employed on national service. Essentially, the membership of this important club must be a dwindling one, for the rule so decrees it. To abandon one annual meeting of the series is to deny the members the privilege of being present at what might unhappily prove to be their last visit. Time reaps rapidly among the members of this body, and each year sees the membership diminish.

The Dunlop Pigeon Post

THE Dunlop Rubber Co. inform me that pigeons from the King's loft at Sandringham have been added to the Dunlop Pigeon Post, organised to operate in a national emergency. The Pigeon Post was organised last July by the Duchess of Kent when she visited Fort Dunlop and released the first flock of pigeons from their baskets. On the eve of the outbreak of war a pair of blue checks arrived from Mr. E. W. Steele, the King's pigeon keeper. They are long-distance birds of five or six years old, of the stock which have won big races from Lerwick in Shetland and Bordeaux. To-day they have four young ones less than a month old.



Paragrams

Current News Reviewed

Cycles to Tanks

THE Managing Director of B.S.A. Cycles, Ltd., Mr. G. D. Burton, has been appointed Director-General of Tanks and Transport by the Minister of Supply.

Cumnock Rally

THE annual rally organised by the West of Scotland Cyclists' Defence Committee at Cumnock was quite successful despite present war conditions, and was attended by a happy crowd of nearly 5,000 cyclists.

J. C. Whitlock's Appointment

THE appointment is announced of Mr. J. C. Whitlock as the new secretary to the British Cycle and Motorcycle Manufacturers' and Traders' Union, Ltd.

Another Record

MISS MARGUERITE WILSON registered her second war-time record recently when she beat her own figures for the London to Brighton and Back record with a time of 5h. 20m. 30s. Her previous time was 5h. 23m. 14s. She was riding a Claud Butler "Miss Modern" Bicycle.

Making Toronto Safe

BECOMING anxious about the foolhardiness of pedestrians in the city, the chief of police in Toronto sent out special patrols with instructions to stand at busy crossings and hand to jay walkers cards bearing the words:

"Your friends are interested in your continued good health and well-being. Don't disappoint them! Enjoy a long life and a happy one. Before you cross the street, watch for the green light."

The experiment was a great success, says the police chief.

Huge Cycling Rally

THE sporting youth of Rumania, Turkey, Bulgaria and Greece recently held a huge cycling rally in Bucharest.

"50" Cancelled

OWING to the present crisis, the Barnsley Road Club have had to cancel their open "50," which was to have taken place at the beginning of August. In place of this, however, they are running an open "25" on the same date. Entry forms are obtainable from Mr. B. J. Bennett, 13, Junction Street, Barnsley.

Dead Heat in Velma "50"

PAPE, of the Castlenau, and Miller, of the Barnet C.C., tied in the Velma "50" on Sunday, July 7, returning a time of 2 hrs. 5 mins. 57 secs.

Maps

MAPS may be kept by British subjects under a new Home Office Order, but aliens must surrender any map of a larger scale than 12 miles to the inch. Maps, however, should be put in a safe place.

Cyclists as Messengers

THE C.T.C. and N.C.U. have organised a service for men and women throughout the country to act as cyclist messengers in the great national defence scheme. They will act in conjunction with the A.R.P. services, the local police, and in the Metropolitan Police area, with the Ministry of Information. The average club cyclist rides a racing machine at about 16 miles an hour and such messengers will prove very useful in carrying important and urgent messages between different services.

Tricycle Association Officials

THE following are the new officials of the Tricycle Association: H. Clark, 33, Boundfield Road, London, S.E.6; T.T. Sec., G. E. Lawrie. 132, Henley Road, Ilford, Essex; Northern T.T. Sec., A. Littlemore, 53, Halton View Road, Widney, Lancs.

Cycle Thieves

CYCLISTS are repeatedly warned of the danger of their machines being seized by parachute invaders. Do not leave them unattended for long. Cycle dealers have been visited by the police, who suggest that their stock of cycles should have the pedals removed, or one pedal and crank. Cyclists are reminded of the Lucas Gem lock, which costs 2s. 6d.

The taxi bicycle which has recently made its appearance in Denmark owing to the shortage of petrol. It can carry two passengers.

NOTES OF A HIGHWAYMAN

By L. ELLIS

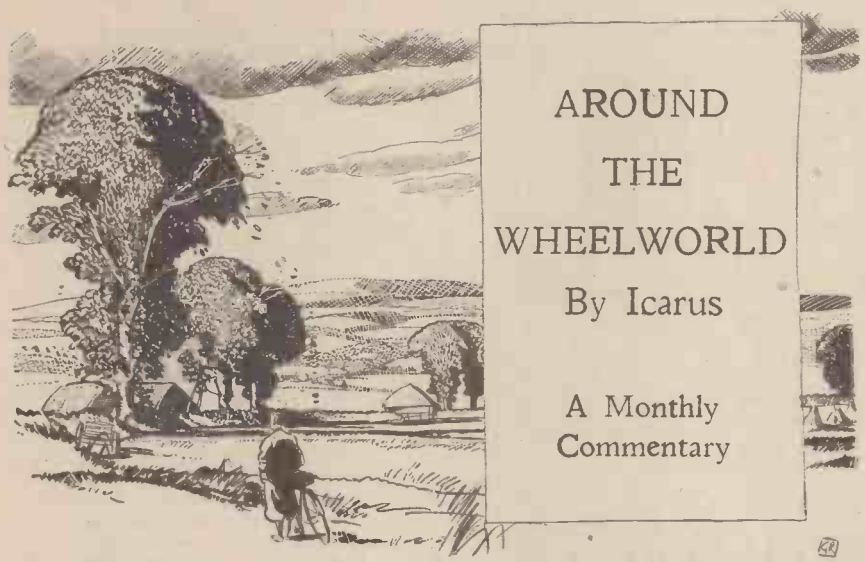
A RUINED Norman abbey, a Gothic market cross, many old inns and a charming old stone town. Such is Malmesbury in Wiltshire, and what more could a touring cyclist want as a stopping place for the night? The town does not strike one at once as possessing many outstanding charms, but after leisurely exploration it will rank with many as one of the numerous worthwhile towns in this country. The abbey affords one of the few examples of a ruin having been renovated and now used as a parish church. It is true that the present church occupies only a fraction of the original site of the abbey, but the curious mixture of ruin and modern masonry is queer in the extreme. The history of the town goes back many centuries and it is said that Maidulph, a hermit, lived here about A.D. 640, when the nearest trace of civilisation was a destroyed British settlement. Some thirty-five years later the community had grown and the status of abbey was granted by the West Saxon bishops. King Athelstan granted a charter

The Gothic Market Cross, Malmesbury.

to the town that had arisen round the monastery in A.D. 924, and even to-day there is an area known as King's Heath, which is actually the grant of five hides (about 600 acres) given to Malmesbury by Edward the Elder.

A Gothic Market Cross

AT the top of the High Street stands one of the three finest Gothic market crosses in England. The other two are at Chichester and Salisbury, and the former is, without doubt, the most beautiful of them all. Malmesbury Cross however is a very fine structure, built in the Perpendicular style in the reign of Henry VII. It stands over forty feet in height and is octagonal in plan. It is completed with elaborate pinnacles and flying buttresses supporting a beautiful central column. In common with the other two crosses it has been carefully restored, the townspeople realising the treasure that has been left in their midst. Searching through the town the tourist will find many old inns dating from the seventeenth century, and the King's Arms, the White Lion and the Green Dragon should be seen. At the bottom of the hill on leaving the town, an old building on the left will be seen. This is now an almshouse, but originally it was one of the Hospitals of St. John of Jerusalem, served by the Knights Hospitallers.



AROUND THE WHEELWORLD

By Icarus

A Monthly Commentary

Narrow Squeak

THE police have powers to detain for 24 hours and without preferring a charge anyone who does not satisfy them as to his identity. It so happened that I acted as a check at the turn of Miss Wilson's successful attempt on the 25-mile record, the turn being at a particular point along the Bath Road specified on the schedule. I went to great pains to measure the particular distance with the second checker. Having checked and rechecked the distance, I scored a mark on the road to indicate it, whilst the second checker went down the road to signal to me the arrival of Miss Wilson. The road was deserted, but after a short time a small crowd foregathered a few yards away. Nothing unusual about that for crowds, who by some mysterious means manage to get prior information about a record attempt, have gathered before. I was holding a stop-watch to take a note of Miss Wilson's time at the turn, and a checker down the road was giving me hand signals indicating that she was not in sight. This crowd, however, was not interested in Miss Wilson's record. Having seen me measuring the road and holding what seemed to be a bomb timing device, and receiving signals from a suspicious character down the road, they were certain that I was a fifth-columnist or a dynamiter. Presently there emerged from the crowd, almost at the double, two notebooks with policemen attached, and they bore down upon me. They asked me what my business was and I told them that I was waiting for a girl on a cycle. They didn't believe it, but asked me what girl, to which I replied that she was dressed in black tights. This convinced them that I was a lunatic at large or a spy, but fortunately for me Miss Wilson arrived at the time to prove the truth of my words. They were satisfied. This little incident does show the difficulties of running road events at the present time.

Invisibility of Traffic Light Signals

CYCLISTS as well as motorists complain of the invisibility of traffic light indications on a bright day, and the Minister of Transport has now informed highway authorities that where masked traffic light signals cannot easily be seen in daylight they may show either the upper or lower half of the signal face, provided that the signal is fully masked again during the hours of darkness. The Road Fund is to pay for the modifications necessary. Easily adjusted fittings are available for the purpose.

A Generous Concession

RECOGNISING that an employee cannot give of his best after being on duty during the night on L.D.V. and A.R.P. work, the directors of Currys have suggested that all members of the staff so affected would be justified in reporting for business on the following morning two hours later than the usual commencing time. Currys have other interesting features connected with their war-time activities. There is the Comforts Fund, the War Savings Group, the Knitting Group, the First Aid and the A.R.P. Squad. It is worthy of note that of the number of Currys employees in the services over 40 per cent. are now in the Air Force.

A Stupid Belief

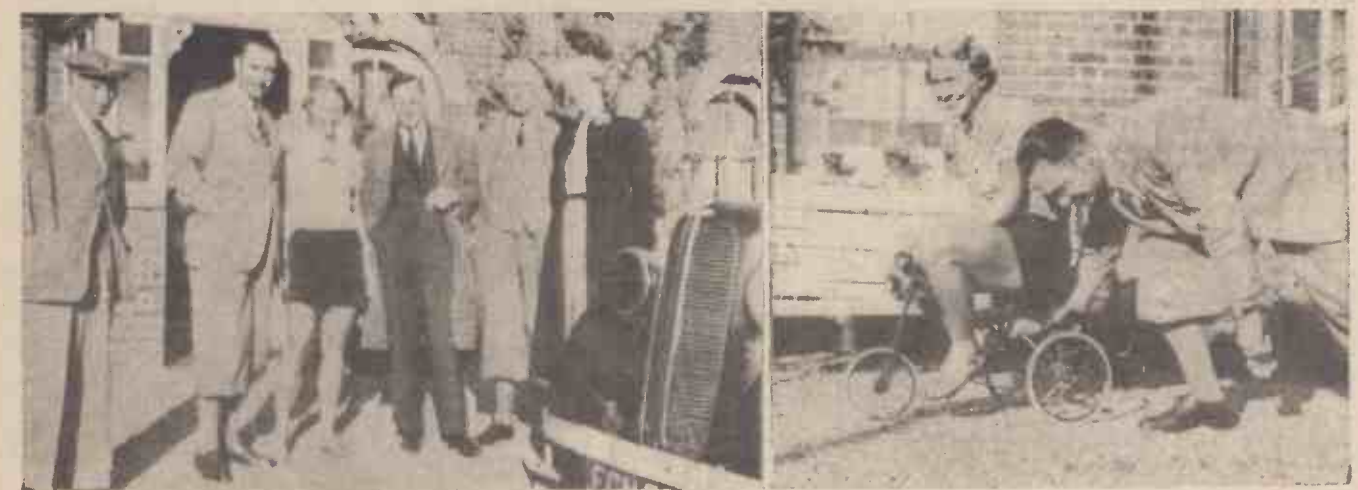
WHEN the Dursley-Pedersen bicycle was on the market it became deservedly popular, for it incorporated startling departures from orthodoxy which in practice proved themselves to be sound. The "experts" were soon dissecting the design, proving this, that and the other, and advancing reasons for the comfort which it undoubtedly provided. One of the fables propounded was that its frame, built and made of smaller members than an ordinary bicycle, was stronger than the latter because every frame member was in compression! This astonishing statement was repeated in didactic and parrot-like manner a few weeks ago in a weekly journal. Anyone who knows the first thing about the principles of structures knows that it would be impossible to construct a bicycle with every frame member in compression. There are some *structures* in which it would be possible to do so, but the bicycle is not one of them. Moreover, even though it were possible it would be most undesirable. Whatever were the reasons for the comfort of the Dursley-Pedersen cycle, and I think the hammock saddle had a lot to do with that; it was not due to the members being in compression!

Armlets for L.D.V. Cyclists

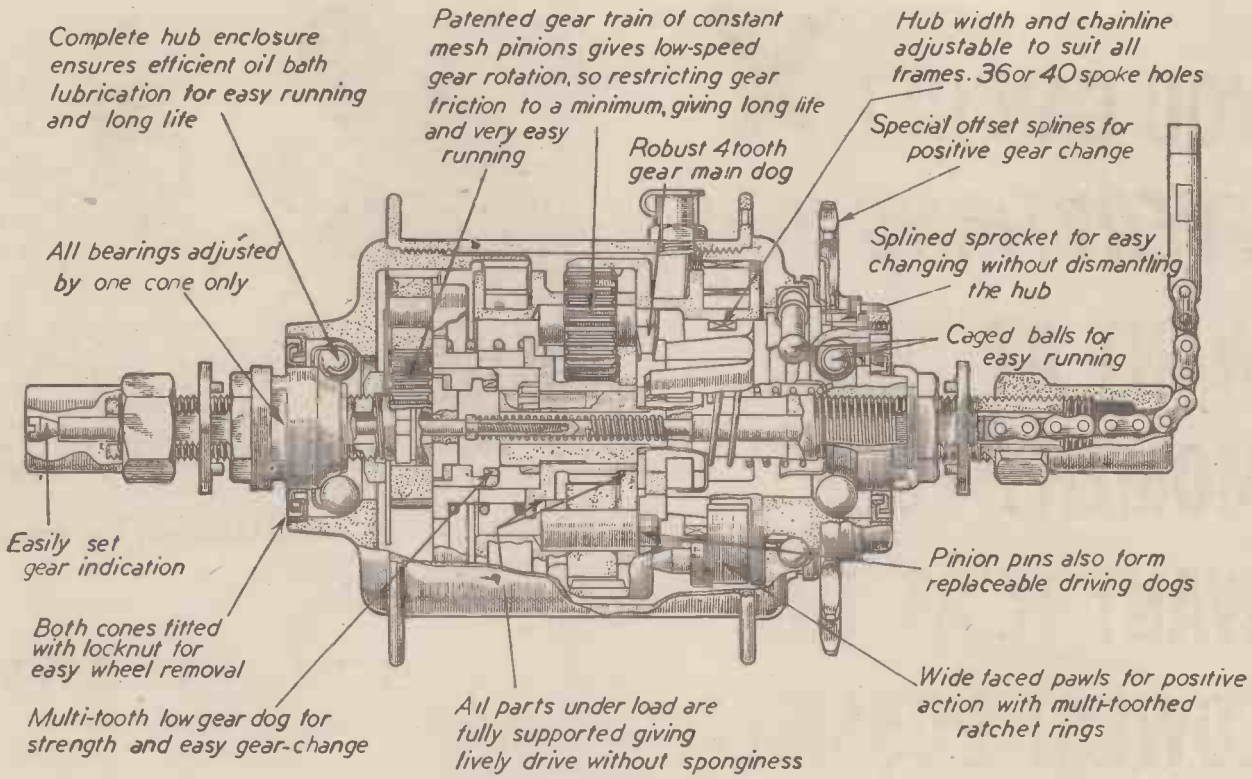
THE N.C.U. has been informed by the War Office that its members can join the L.D.V. as messengers or patrols and wear the L.D.V. armlet in conjunction with the N.C.U. official armlet. The N.C.U. are also preparing a register of lady cyclists who are prepared to act as messengers for the A.R.P. or the local police.

Monty Southall

MONTY SOUTHALL, who was wounded whilst in France, is back in this country recuperating. His brother Frank Southall tells me that he is making slow but sure progress. Frank also expressed great regret at the cancellation of the Bath Road "100," in which he figured so prominently and so successfully a few years ago.



At the "Lamb," at Theale, on the occasion of Miss Wilson's successful attempt on the W.R.R.A. 25-mile record. Left to right: C. R. Frost and Jack Westaway (Bath Road Club), Marguerite Wilson, Timekeeper White, C. R. Davey and Mrs. Davey. In the right-hand picture Miss Wilson practises a little tricycling, pushed off by Jack Westaway



A sectional view of the Sturmey-Archer 4-speed A.F. hub gear.

Gears And Gearing

By A. W. BRUMELL

Continued From Page 15 of Last Month's Issue

THE main advantages of hub-gears are that they do not need any extra fitments attached to the frame of the bicycle—barring, of course, the gear-lever and tiny pulley to take the control wire—nor do they require any "spreading" of the chain stays. In other words, if the rider for any reason requires to use another wheel or to ride a "fixed" for a change, all he has to do is to drop out the three-speed wheel and put the other one in. Also the mechanism is enclosed in an almost waterproof case, the lubricating is done quickly and easily through one small hole with the minimum of trouble. The trigger release on the handlebar is a great advance in gear control. Verily can the gears be changed by a mere flick of the finger!

Derailleur Gears

Now let us examine the "derailleur" system of changing gear. A derailleur gear consists of a free wheel with two, three or four sprockets, a mechanism that alters the line of the chain and causes it to jump from one sprocket to another and a spring-operated jockey-pulley or tension pinion to take up or let out the slack in the chain. This result is achieved in a variety of ways by the numerous different makes of derailleur but they can be classified roughly under three heads.

The first and oldest type has a jockey-pulley suspended from the chainstays as near the rear-fork end as possible and below this a tension pulley to which is attached a long spring whose other end is hooked to a clip fastened near the bottom bracket. The chain passes in the shape of a letter "S" round one of the sprockets on the rear hub, up over the jockey pulley and round the tension pinion. The jockey pulley is on a sliding shell, its position being regulated by the control lever fixed to the top or down tube. Movement of the latter causes the jockey pulley to move horizontally, taking the chain into line with a different cog on to which it will either drop or jump up; the tension pinion taking up or letting out sufficient chain to keep that properly tensioned. This model is very reliable and, if properly fitted, is practically trouble-free, requiring neither constant nor even frequent adjustment. A small disadvantage, particularly for the racing man, is that it does not permit of as rapid a drop-out of the back-wheel as those types which dispense with one of the pulleys, and make the tension pinion also do the chain-shifting. These latter are of course lighter and allow the rear wheel to drop straight out.

Another Variety

The third variety has a long tension arm fastened to a frame near the bottom bracket. This merely tensions the chain, the shifting of which is done by a fork unit fastened about two-thirds of the way along the chain stay. This model is, of course, very light and completely frees the drop-out from any encumbrance whatsoever. It is used almost universally by the French and Belgian crack professionals, but it has the great disadvantage that the long tensioning arm is very liable to damage and can be easily pushed out of line.

With derailleurs the gears available are dependent solely on the sizes of the individual sprockets on the free-wheel and are not, therefore, a fixed percentage distance apart as regards size. Some of them can be close together and the rest wide apart; one can be very small and the others large or *vice versa*. They can readily be used with an ordinary hub though the best results are obtained using hubs built for the purpose. The whole apparatus can be easily dismantled if anything goes wrong and converted into a single gear by shortening the chain. Every part of the apparatus is on view—faults can be easily detected and put right. This also means, of course, that it is rather exposed to the weather, a point of considerable importance, when there is a lot of snow or mud about. Derailleurs require frequent oiling and should always be kept swimming in it. There is very little difference in weight between a derailleur and a hub-gear.

A Disadvantage

A great disadvantage of the derailleur is that unless the machine was made to take it, it involves a spreading of the chain-stays to make room for the triple free-wheel, while the rear wheel usually has to be "dished" to ensure that it remains in line with the front. Though in theory, since it is running most of the time out of line, the chain should wear very quickly, I have always found it to have just as long a life as on a freewheel single-gear and definitely longer than it is possible for it to have if the rear cog is "fixed." In fact, a derailleur chain seems to run and change better the older it gets—up to a point that is, of course. The chief source of running expense with a derailleur is that the cogs require renewing every time one has a new chain. Otherwise new chains tend to ride up off old cogs every time one changes gear.

(To be continued)

WAYSIDE THOUGHTS

By F. J. URRY

Further Hints on Choosing a Bicycle

I WOULD always recommend a size of tyre not less than 1 in., and the use of a light-weight tyre generally known as road racing (which they are certainly not), but which in my experience last as long (if they are kept properly inflated) as the fully rubbered type usually supplied with the average bicycle. The reason I say use a light-weight tyre, even if the bicycle is purely for utilitarian purposes, is that a bicycle so shod is far easier to propel, the difference in miles per hour can certainly be put at one mile and maybe it is nearer two, and equally certainly the difference can be measured in muscular effort even by the inexpert cyclist. In the matter of price the difference is not a great one, at the most half a crown per cover, and that is a cheap price to pay for ease, when that ease gives as long service as the fully rubbered cover.

Brakes are one of the important items which should always receive attention. It has become the fashion in these days for caliper brakes to be fitted on most of the better-class machines, that is the scissor-like movement of the brake-blocks on the walls of the rim. Personally, I have never been able to understand why these brakes have become so popular except among the racing fraternity, who naturally desire a quick method of wheel removal without interference with brakes.

But most of us are forced to fit caliper brakes in these days because brakes of the pull-up type in super quality, acting on the bed of the rim (as in the case of the roller-lever type as fitted to the ordinary roadster machine) are not now obtainable.

Brakes

There are literally dozens of good caliper model brakes on the market, and most of the big makers fit brakes that are entirely reliable.

Presuming that you have chosen a bicycle following the rough outline I have given you, then most of the roads in this country are within your province of wandering, for you have a vehicle that can take you silently and happily to the delectable places at a minimum cost and a maximum of healthy exercise, and you can measure the latter to suit entirely your own mood and your own convenience.

Possibly in due course I shall have something further to say about these matters, and also the conditions along the road and the best manner in which to meet and overcome them without undue trouble, and certainly without worry or irritation.

Having obtained the bicycle (the best you can afford, remember), and having satisfied yourself you are really comfortably seated, the next thing to make you an easily moving rider in the traffic stream or over the lonely byway is the proper position awheel.

Astonishing it is to me that so many thousands of folk give not the slightest effort to make the bicycle fit them; they are lazily content to try and fit themselves to the bicycle, which is absurd. Why is it, do you think, a bicycle grants its owner easy adjustment of saddle position, saddle height, and handlebar position, and possesses a set of spanners to achieve these purposes?

If such adjustments are made correctly, riding becomes a pleasure.

It is unwise to lay down a "position law" to be faithfully followed by all and sundry, for cycling is not a dictatorial pastime calling for the imposition of unalterable rules. It is a travel method to suit you, an accommodation for free movement which can, and should, become a genuine pleasure.

Sir Edmund Crane and Mr. F. J. Urry during a tour in Wales.

Body Position

Broadly speaking, the body position awheel should be that of an easy writing-desk posture, a slightly curved spine at rest on its perch.

The hands should be lightly on the handlebar grips, with the arms almost at full stretch; then the weight of the individual is nicely distributed, but at the same time has power to exert muscular energy through legs and arms, with the fulcrum point at the saddle.

The arms are important in the distribution of the work. If you don't believe that, try riding up a slight slope without using your arms for leverage. The position of the arms awheel are an important factor in the propulsive effort.

That is why I choose a handlebar with a slight drop and set on an inch forward lug from the stem. My hands are then comfortably on the grips, my body leaning slightly forward, and I can use both arms and legs in perfect propulsive co-operation.

Take a glance at the rider with upturned bars and a poker-straight back. It looks quite comfortable when the going is easy on the level or with the wind abaft, but watch him on an up grade or against the breeze; bent elbows, swaying body, often a worried look, and certainly a consciousness that he is riding a bicycle, doing something unnatural.

Cycling Should be Natural

And that is my point. I want cycling to be natural, as it certainly can be, and the rider to be conscious only of its ease, and of his power to improve his muscular road speed, at least three times his walking pace, with the aid of this wonderful bit of mechanism.

So much for the body and arm positions, points which are frequently neglected, and which to me are almost as important as seating position, leg length, and that prime consideration of all, saddle comfort.

Now let us consider the seating position for a few moments. Here again you need to experiment, for a quarter of an inch in saddle height makes a difference, as does the same distance applied to a forward or backward saddle position.

Personally, and again I say one can only give their own experiences, the nose of my saddle is two inches behind a vertical line drawn through the centre of the bracket. That is the common position adopted by most tourists.

My saddle is adjusted to be horizontal with the ground, which nicely distributes my weight between seat and bars, and furthermore allows me to move my position for easy or working actions just that fraction of an inch which makes for comfort in each condition.

Some people like the nose of the saddle slightly tilted and find comfort thereby, but it does not give quite such freedom of movement in the seating accommodation. The much-tilted nose is an error, for it means undue pressure on the fork, which can be painful, and even harmful. Saddle position is of the utmost importance, and no rider can say he is comfortable unless he can sit there all day and feel perfectly at ease.

Saddle Adjustment

To adjust the saddle to the correct height for obtaining the best muscular effort is also very important, both from the riding and the safety view points. I am presuming you have a fairly modern bicycle with a low bracket, i.e., the axle bracket not more than 10½ in. from the ground, measured from the base of the bracket.

Any model of machine which is built higher from the ground than that is wrong, and definitely out of date, awkward, and ungainly. This is an important point to watch in purchasing either a new or second-hand machine.

When you are squarely seated on the saddle, the ball of the foot should be able to rest comfortably on the ground with the machine motionless. This can be done by adjusting the saddle height so that the centre of your foot can rest on the pedal at its lowest point without the knee joint being fully straightened. That is the ideal leg length, giving you full muscular power, easy flexing of the leg joints, and the ready facility to obey road signals by coming to a standstill with one foot on the ground, and still retaining complete control of the machine.

(continued on page 25)

So much for positional cycling, simple to achieve with the application of common sense and a spanner, yet, and here is the snag, how comparatively few folk take the trouble to give themselves a fair chance to be decent riders!

Presuming you have done all these suggested things, you know how to ride in the broadly accepted sense of that term—and how few folk do not?—then pedalling action comes into the scheme of perfect riding, and very much depends on the degree to which you are capable of developing that action, as to how easy you make cycling.

Pedalling Action

Notice the clean action of the expert rider and racing man. His speed depends on the easy flow of power throughout the complete revolution of the pedals, obtainable only by the correct use of his feet and ankles. He drops his heel at the top of the stroke, levels it with the rest of the foot when the crank is horizontal, and lifts it slightly as the pedal reaches its lowest point to relieve any back pressure on the drive.

It sounds complicated when read, but it is the natural action, easily acquired with a little practise, and means a smooth application of power as opposed to the jerky effort too frequently seen. Style in cycling, as in other games, counts for much, and once cultivated you never lose it; it is in very deed a conscious part of the pleasure of cycling and imbues the rider with a sense of power.

The young folk can ride faster without fatigue, the older ones easier without weariness, always providing they have taken the chances that fall to them to become cycling fit, not an athletic performance in the strict sense of the term, but an ability to sit on a saddle for an hour or so at a time without discomfort.

Three score years have gone over me, and still I can ride a century in a day and enjoy the journey. I seldom do, because the need does not exist, as I look upon touring and pleasure riding to provide me with a scenic procession of loveliness, ever-changing with the sunshine and the shadows.

In these days I am in no haste to change counties for the sake of crossing a border-line, providing the immediate scene grants its meed of satisfaction characteristic of the place. Why should I be? For when cycling is not a convenience or a sport, it is a holiday—even for the brief period of an hour—and holiday rant has no attractions for me.

I do not expect everyone to like cycling, for I am old enough to be aware that some folks are too nervous, some too wedded to town life to realise the loveliness of the blue hills, and some, alas, too forgetful that heaven gave them limbs to exercise. But I do understand that thousands of my compatriots have yet to learn the solace of cycling, its joy of movement, its individual freedom, its perfect silence, and incomparable ease if correctly understood and observed.

That is the reason I have tried to stress the preliminary things necessary to make the complete cyclist, things I have discovered in 400,000 miles of riding, to be of utmost value.

THE BRIGHTON AND BACK RECORD

Miss Marguerite Wilson knocks nearly 3 minutes off her own record

By F. SOUTHALL

Miss Marguerite Wilson who now holds practically all the women's R.R.A. records.

MISS MARGUERITE WILSON had one of her hardest rides when she beat the Brighton and back record for the second time. The record as it stood was quite hard, owing to the fact that it was already in her name. Although her time of 5h. 20m. 30s. are very hot figures, I am quite sure that she could get another 10 minutes off even now. This would, of course, bring the figures inside evens for the 104½ miles. As it stands at present it is only 8 minutes outside. It is rather hard to judge the merits of both rides, as they were both done in different conditions. The first attempt last year, when she rode the distance in 5h. 23m. 14s., was started earlier in the morning, which gave her an hour-and-a-half of darkness to ride in, and also it turned out to be very cold, with quite a good percentage of white mist to ride through near Brighton. The gears she used on that occasion were 75, 86 and 93, and I was told that she preferred to use a 93 much more than the 86. The wind on this occasion came up from the north-west, and made the finish rather hard, although it did not blow so strongly against her as it did on her recent successful attempt.

Gears Used

The gears used this time were a Sturmey four-speed comprising 66, 76, 84, and 90. Of these she did not use the 66 at all, and only on such slopes as Bolney Hill and Handcross Hill did she use a 76, and for miles she ignored the 84 and used the top, even wishing that this was higher. The schedule was made ont to beat the existing record by three minutes, and this gain was set out in the first 50 miles. During the old record, the first 50 miles took her 2h. 36m., but on this occasion she was well inside 2h. 30m., and the going became very favourable down to the coast, with the result that she was 10 minutes in hand of her schedule, still well inside evens. The return from Brighton, however, was very hard indeed, the wind came up against her stronger and stronger, and she naturally had to ride at a slower speed. When you are following a record breaker in a car, you cannot judge the strength of the wind at all, but I on this occasion followed on a cycle from a point south of Bolney Cross Roads, and could thoroughly appreciate the conditions in which the record was being beaten.

A Stiff Climb

The mile climb up to Handcross Village was really tough but was ridden strongly at about 14 miles per hour. On reaching the top Miss Wilson took a drink from Charles Davey, who also informed her as to how he was going. At this point she had 1h. 8m. left to equal record, and 19¾ miles to go. This sounds fairly easy, but when you take in the ride over the switchbacks, the climb up Merstham Hill, all against a headwind, there was not much time to lose, and it was really a splendid effort to knock another three minutes off of a tough record in these conditions. Miss Wilson rode a Claude Butler cycle, fitted with a Sturmey Archer four-speed gear, and equipped with Dunlop tyres. This record, of course, was Miss Wilson's second W.R.R.A. record this season, the first one being the London to Birmingham, which came fairly easy to her.

Miss Wilson, on Sunday, July 7th, also broke the W.R.R.A. 25 mile record, as recorded on another page.

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'ADEPT' 2¼ in. INDEPENDENT 4-JAW CHUCK, Price, 16/-; Post 6d. THE SUPER 'ADEPT,' 35/6.

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Easily made from our castings

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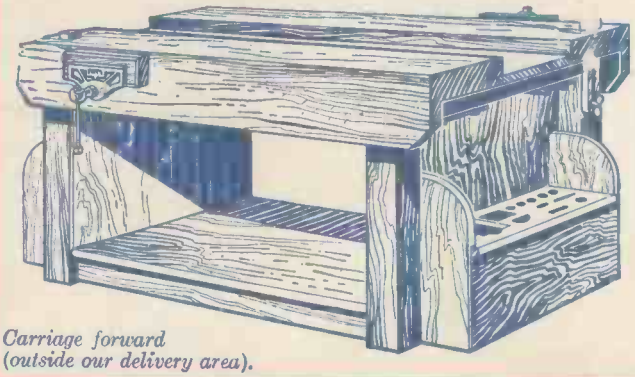
SOLID DOUBLE-SIDED WORK BENCHES



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POLISHING, BORING and GRINDING HEAD

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A high-grade production by Messrs. Jones and Shipman. ½ in. capacity with No. 1 Morse Taper Arbor. Only a limited number available at this low price.

To-day's value 30/-.

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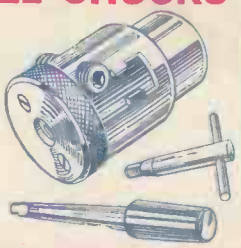
20/-



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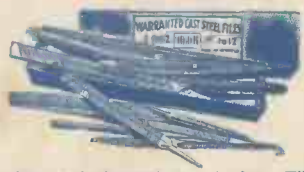

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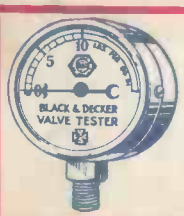

Calibrated to 10 lb. per square inch, but can be calibrated to approximately double this pressure. Amazing value.

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Made from special alloy steel, oil hardened and cadmium plated. Six sockets, complete with double ended ball loaded crank handle. Sizes: 7/32, ¼, 9/32, 5/16, 3/8, 7/16 and ½ in. Whitworth.

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Tested to 12,000 volts

Strongly made, insulated with thick rubber. In two sizes: 6 in. 7 in., 2/6.

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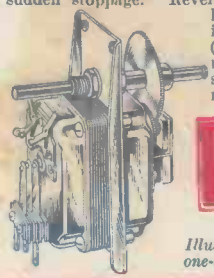
Will work through any suitable transformer. Rating, 12 to 14 volts continuous, to two minutes at 24 volts. **Incorporating bi-metal thermal cut-out to prevent overheating, and automatic clutch to avoid breakage under sudden stoppage.** Reversing switch, self-lubricating bearings. Rotor speed (no load) 2,000 r.p.m. Output spindle speed 58 r.p.m.



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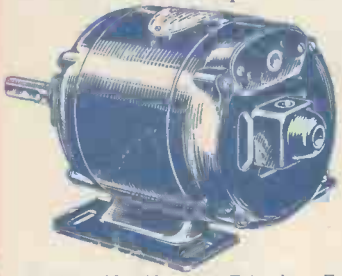

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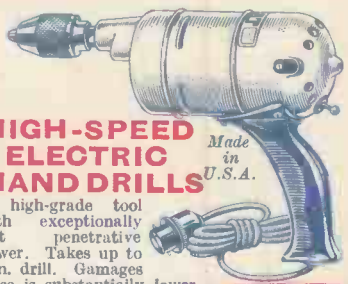
For A.C. mains, 200-220 and 230-250 volts, 50 cycles.



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