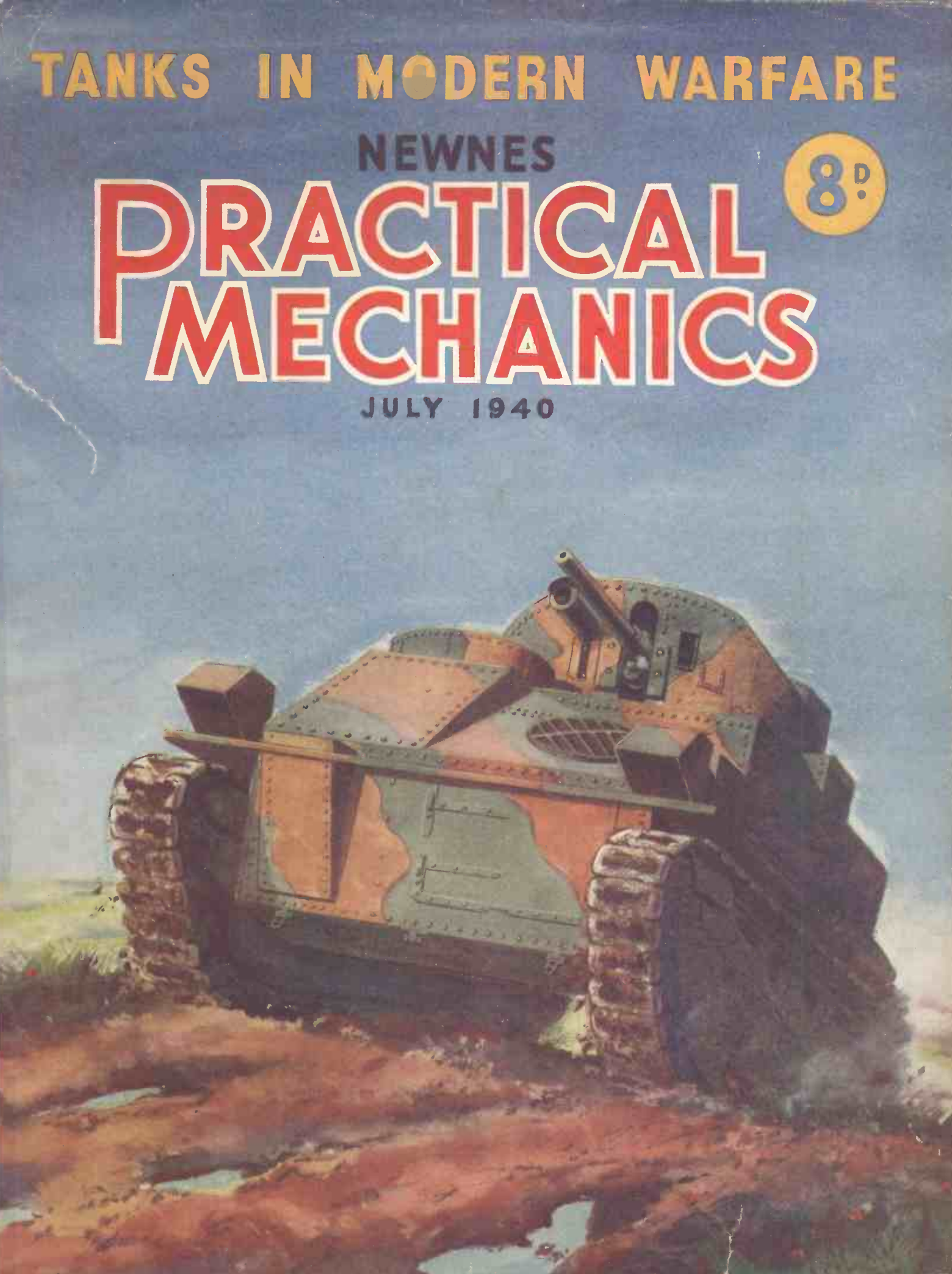
TANKS IN MODERN WARFARE

NEWNES

PRACTICAL MECHANICS

8D.

JULY 1940



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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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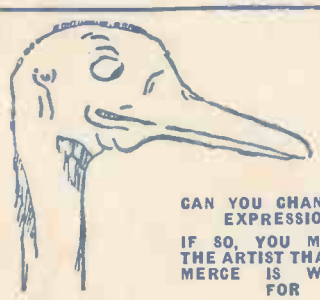

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'Phone: Temple Bar 4363.
Telegrams: Newnes, Rand, London.
Registered at the G.P.O. for transmission by Canadian Magazine Post.

PRACTICAL MECHANICS

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

Editor: F. J. CAMM

VOL. VII. JULY, 1940, No. 82

Mechanised Warfare

IT is more than ever apparent that this is a war of technicians, engineers, and scientists, and that it will be won, not by masses of men, but by masses of tanks and aircraft. This means that we must have ample supplies of material of which Germany to-day seems particularly short. We are more fortunately situated in that respect, but it is not too soon for us to consider the problem of substitute or ersatz materials, for even though we do not run short, if we can augment the supply by the production of synthetic materials we shall help to shorten the war because such materials will enable us vastly to increase our output of the weapons of war.

The Final Sockdolager

THE tank, a British production, is playing a mighty part in the Continental holocaust, but whether it will be able to deliver the final sockdolager is a matter of conjecture. It is my view that economic warfare plays a much more vital part. If you can stop up the supply of materials to our enemies you prevent him making the very machines you seek to destroy. Prevention (of manufacture) is better than cure, or destruction after manufacture. Fortunately for us, we own the largest Navy in the world which is able to keep open for us ports which are closed to the Germans, whilst the undoubted aerial supremacy attained by our Hurricanes and Spitfires, ensures that sooner or later we shall destroy Germany's existing stocks. That is a lesson, apparently, which the Italians have yet to learn, but learn it they will.

The Tank

THE tank was produced during the last war, and actually got into production in 1916. Thus, it is only 24 years ago since we taught the Germans the rudiments of modern warfare. Tanks were first used in the Battle of the Somme, and their appearance so hypnotised and paralysed the Germans that they fled in hysterical

FAIR COMMENT

By the Editor

disorder. For example, only one of the tanks attacked the village of Gueudecourt, and the Germans became so frightened at the sight of it that they surrendered at once. Within a short time 300 other Germans had been destroyed. The German High Command labelled them as military toys, but there can be no doubt that they played a large part in the defeat of Germany. They do not call them toys to-day. Now that the Germans have so many thousands of them, the thought occurs that considerable use could be made of the thousands of cars in this country, lying idle as a result of petrol restrictions and high horse-power tax, by converting them for war purposes. If they were modified by suitable armouring and the fitting of solid tyred artillery wheels, and equipped with light guns, they could provide a most potent mobile force of over half a million. Because of their high speed and manoeuvreability, they could defeat the tanks. This suggestion is no more fantastic than would have appeared a month ago the suggestion that we should use river craft to evacuate our troops from Belgium, yet such have proved to be most successful.

EIGHTPENCE A MONTH

With much regret we announce an increase in the price of this journal to 8d. The very heavy increase in the cost of paper, as well as rising costs in other directions, have made the step unavoidable if the service to readers is to be maintained. The alternative of a reduction in the number of pages would have meant both the sacrifice of several features for which the journal is valued by its readers, and the loss of the services of our specialist writers whose contributions form such an important part of our work. We prefer to maintain our service and our features, knowing that our readers would endorse our decision. We feel sure that we can rely upon their loyalty and understanding in our difficulties.

THE EDITOR

Inventor of the Tank

THE question often arises as to who invented the tank. The answer is that it was not the invention of any single man, but an adaptation of the Holt Tractor. Many people claim to have invented the tank, but the fact is that a large number of designers were engaged upon the adaptation of an existing piece of machinery. The present writer had as much to do with the invention of the tank as anyone else, for he was engaged on its production. The suggestion that any one man could have invented it is, of course, absurd. The ability to design such a machine presupposes that the designer had vast scientific and technical knowledge as well as more than ordinary engineering experience. Some of the claimants to the invention of the tank have never been trained as engineers, and are without technical knowledge.

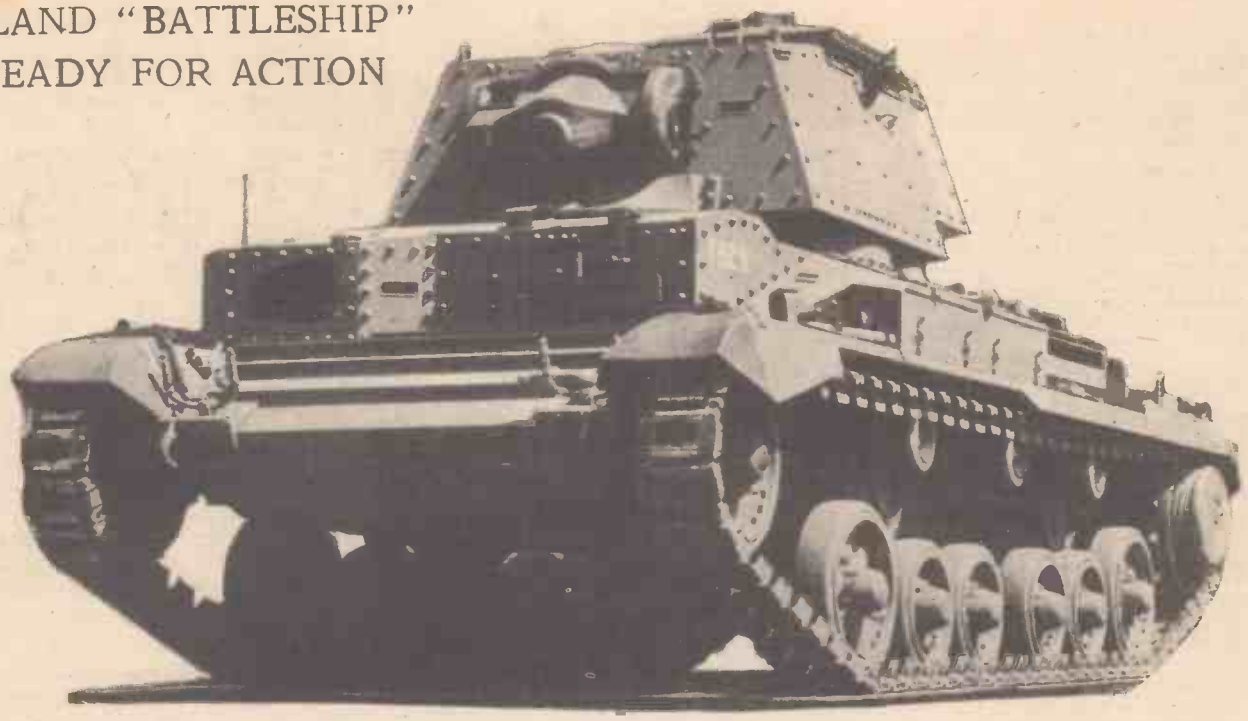
Outwitting the Tank

THE original suggestion that we should produce a tank emanated, I believe, from an Army officer, but it was the Commander in Chief in France who, through his experts, drew up the specification of the type of machine they required. Mr. Winston Churchill formed a committee at the Admiralty with Sir Tennyson d'Eyncourt as chairman, to consider the matter, and they carried out trials with a number of machines, such as steam-rollers and caterpillar tractors.

We have no doubt that each country is endeavouring to design a machine which will defeat the tank, for it is one of the anomalies of modern warfare that as soon as a new death-dealing machine is produced someone produces another machine by means of which it may be rendered obsolete.

With our remarkable and almost inexhaustable resources, there cannot be room for doubt that our technicians will find the means and the machines to defeat the foe.

A LAND "BATTLESHIP" READY FOR ACTION



Tanks in Modern Warfare

A "Military Toy" was what the Germans called the Tank when it first Made its Appearance in Warfare Nearly 24 Years Ago

IT was during the latter part of the last Great War that tanks were first used in warfare. These ponderously moving forts had been secretly constructed by the British and were used on the Somme in September, 1916. It was one of the greatest surprises of the war for the Germans when they first saw these monsters crawling slowly over hedges and ditches, spitting fire from their guns as they advanced. They were driven by petrol engines and with the conclusion of the war in 1918 designers at once set to work to develop the tank. Larger tanks were built, stronger armour plating was used and they were made more speedy. More guns were carried by them and to-day these steel monsters are armed against everything but a direct hit.

Amphibian Tanks

In 1931 an amphibious tank made its appearance, made by Messrs. Vickers-Armstrong. It was able to travel at 40 miles an hour overland; cruise at six miles an hour in water, and climb a slope of 30 degrees continually and a slope of 45 degrees for short periods. It weighed 2 tons 15 cwt., was 8 ft. 10 in. wide, 13 ft. long and 6 ft. high.

Year by year the performance of the tank was improved and the present-day monster is capable of traversing the roughest ground by means of its caterpillar tracks and their weight and manoeuvrability make it possible to smash down enemy earthworks and pave the way for the attacking infantry. The British Army employs three types of tanks—light, medium and heavy. The light tank is capable of travelling over the ground at 40 miles an hour and has a crew of three. It is armed with twin machine guns, can ascend an incline of 45 degrees and cross a 5 ft. gap. It weighs 4¾ tons and can negotiate an obstacle 2 ft. high. The medium tank, which weighs 12 tons, carries a crew of five and is armed with three machine-guns and a three-pounder gun. It has a speed of 20 miles an hour, can ascend an incline of 45 degrees and negotiate an obstacle 3 ft. high. The tank can also cross a 6 ft. gap.

The heavy tank has a speed of 30 miles an hour and weighs 16 tons. It has a crew of six, can ascend an incline of 40 degrees and negotiate an obstacle 3½ ft. high. It is armed with three machine-guns and a 3-pounder gun and can cross a gap of 9 ft.

French and German Tanks

The French enormous 68-ton tank easily dwarfs all the others and carries a crew of 12. It travels at only 12 miles an hour and is armed with a 3-in. gun and five machine-guns. Their medium tank is slightly lighter and slower than the British and only carries a crew of three as against our five. It is armed with one anti-tank gun and one machine-gun. The light tank weighs five tons, which is ¼ ton heavier than ours, has a crew of two and is armed with one anti-tank and two machine-guns.

Little is known of the heavy German machines so we can only give details of their light and medium tanks. The light tank weighs 4 tons. has a crew of two and travels at 35 miles an hour. whilst the medium tank weighs 12 tons. has a crew of four and travels at 20 miles an hour. The guns carried by the light tank are two

Two types of German tank. On the left is a medium and on the right a light tank.

GERMAN TANKS

Light
Weight: 4 *tons. Crew of* 2.
Speed: 35 *m.p.h. Armaments:* 2 *machine-guns.*

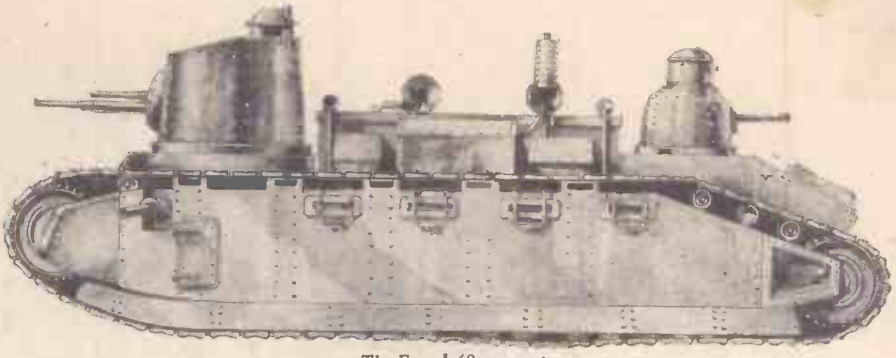
Medium
Weight: 12 *tons. Crew of* 4.
Speed: 20 *m.p.h. Armaments:* 1 *gun and two machine-guns.*
Little is known of the heavy tanks.

FRENCH TANKS

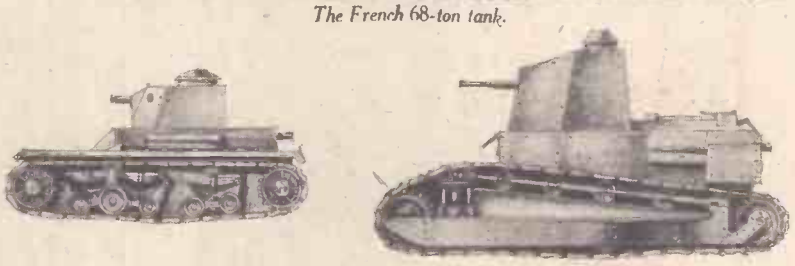
Light
Weight: 5 *tons. Crew of* 2.
Speed: 25 *m.p.h. Armaments:* 1 *anti-tank gun or* 2 *machine-guns.*

Medium
Weight: 10 *tons. Crew of* 3.
Speed: 15 *m.p.h. Armaments:* 1 *anti-tank gun and* 1 *machine-gun.*

Heavy
Weight: 68 *tons. Crew of* 12.
Speed: 12 *m.p.h. Armaments:* 1 3-*in. gun and* 5 *machine-guns.*



The French 68-ton tank.



A French light tank is shown on the left and medium on the right.

machine-guns and the medium has one gun and two machine-guns.

Tanks in Action

It is obvious that tanks fighting in mass formation are far more effective than single units and it is in this way that the tanks' offensive power can be brought to bear fully on the enemy. The crew of the tank must be highly trained and ready for any emergency. They are trained to do running repairs so that if the tank gets damaged going into action it may be possible for them to patch it up so that the machine may carry on with the action. All tanks are equipped with wireless telephony and wireless telegraphy.

When the German tanks go into action they work in conjunction with low-flying bombing planes. The Germans have also introduced flame-throwing tanks operated by troops swathed in asbestos. The flame-throwing apparatus consists of a long barrel through which is squirted flaming petrol.

A Vulnerable Point

The track in a normal German tank consists of a light steel chain. This chain runs over a toothed driving wheel at one end and a similar toothed wheel at the other end of the track. Slack in the chain is taken up by the second wheel which is movable. Four wheels, separately sprung, and fitted with artificial rubber tyres carry the main weight of the tank. When travelling over a smooth surface or along a road, the tank usually runs on these wheels, as, in order to save wear on the tracks they are removed. The Germans call the artificial rubber Buna and if through hard wear or enemy machine-guns the rubber is stripped off the wheels the "idler wheel" finds it impossible to take up all the slack that develops in the tracks, and there is a tendency for these to ride off the guides.

American Tanks

America is using tanks which are capable of travelling at 50 miles an hour and are manned by a crew of four. Their armament consists of two fixed thirty calibre machine-guns, one fifty calibre anti-tank machine-gun and one sub-machine gun. They can be controlled by radio by the commanding officer at his observation post.

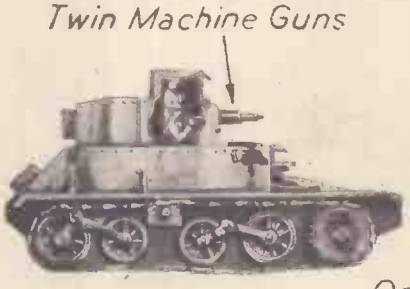
They have also an all-welded armour-plated tank which is capable of very high speeds. The tank weighs 10,000 lb. complete, and is 2,000 lb. lighter than the present conventional type U.S. Army tank. The machine carries one driver, a machine-gunner and a cannoner. Besides machine-guns, it carries an anti-aircraft gun.

BRITISH TANKS

Light
Weight: 4¾ *tons. Crew of* 3.
Speed: 40 *m.p.h.*
Can ascend incline of 45°.
Negotiates obstructions 2 *ft. high.*

Medium
Weight: 12 *tons. Crew of* 5.
Speed: 20 *m.p.h.*
Can ascend incline of 45°.
Negotiates obstructions 3 *ft. high.*

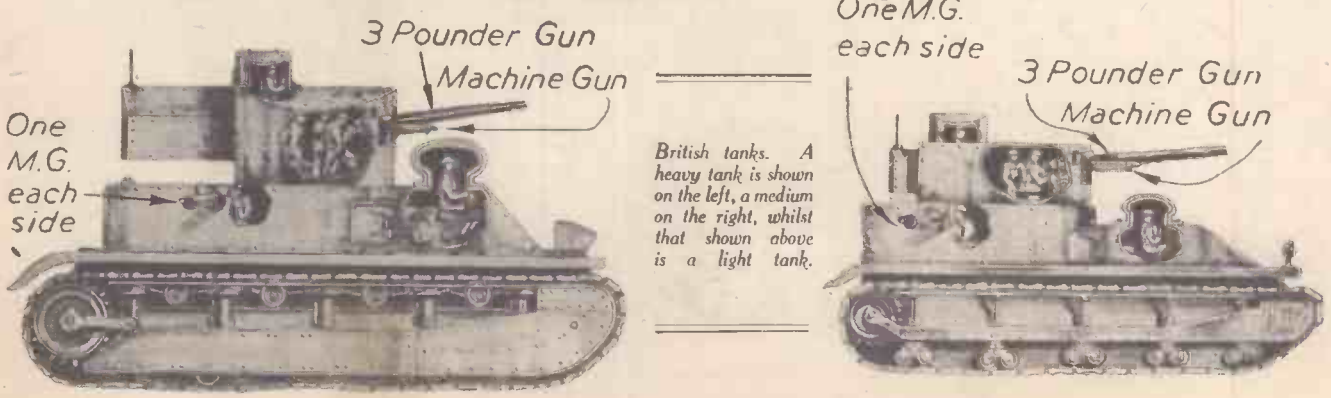
Heavy
Weight: 16 *tons. Crew of* 6.
Speed: 30 *m.p.h.*
Can ascend incline of 40°.
Negotiates obstructions 3½ *ft. high.*
80 *ton tanks are now being built but no details are available.*



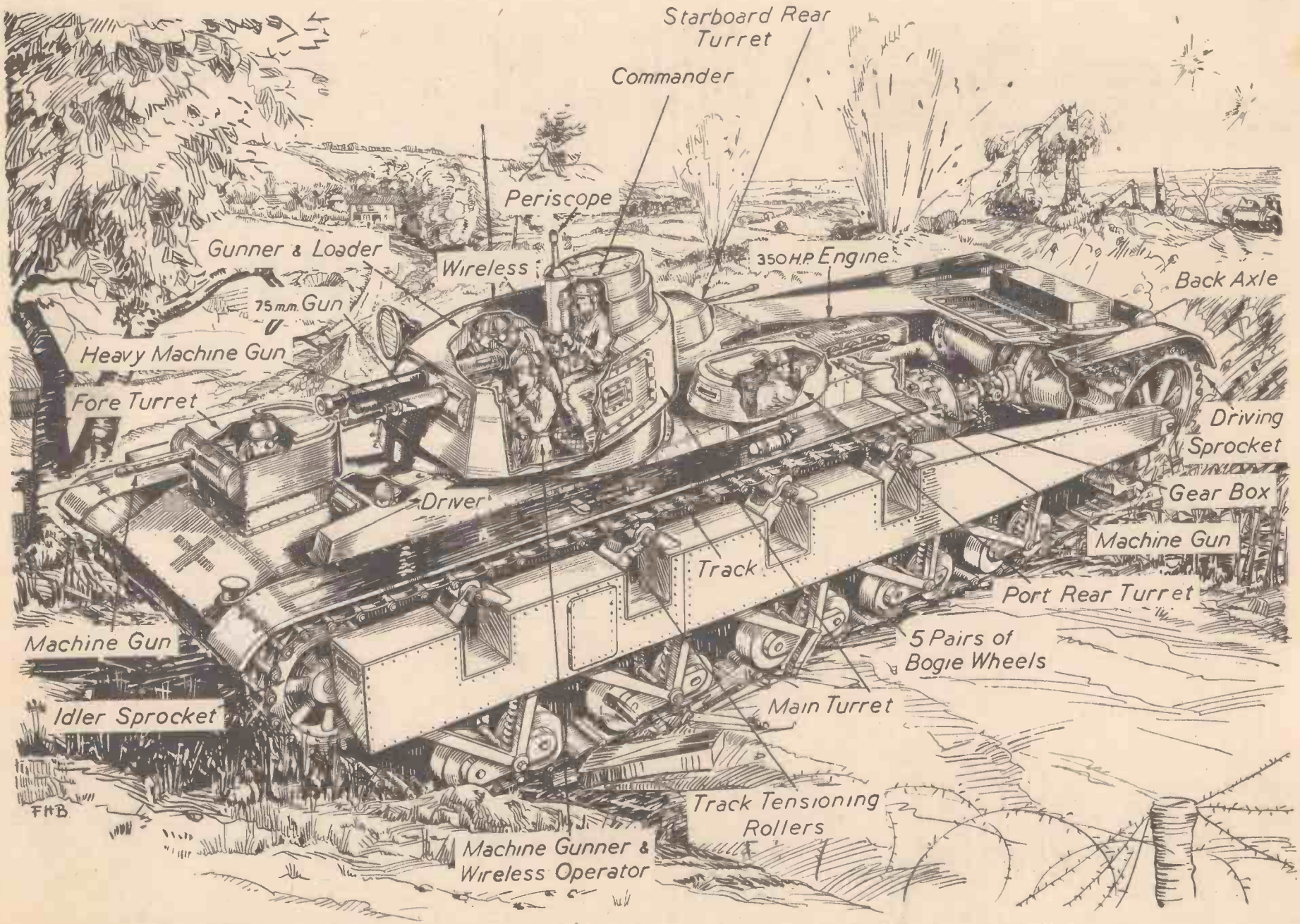
The Bren Gun Carrier

And finally we come to the Bren gun carrier which is a tank in miniature. It is capable of high speeds and with its crew of three and gun can inflict heavy losses in open country. Though the carrier has not the tank's power to smash down large obstacles, it can travel over very difficult ground.

As is to be expected in warfare, as soon as a new weapon makes its appearance on the field of combat, inventors at once set to work to devise a weapon to counter it. Tank traps and anti-tank guns have made the tank a less formidable weapon than most people think. Battalions are formed whose special duty it is to fight against tanks. They are armed with light mobile guns which fire a 2 lb. shell and have great penetrating power. The French also have an anti-tank gun which will pierce very strong armour plating and is said to be very accurate at long range. There are also special anti-tank rifles in use.



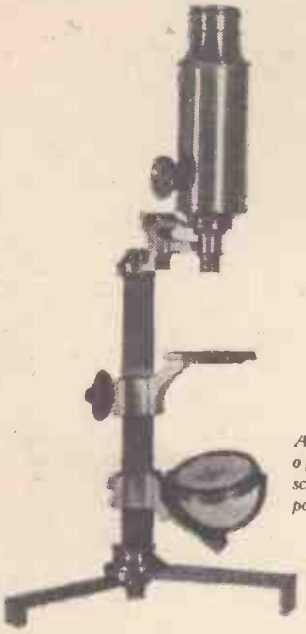
British tanks. A heavy tank is shown on the left, a medium on the right, whilst that shown above is a light tank.



The German heavy-medium tank which is now being extensively used on the Western Front. It has a crew of eight, and is armed with a number of machine guns and a 75-mm. calibre gun.

The Electron Microscope

The New Technique of Super Magnification by Electrical Means



An early form of optical microscope; magnifying power about x50

An ordinary optical miscroscope of a simple amateur type. With this instrument a magnification of about 200 times can be obtained

EVER since scientists evolved their theories concerning the existence and structure of atoms and molecules they have always wistfully contemplated the fact that these exceedingly minute particles of matter must for ever remain invisible even under the most powerful optical microscope which could conceivably be constructed, the reason for this being that these ultimate specks of matter are actually smaller than the wave-lengths of visible light. For, by no imaginable optical means can a particle smaller than a wave-length of light be observed by means of light itself.

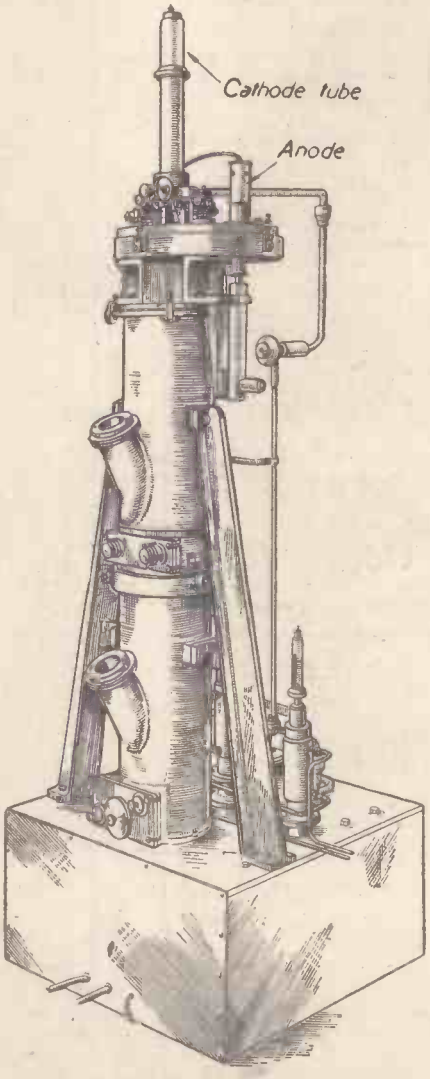
The smallest particle which is visible to the naked eye is about 1/100th of an inch in length or breadth. Below this size, all particles are totally invisible to the average unaided eye. Using an ordinary microscope with average high-quality lenses, we can attain a magnification of about 1,000, and by very careful working with special instruments it is possible to increase this degree of magnification under favourable conditions up to as much as 2,500.

Ultra-microscopes

Then, of course, there exists the so-called "ultra-microscope," the details of which are fairly well known. The ultra-microscope is merely a special type of optical microscope which, instead of employing ordinary light, uses ultra-violet light or even the still shorter X-rays. When fine particles in, say, a colloid solution are examined through an ultra-microscope by means of short ultra-violet rays obliquely applied, the particles, being somewhat bigger in size than the very short wave-lengths of ultra-violet light, intercept some of the rays and thereby reveal themselves to the observer as shadows, or, in some special circumstances, as bright objects on a black background.

Many wonderful observations have been made by means of the ultra-microscope, it being possible to observe particles of about the dimension of 1/10,000th of a millimetre by this method. There are 25.4 millimetres to an inch, from which fact the reader will be able to form some notion of the extreme "reaching" power of the best modern ultra-microscopic observation.

But still. even the ultra-micropscope cannot hope to reveal directly the almost infinitely tiny atoms which, when grouped together as molecules, make up matter as we know it. Consider, for instance, the hydrogen molecules, which are ordinarily supposed to consist of two hydrogen atoms bound together by some powerful attractive force. It would take some two million hydrogen molecules arranged in a line with each molecule just touching its adjacent companions to make up a row one millimetre in length. Other molecules, particularly those of complex organic substances, such as the proteins and cellulose, are very much bigger than hydrogen or similar molecules. Nevertheless, they are all smaller than wave-lengths of visible light and consequently we can never hope to observe them directly by means of an ordinary optical microscope no matter how powerful such an instrument might be.



A modern electron microscope used for the super-magnification of bacteria. The cathode-ray electron tube is at the top of the instrument, the observation window or eyepiece being below

A New Principle

Of recent years, however, an entirely new principle of magnification has been evolved, which principle, although it will hardly permit of our being able to observe individual atoms as they exist in particles of matter, may, nevertheless, render it possible for us to see some of the larger molecules and the "lattices" or frameworks in which atoms arrange themselves in crystals. The "electron microscope," several of which instruments have been experimentally constructed within the last two or three years has, up to the present time, attained a practical magnification of as much as 20,000, compared with which resolving power, the ordinary "x 1,000" magnification of our everyday optical "high-power" microscopes appears as trivial as the slight optical aid given by a simple spectacle lens.

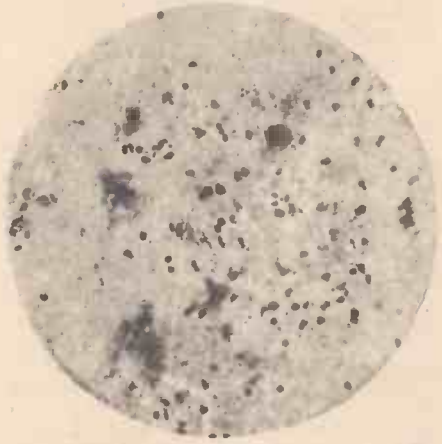
The electron microscope traces its origin to the realisation of the fact that under some circumstances moving electrons could be used for the production of magnified images instead of light rays, these travelling electrons being suitably deflected by electric or magnetic fields just as ordinary light rays are refracted in an optical microscope by passing through a series of lenses.

Upon this principle—a fairly simple one in itself—the electron microscope depends for its action. Essentially, the electron microscope consists of a cathode discharge tube which forms a source of electrons when activated by a high-potential electric current. The electrons are projected downwards through a very small aperture or diaphragm-opening along the axis of a highly-evacuated metal cylinder.

Ironclad Coils

The electron stream thus produced is passed successively through specially-constructed ironclad coils which represent the condenser, the objective-lens and the eyepiece of an ordinary optical microscope. Finally, the electron stream is allowed to impinge upon a fluorescent stream, upon which the produced image may be visually observed, or, alternatively, it may impress its image on a photographic film or plate.

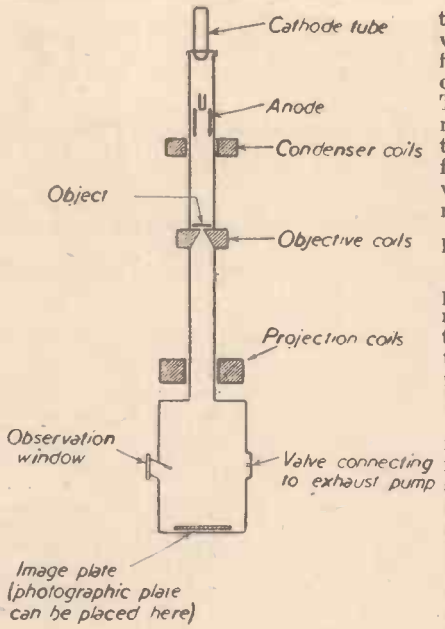
Let us now grasp clearly exactly how the electron microscope produces its magnified images. The ordinary microscope gives its "picture" or image by the absorption and diffraction of light rays. When, however, a stream of electrons passes through a thin layer of matter, some of the electrons, as they approach the individual atoms or molecules in the material layer, undergo a change in energy content and/or in direction. Consequently, they are swung out of their original path very much in the same manner as rays of light undergo a change of direction when they are made to pass through a magnifying lens. It is upon this change-of-direction of the electron stream that the magnifying powers of the new electron microscope depend. Since, however, the individual electrons constituting the cathode stream are exceedingly minute compared with the wave-lengths of ordinary light, and since they are much smaller than even ordinary atoms, it follows that by the utilisation of an electron stream for this type of "electrical magnification" we have a means by which it may be possible for us actually to observe particles of true molecular dimensions.



Tuberculosis germs magnified 1,000 times by a high-power optical microscope

Not Yet Perfected

The electron microscope is not yet a perfected instrument, despite the fact that its theory has been fairly satisfactorily worked out. It suffers at present from a number of drawbacks, chief among which is the extreme difficulty of constructing the deflecting coils so that they produce a perfectly symmetrical electrical field around the central electron stream. If, of course, the electrical fields produced by the coils are not perfectly symmetrical, distortion of the electron beam will be set up, and this will make impossible the attainment of sharp and "critical" images. Another disadvantage inherent, as yet, in the electron microscope, is the necessity of having the object under examination in as "thin" a condition as possible. So, also, is the fact that the object under examination must be placed in a high vacuum. Furthermore, it frequently happens that the object to be super-magnified in the electron microscope itself becomes destroyed and even disintegrated owing to the enormous electrical energy of the high-speed moving electrons which pass through it.



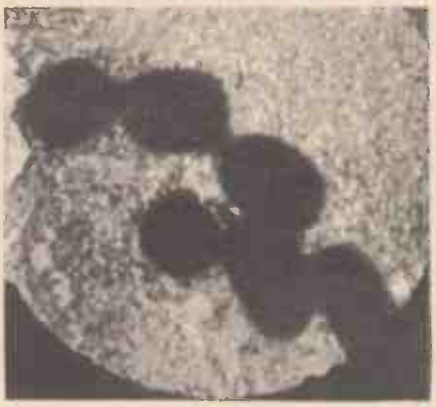
Condenser, objective and projection (eyepiece) coils correspond to these components in an optical microscope

The cathode tube of the electron microscope necessitates the employment of a potential of 50,000 volts or even more. It is a difficult matter to obtain a perfectly steady pressure or voltage at this exceedingly high potential. If, however, the electrical pressure applied to the cathode fluctuates even slightly, the emitted electrons vary in their energy contents, which variation sets up distortions in the magnified images as seen on the fluorescent screen or produced on the photographic plate. The electron stream used for this electric-magnification is, indeed, even more prone to distortion and to the production of faulty images than is the beam of light rays which is utilised in the ordinary optical microscope.

Imperfections in Constructions

It would appear, however, that the present-day imperfections of the electron microscope are all ones of construction, and that, with increasing experience and skill in the making and usage of such instruments, results far surpassing those obtained at present will be forthcoming.

Up to the present time, the electron microscope has been employed for examining the nature of very thin films of material and for elucidating the structure of exceedingly minute bacteria. The electron microscope does not at present give the fine detail which is characteristic of high-quality optical magnification. Rather, its magnification is yet of the semi-shadow variety. Still, it is capable of producing a degree of magnification far beyond the limits of even the most powerful of optical microscopes or ultra-microscopes, and there is every reason to believe that, with further study, experiment and experience in this direction the electron microscope will provide physicists and scientists generally with an implement which will enable them to discern all but the very atoms themselves.



An electron-microscope picture. Bacteria 18,000 times magnified. The mottled background probably represents actual groups of molecules

New Oil-finding Method

AT a meeting of the American Institute of Mining and Metallurgical Engineers in New York recently, a new and simple method of prospecting for oil by analysing a quantity of surface soil was described. Among the advantages claimed for this process, devised by Mr. Herbert Hoover, junior, and Mr. Washburn, of Pasadena, California, is that it may disclose the presence of oil as deep as 10,000 feet below the surface.

The apparatus was described as a semi-circular tube through which the gas mixture to be tested is forced by electronic bombardment past magnetic fields. Gases of a certain molecular weight are curved along a known arc by the magnetic field and made to pass through slits into chambers, where they are gauged quantitatively.

Half a dozen different gases will take as many different paths and be directed into half a dozen different slits, providing at once a quantitative and qualitative analysis of complete mixture.

The richness of the sample in the gases indicates the richness and probable depth of the oil in the earth.

Emergency Winding Gear

MR. D. M. MOWATT, convener of the miners' rescue station at Coatbridge, has invented an emergency winding gear for collieries. It is claimed that the invention, which will be used in any emergency to prevent miners being entombed, can be operated as quickly as the normal winding gear. It includes two emergency cages and a small pithead frame with winding-wheel attached. The equipment is mounted on a chassis and can be transported to any colliery where winding gear might be damaged in air raids. The set would enable a rescue brigade to bring miners to the surface in a few hours.

Non-Stop Return Atlantic Flights

IF necessary, non-stop return Atlantic flights can become a reality in from 12 to 18 months, according to a report submitted to the United States Congress by engineers of the National Advisory Committee for Aeronautics. It is stated that changes in wing design and the "finning" of engine cylinders will greatly increase the range, speed and efficiency of aeroplanes. It is predicted that the new streamlined wing will reduce the air resistance by one third and will permit speeds of from 450 to 500 miles an hour. The speed and efficiency of the engine, it is expected, will be increased by about 300 per cent. by the "finning," which is based on the principle that the engine becomes more efficient, the faster the heat is carried away.

Mine Layers At Work

How Under-sea Bombs are Constructed and Laid

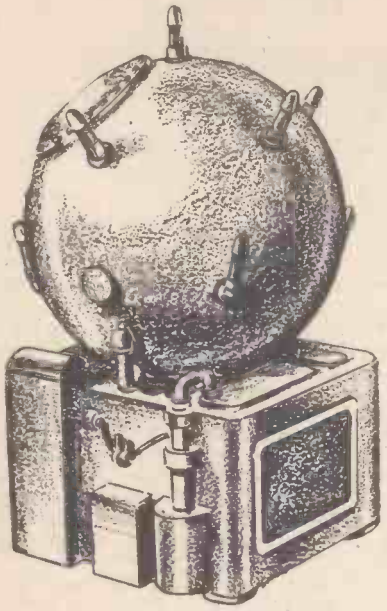


Fig. 1.—The mine before laying.

THERE are three methods of laying a mine—by seaplanes, submarines and surface vessels. Seaplanes are used chiefly for laying magnetic mines as described in last month's issue, whilst the submarines and surface vessels are used for the ordinary type of mine. Briefly, the marine mine is cylindrical in shape and is kept buoyant by means of an air-chamber. It also contains a high-explosive apparatus for detonating the explosive. Although there are various sizes of mine, the average, ordinary moored mine is about 650 lb. in weight and contains about 350 lb. of high explosive such as trinitrotoluol (T.N T.).

The air-chamber takes up about half of the interior, and as will be seen from the illustration of the mine, is fitted with a number of "horns." There are generally five or six of these and each one encloses a chemically filled glass tube The explosive is detonated when the glass tube is broken and the chemical released.

The Connecting Cable

A cable connects the moored mine to a 5-cwt. metal "sinker." In Fig. 3 is shown a mine and sinker immediately after being dropped by the mine-layer. The mine has parted from the sinker from which the mooring cable is being payed out. The length of the weighted cable appearing below the sinker determines the depth that the mine will be moored below the surface of the sea.

The weighted cable on touching the sea bottom automatically checks the pay-out of the mooring cable causing the mine to be drawn below the surface of the water, as shown in Fig. 4. In Fig. 5 the mine is shown after all the laying operations have been completed, and it is anchored to the sinker at the pre-determined depth from the surface In the event of the mine parting from the mooring cable, the mine rises to the surface, as shown in Fig. 6, and is rendered inoperative by reason of a device situated above the mooring shackle, as can be seen in the sectional drawing.

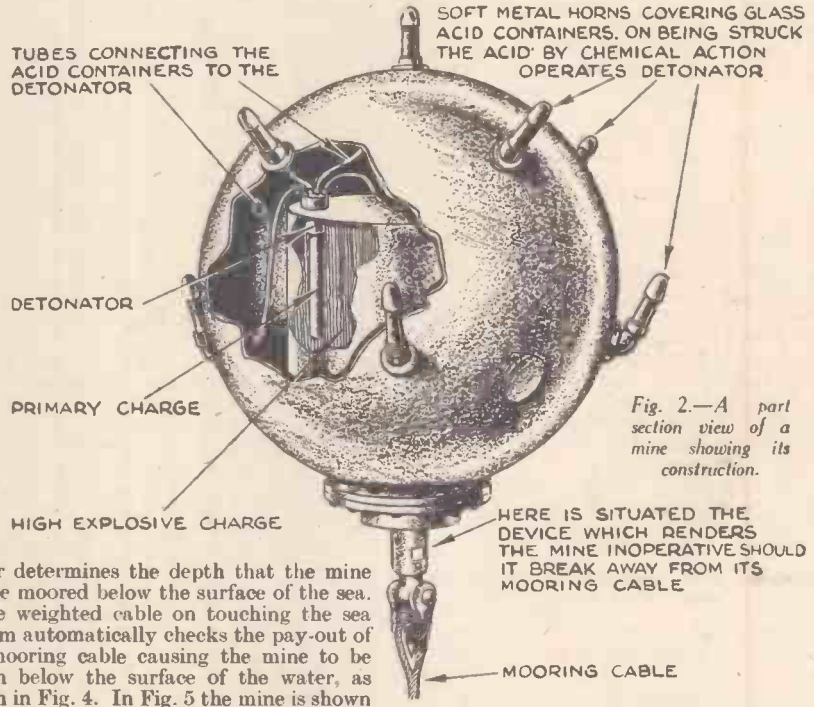
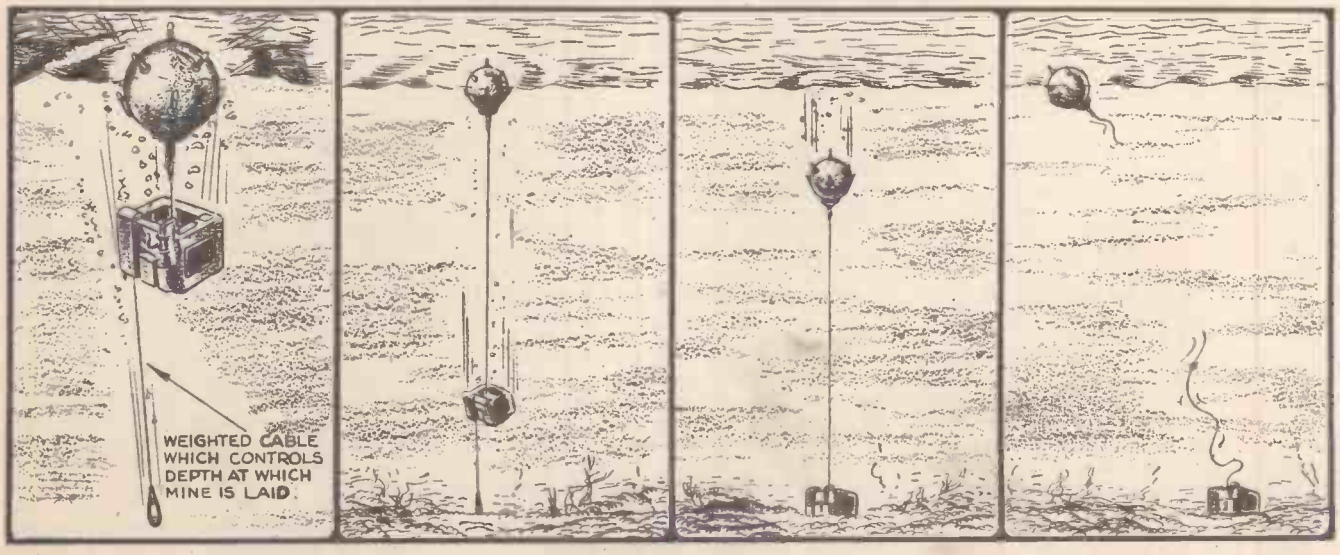


Fig. 2.—A part section view of a mine showing its construction.

Floating Mines

With the drifting or floating mine, which is similar in principle to the mine just described, the cable which connects the mine to the sinker is cut and then rejoined with a chemical substance which gradually dissolves in sea-water. This enables the mine-layer to get well away before the mine breaks loose, and in this case the mine is not rendered inoperative.

Sometimes a hydrostatic device is fitted to the mine to keep it under water, even after it has come adrift. The floating mine is considered to be not so dangerous as the moored mine, as the waves set up by an approaching ship have a tendency to push the mine out of the way.



Figs 3 to 6.—Three stages in the laying of a mine. If the mine accidentally comes adrift as shown on the extreme right, it is automatically rendered inoperative.

The foregoing method of mine-laying is carried out by surface vessels, but with a submarine a different technique is used. The German U-boats can lay the mines whilst they are still submerged. They can carry about 36 mines and these are carried in tubes or chutes, in the hull of the submarine. From here they are released one at a time.

Aeroplanes are also used by the Germans for laying bubble mines. They are dropped from bombing planes by means of a parachute. An advantage with this type of mine-laying is that mines can be laid in an already mined area without danger to the aeroplane. How mines are swept and put out of action was described in last month's issue.

Our Busy Inventors

By "Dynamo"

Whistle While You Walk

A NOVELTY cane which will be useful in the black-out has been patented in the United States. It is tubular and has a plunger round which a helical compression spring is closely wound. On the principle of a locomotive whistle which shrilly announces its approach, this whistling cane in the darkness should prevent the colliding of pedestrians. The same arrangement might be incorporated with an umbrella.

To Prevent "Housemaid's Knee"

MAIDS, charladies, painters, and all those who in the course of their work have to bend the knee will be interested in a scrubber's scooter which has recently made its debut. Constructed of welded steel and fitted with four ball-bearing castors, this knee rest will enable floors to be stained, polished and washed with the maximum of comfort. It should contribute to the prevention of "housemaid's knee," the complaint which attacks those who are so often caught bending.

Pointless Darts

THE type of dart board at present in use is entitled to be enrolled in the noble army of martyrs. St. Sebastian, the patron Saint of Archers, is said to have been bound to a tree and shot at with arrows. The dart board is the long-suffering target of innumerable missiles. Each successful aim results in a piercing of the board. The latter, made of soft material, is, as a consequence, not everlasting.

An improved dart board is the subject of an application to the British Patent Office. All parts of the board that count for scoring are loose or hinged, so as to fall out of position when hit by the dart. This will avoid the necessity of using a sharp-pointed dart. The scoring parts, displaceable by a hit, are mounted in such a manner that they can be restored to position by blocks on a shutter sliding parallel to the surface of the target. The face of the board is covered with green baize like a billiard table. A net catches the fallen darts. It remains to be seen whether enthusiastic dart players will regard this new board as agreeably less to the point.

To Buoy You Up

IN these troublous times the perils of the sea produced by Nature have been greatly intensified by human nature or, rather, inhuman nature. Consequently, a newly-devised safety swimming suit is very apposite. There has just been patented in the United States a one-piece swimming garment having, attached to the back and breast, portions which can be inflated. Other inflatable elements are in the front, rear and sides of the legs. Valved means, accessible to the mouth of the wearer, enable him to force air into all of the inflatable parts.

The Horse's Reign

ONE sequel of the rationing of petrol is the return of the horse to the highway; Old Faithful has staged a come-back. It is appropriate that, at this juncture, there should be made in our country an application to patent an improved bridle. The aim of the inventor has been to provide means for controlling animals which are difficult to manage. Some of these intractable creatures are known as "pullers," and "dead mouths."

Previous bridles have included the snaffle, which is a simple and gentle kind of bit. There has also been a curbing bit consisting of a bar which passes through the horse's mouth alongside the snaffle bit, and likewise a chain hanging below the animal's lower jaw. With such arrangements, however, there is caused continual pressure. This benumbs the horse's mouth and interferes with the intimate relationship which should exist between the hand of the rider or driver and the mouth of the animal. The object of the new invention is to remedy this defect while furnishing the same or an even greater degree of control.

The bridle in question comprises a noseband encircling the horse's head above the nostrils and having at each side a guide member, through which slides a curbing rein. The ends of this rein are attached to a chain or similar curb between the guide members and adapted to lie under the animal's jaw.

This curbing device can be easily detached, so that it may be removed or replaced quickly. It can be carried in one's pocket or other receptacle of limited size.

Giving a Horse His Head

APROPOS of harness for horses, it is interesting to note that the minds of many Victorians were exercised upon the subject of the bearing rein. This particular rein forced the horse to arch his neck in order to add smartness to his appearance. Humane folks contended that it was cruel, inasmuch as it restricted the free movement of the animal's head. Equally good people maintained that it was the tightness of the bearing rein which occasioned the horse discomfort and that a loose rein of this description would not inconvenience the animal. In fact, they affirmed that in the case of an equine "Weary Willie," who is apt at times to allow his head to droop, a medium bearing rein would prevent this lazy habit. And I presume that, when pulling a load, the freedom of the animal's head could be achieved by loosening the rein.

An eminent clergyman of the eighteenth century, the Rev. John Wesley, made some illuminating remarks upon the management of a horse. This reverend gentleman travelled more than 4,500 miles a year on horseback over bad roads and sometimes no road at all. And he used to read as he travelled. Yet he says that his horse practically never stumbled. The secret was that he threw the reins on the neck of the animal. And this method, in preference to a tightly-held rein, Wesley contended, prevented his steady steed from falling. Verily a stable horse.

Accommodating Bedspreads

OWING to the advent of summer, the eiderdowns on our beds are too warm. But these padded covers are frequently kept in use for ornamental purposes, particularly where a certain decorative colour scheme is desired. Consequently, at night, the eiderdowns are apt to be creased and damaged through being folded back or temporarily removed. But it is often found that the entire removal of the cover is too drastic, and a light counterpane is necessary.

Bearing these facts in mind, an inventor has made an application for a patent in this country for a bed-cover which will effectually meet the case. According to his invention, a bedspread has a central bed-covering portion and valances at the sides and the end. Across the central portion is a detachable panel and between this and a base sheet is a removable pad. As a result, the bedspread can be suited to the season.

The Electrocution of Flies

THAT tiny aviator, the housefly, is circling over the bald pates of those of us who guard the home front, or settling upon our rationed joints. To demolish the gossamer-winged raider an electrified screen has been devised. It is easy to instal in the door or window and will electrocute the annoying pests. The transformer requires a normal input of four watts. When the screen is within reach of human beings or animals, a metal guard of light weight is available. The manufacturer, however, states that the screen affects injuriously only insects.

Paper Footwear

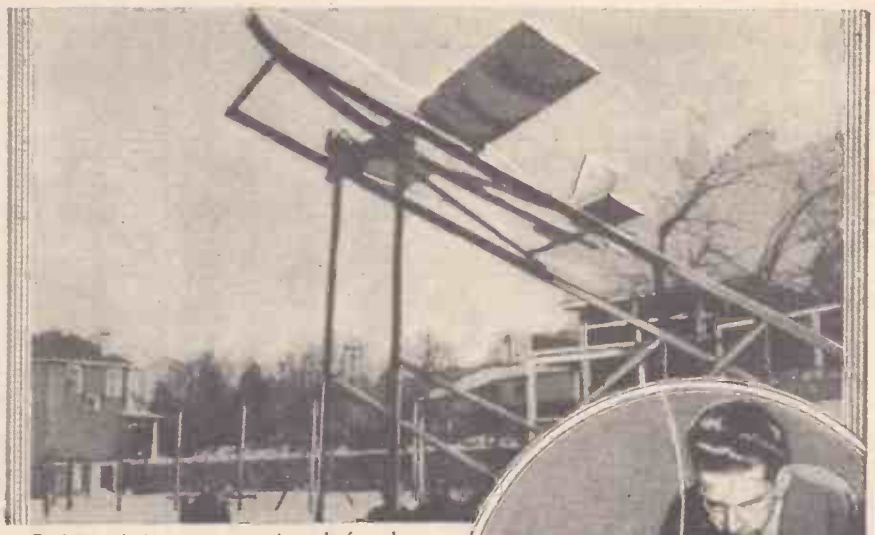
PAPER slippers for the shower bath and for lounging have made their advent. With paper at a premium on our side of the Atlantic, one does not expect this footwear to become the vogue here. However, the source of my information is America, where the value of paper has not approximated to that of "dem golden slippers" about which the coloured coons used to sing. It is claimed for these paper slippers that they do not collapse nor disintegrate in the shower bath. There are no sharp edges which might cut the feet. And they do not slip on any kind of floor, as non-skid spots on sole and heel allow sure gripping.

A ROCKET MAIL PLANE

Recent Tests Carried Out in America With a Rocket Mail Plane Have Proved Successful

AMERICA'S first air mail rocket, "Gloria," although covering only a few hundred feet in a recent test flight at Greenwood Lake in New Jersey, may in time be considered as significant as that first historic flight of the Wright brothers at Kitty Hawk, which covered an even shorter distance.

Despite the short distance covered, the rocket mail flight has been termed a success because it proved certain basic principles important to the world wide research programme. It proved a rocket motor can lift and propel a loaded aeroplane fifty-times as heavy as the motor itself. It also proved a rocket aeroplane can maintain a safe stability whilst in the air. From the first flight it appears that the principle of the reaction motor is basically sound, although it can stand improvement.



Rocket mail plane on a catapult ready for take off, and the tiny but powerful motor.

Carrying out final adjustments to rocket driven mail planes.

Design of the Rocket Plane

The "Gloria" was an undertaking of the Rocket Aeroplane Corporation of America whilst the aerodynamic design of the wings and fuselage was the contribution of the Guggenheim School of Aeronautics. Loaded with air-mail covers addressed to stamp collectors the "Gloria" skidded to a halt on the ice about 2,000 feet from the point of takeoff. The "Gloria's" two-pound motor actually develops 300 horse power per minute. On the test block it registered almost fifty pounds of re-action on a measuring device. Propelling a 100-pound aeroplane at a speed of about 4,000 feet per second, the rocket motor would develop an equivalent of 160,000 foot-pounds per second.

Whilst the motor is a hollow pipe with no moving parts, its construction involved many difficulties. At present the main difficulty in building a rocket motor is that it is made of monel metal. When a better heat-resistant substance is developed, there will be a great improvement in the performance records of rockets.

Fuel

Another important consideration at present is fuel. After many disappointments, rocketeers have abandoned powder fuel and substituted liquid fuels. Powder rockets create detonation waves which cause dangerous explosions. Liquid fuel lends itself to easier manipulation and control, and is safer to handle. The "Gloria's" motor burned a mixture of powerful fuels blended in a combustion chamber. Fuel tank No. 1 contained liquid oxygen, temperature about 200 degrees centigrade; tank No. 2 contained mixture of alcohol, petrol, methae and other liquids; tank No. 3 contained compressed nitrogen gas. The nitrogen gave the necessary pressure to the other tanks.

As the liquids from tanks 1 and 2 are sprayed into the combustion chamber, they explode with a terrific impact. The sudden combustion generates a hot gas having a volume many thousands of times the original volume of the fuels. The pressure of the escaping gas lifts the rocket against gravity. Theoretically, the "Gloria" was supposed to build up her speed until she reached a maximum of 500 miles per hour. This is a long way from the speed required to escape the earth's gravitation—25,200 miles an hour.

High-Speed Communication

Rocketeering experimenters are not especially interested now in exploring outer space. They want, first, to build a rocket that will be useful for high-speed communication in comparatively low altitudes. Such rockets would be useful in sending mail to remote and inaccessible places. Military tacticians see still other possibilities. A rocket might be made into a flying projectile with its own power-generating plant. It would fly faster than the fastest aeroplane and escape anti-aircraft attacks. For obvious reasons, both the aeroplane and the balloon are inefficient above 40,000 feet, but the rocket

motor operates better in a vacuum than at low altitudes.

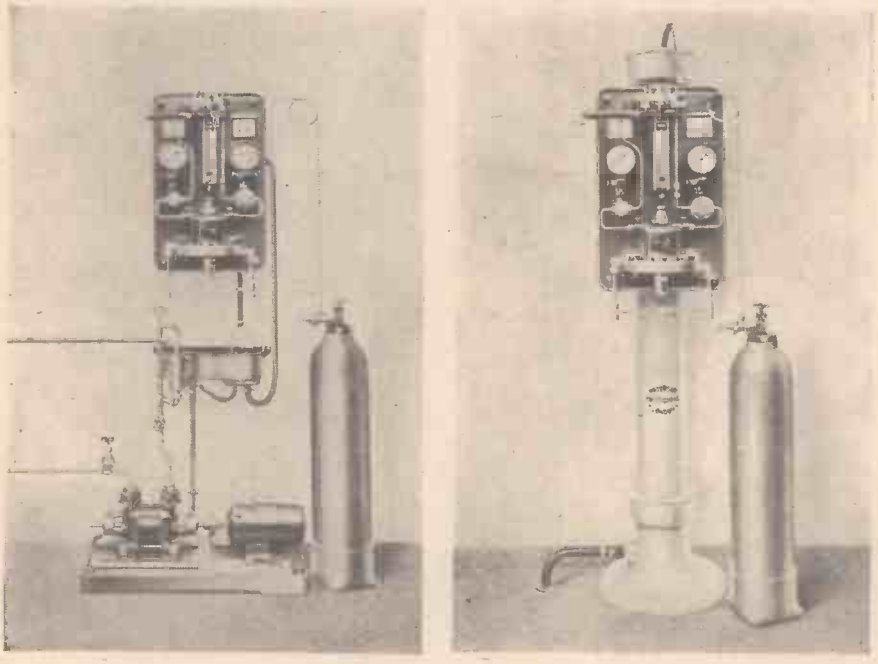
With the rocket motor, there is no waste of energy in the transmission of power through shafts, gears or drives. For the first time, man has found a means of getting power direct from the heat of combustion. That is the principle of the reaction motor, and it is likely to find many useful applications in the future. Theoretically, at least, rocketeers have gone far. One has already designed a rocket aeroplane with a propeller. The combustion chambers are contained within the propeller blades. They have also studied the possibilities of man-carrying rocket aeroplanes. A 150-pound man in a 250-pound ship would require fifty pounds of rocket fuel for an eight mile flight.

Air Travel by Rockets

A vista of what air travel by rockets may be like fifty years hence has been opened by the patent of Prof. Robert H. Goddard, a Clark University scientist, who has been experimenting for years at Roswell, N.M., with funds supplied jointly by the Carnegie Institution of Washington and the Daniel & Florence Guggenheim Foundation.

The Jekyll-Hyde aircraft, as described in the patent, would change its shape from a conventional aeroplane at lower altitudes to a streamlined rocket ship when the rarefied stratosphere is reached. In the troposphere, the layer of air immediately surrounding the earth, the rocket aeroplane has wings, propellers, a tail skid, landing wheels, rudder and other conventional parts. In the stratosphere and above, only stubby wings are left.

Instead of being driven by propellers at these high altitudes, the rocket ship is hurled along by jets of gases streaming at high speed from nozzles in the tail. *Reproduced from General Knowledge.*



Two types of chlorination plant. (Left) Pressure feed. (Right) Automatic gravity feed.

Killing Bacteria

The Use of Chlorine Gas

DURING recent years considerable advances have been made with the disinfection of sewage and sewage effluents as well as general industrial effluents, using chlorine gas. This is ideal for the purpose, and one of the most important benefits is the elimination or great reduction of foul smells from decomposing organic matter, largely caused by the evolution of sulphuretted hydrogen. Chlorine combines immediately with the latter, liberating free sulphur and preventing the smell from this source. Equally important advantages of the chlorination of sewage and sewage effluents are the effective control of the fly nuisance in summer and the prevention of the troublesome slimy algoid growths on the filters, which cause also the trouble of " ponds " of liquid on the surface on the beds due to non-uniform penetration.

Chlorination

The chlorination is carried out in the settling tanks or other portion of the equipment before reaching the filters, whilst still another advantage is the prevention of foaming in the tanks. In this connection the " Chloronome " equipment of the Paterson Engineering Co., Ltd. of London (Windsor House, Kingsway, W.C.2), one of the main pioneers of the use of chlorine gas for water, sewage, and effluents, is being largely used. Essentially this apparatus, it will be remembered, consists in basic principle of a cast aluminium panel fitted with control valves, narrow-diameter flexible copper tubing coupled to a cylinder or small drum of liquid chlorine, pressure gauges, metering device, filter moisture seal, and two pressure reducing valves operating in series. By means of the latter the chlorine gas always discharges to the apparatus a one uniform low pressure, generally 10 lbs. per square inch, irrespective of the high pressure in the cylinder or drum, which varies as the latter empty themselves.

The chlorine, adjusted in supply as required by the control valves, then passes in most of the designs into a small water absorption tower forming part of the apparatus, which is in the form of a vertical narrow diameter cylinder of glazed earthenware, carrying the panel, so that a relatively concentrated solution of chlorine in water is formed and passed to the bulk supply of effluent or water as so to ensure uniform and rapid chlorination.

Types of Machine

A number of different types of machine are, however, available, including small units having a capacity of up to 10 lbs. of chlorine per 24 hours, whilst a special very small portable set is also provided, carried about as required by one man. This is particularly valuable also for the sterilisation of drinking water, incidentally of great importance in war.

Equally important is the chlorination of sewage and industrial effluents, thereby rendered harmless before discharge to rivers and streams, generally requiring about two parts of chlorine per 1,000,000, or slightly over, but depending upon the conditions. Ordinary effluents from sewage works, for example, frequently contain large counts of bacteria which cannot be discharged direct, whilst river conservancy authorities all over the world are quite rightly insisting upon a much higher degree of bacterial and other purity of effluents, since more and more demands are being made upon rivers for towns supply.

An Aircraft that Hovers

ABLENHEIM was returning over Germany after a successful bombing attack on an enemy bridgehead when the pilot sighted an unfamiliar type of aircraft flying low along a deep valley.

Diving at more than 300 miles an hour, the Blenheim pilot attacked with his front gun, opening fire at about 35 yards.

" To my amazement," the pilot reported afterwards, " the enemy aircraft appeared to stop and stand still in mid-air, forcing me to over-shoot."

Pulling out of his dive the R.A.F. pilot sought to renew the attack, but the enemy aircraft was now flying so low that the steepness of the gorge prevented further attack.

The mystery of this " hovering " aircraft was solved later, when the Blenheim pilot identified it from a photograph as a Fieseler " Storch," a German trainer-type aircraft which has such extensively slotted wings that it is endowed with remarkable slow-flying qualities.

Its proper name is Fieseler Fi 156, and it is used sometimes for army co-operation work, especially for observation, for which its low speed makes it eminently suitable.

This aircraft was evolved from a number of successive types built by the German firm of Gerhard Fieseler Werke, founded by Herr Gerhard Fieseler, the acrobatic pilot who designed the earlier models especially for his aerial displays.

Although the Fieseler Fi 156 has a top speed of something like 110 m.p.h., its minimum speed is only 31 m.p.h. A speed that is definitely " hovering " compared with normal modern speeds.

MASTERS OF MECHANICS

No. 58.—Otto von Guericke, Inventor Of The Air Pump And Investigator Of Atmospheric Pressure

"NATURE," observed the philosophers of old, "abhors a vacuum." But why this supposed natural antipathy to a vacuous space should be such a prevailing one, the few scientific thinkers of the age of Galileo entirely failed to explain.

Even the famous Galileo himself, when confronted with the fact that water could be raised by suction up a tube to a maximum height of 30 ft. had to admit himself beaten when he was asked for an explanation of that fact. His rather lame answer to the foregoing query was to the effect that whilst Nature truly abhorred a vacuum, she apparently only abhorred it to the extent of a column of water some thirty feet in height. Which, of course, as Euclid had remarked some couple of thousand years previously, is absurd.

It is very easy for us moderns to visualise the fact that we live at the bottom of an ocean of air, just as much as deep-sea fishes and other creatures have their existence at the lowest ocean levels. And, in the light of our knowledge, we find little difficulty in comprehending the sometimes strange effects which our life at the bottom of the earth's enveloping blanket of air is often fraught with.

We know nowadays why, under normal atmospheric conditions, a column of mercury some thirty inches in height will stand upright within a vertical tube without flowing downwards from the tube into an underlying reservoir or container. This effect, the basis of the barometer, is caused by the downwards pressure of the atmosphere on the mercury. If such a mercury column be set up on the top of a high mountain where the air pressure is less, it will be found that the mercury column will decrease in height, and if, of course, by modern means, we remove the air from the external surface of the mercury in the reservoir, the column will collapse, there then being no air pressure to support it.

Air

Air, to our scientific forefathers, was an intangible and, to a large extent, a somewhat unreal entity. No one in the olden days suspected that air could be dealt with very much like water, that it could be compressed, expanded, made to flow along pipes, and even, indeed, actually weighed! And so, not being able to grasp the essentially mechanical nature of air (or of steam or gases, for that matter), early experimenters found themselves very much handicapped when they came to offer explanations of certain natural effects. Moreover, their inability to conceive air as being an essentially material medium severely militated against their progress in the mechanical arts.

Otto von Guericke, the famous and somewhat romantic Burgomaster of Magdeburg, in Prussia, goes down in history as the first man who successfully applied himself to the systematic elucidation of the nature of air pressure and as the individual whose work exploded the old superstition regarding Nature's supposed dislike of a vacuum. Guericke, a somewhat universal genius and an apparently indefatigable experimenter, has also earned deserving fame for himself as the inventor of the first electrical machine,

Otto von Guericke

which took the form of a rotating globe of sulphur making frictional contact with a pad of silk or similar material. Guericke's electrical exploits, however, do not properly concern us here. Such we must reserve for discussion in a future series of articles on electrical pioneers.

Guericke's Fame

The bulk of Guericke's fame rests upon his discovery of the air pump and upon his realisation of the fact that air is very much like water in many properties and that it obeys the same laws of pressure. The experiments of von Guericke, which began in the middle of the 17th century paved the way for the coming of steam power, via the "atmospheric engine" of the early part of the following century. For the "atmospheric engine" of Newcomen and other inventors was, as the reader will, no doubt, recollect, worked by the downwards pressure of the air upon the upper surface of a large piston operating within an open-ended cylinder. All that the steam was employed for in the "atmospheric" type of engine was to create, by condensation, a vacuum underneath the giant piston, whereupon the piston itself was rammed down in the cylinder by means of the air pressure on it.

A modern laboratory air pump

As we have remarked, the "atmospheric" engine was the eventual outcome of Otto von Guericke's work. So, too, was the laboratory air pump of Robert Boyle, with which we have already dealt in this series of articles.

As regards Otto von Guericke himself, he was born in the old city of Magdeburg on November 20th, 1602. Of a clever and ingenious disposition, we find that he first studied law at Leipzsig University, and that subsequently he took up the subject of mathematics with much gusto, his aim thereby being to qualify himself for certain mechanical studies which he intended to embark upon.

Stayed in England and France

Guericke stayed for a while in France, and it would seem, also, that he resided for a period in England, although little or nothing is known concerning his activities in our country. Neither Sir Isaac Newton nor Robert Boyle were born at the time Guericke came to England, and we can only surmise that he visited our country for the sake of enlarging his education generally rather than coming to our shores on some definite mission. At any rate, after his return to Germany, von Guericke settled for a time at Erfurt, a town in Saxony, and followed therein the occupation of "master engineer"—probably of some mineral mills.

Some time before the year 1627, however, he had returned to his native town of Magdeburg and had settled there, for in the year above mentioned we have a record of his being elected a member of the Senate (or Town Council) of Magdeburg. Subsequently, he became (at the age of 50) Burgomaster or Mayor of Magdeburg, and it was during his term of office in this capacity that he conducted the pioneering experiments which have made his name famous.

The Italian, Evangelista Torricelli, a contemporary of Guericke, had discovered the principle of the mercury barometer. and had thereby demonstrated the materiality of air in supporting the mercury column. Von Guericke showed great interest in the work of Torricelli. As a result, he flung himself into the task of trying to devise a machine which would extract air from closed containers and thereby prove that a vacuum was possible, despite Nature's accredited dislike of it.

A Crude Air Pump

Realising that air could be treated like water, he devised a crude form of air pump comprising a plunger or piston working within a metal barrel. With this implement he attempted to extract water from a closed cask full of the liquid, but he found such a task to be almost impossible. Despite the exertions of two or three strong men, the piston of the pump could not be drawn outwards in order to enable the water in the barrel to be sucked out. Guericke, whose

idea had been to extract the water from the filled cask, and thereby to leave the barrel full of "nothingness," quickly grasped the fact that the external pressure of the air on the pump piston prevented it being drawn outward. As our own Robert Boyle, the "First of the English Chemists," afterwards remarked, there is a spring in the air, which makes it resist forces very much like a spring of coiled metal.

By great efforts, however, Guericke did actually extract some of the water out of his closed casks, but having done so, he found that such experiments were all to no purpose, for immediately some of the water left the casks the surrounding air leaked rapidly into them through the pores of the wood.

By using metal containers, however, Guericke found it possible to exhaust them of air, using for the purpose an improved air pump of his own construction. With these exhausted metal containers he gave a number of startling and spectacular demonstrations.

A Demonstration

One of these demonstrations, for instance, consisted in joining together the two hemispherical halves of a copper globe, the opposing rims of the two hemispheres being separated by a thin washer of oiled leather in order to allow of a better air-tight joint being made. Through a small stop-cock screwed into one of the joined hemispheres, the copper globe or sphere was exhausted by means of Otto von Guericke's air pump and the exhausted sphere was then suspended downwards from a strong hook. Attached by chains to the lower hemisphere of the copper globe was a platform upon which were placed many heavy weights. Despite the load on the platform, the two hemispheres of the copper globe remained in firm contact, being, of course, maintained in that condition, as von Guericke himself plainly realised, by the external pressure of the air. As soon, however, as the stop-cock was opened, thus admitting air to the interior of the globe, the lower hemisphere, with its load of weights, dropped instantly to the ground.

In another spectacular demonstration of Guericke's, a team of men attempted to pull asunder the two halves of the exhausted copper globe. Here, again, however, there was no result until the stop-cock in one of the hemispheres of the globe was opened, whereupon the human team fell at once to the ground!

"Magdeburg Hemispheres"

Of all the experiments of Otto von Guericke on air pressure, the most famous and the most spectacular was that of the "Magdeburg Hemispheres." These consisted of a hemispherically divided copper globe, similar to the one described above, but considerably larger. These were exhausted of air, and subsequently a team of 16 horses was set to the task of pulling the hemispherical halves of the globe apart. Eight horses were harnessed to one of the hemispheres and the remaining eight to the opposite hemisphere. The two horse teams pulled in opposite directions, yet the exhausted sphere resisted their exertions and its two hemispherical halves remained united under the external pressure of the air.

This experiment, von Guericke performed before a large crowd of interested spectators, including one or two royal princes.

Always a bit of a showman, Guericke, at the conclusion of his "Magdeburg Hemispheres" experiments was wont to instruct a very small boy to open the stop-cock attached to one of the copper hemispheres, whereupon, the air rushing into the globe, the hemispheres, fell apart almost of their own accord.

The famous "Magdeburg Hemispheres" still exist in the museum of that town. And also are to be seen there the many curious air and water pumps, casks, barrels, and other crude and cumbersome pieces of mechanical apparatus by means of which the worthy Burgomaster first gave the world at large its practical demonstration of the mechanical properties of air.

The first vacuum pump. Attempting to extract water from a sealed cask filled with the liquid

Water Barometer

On the side of his house at Magdeburg von Guericke erected a "water barometer" consisting of a metal tube some thirty feet in height. The tube was closed at its upper end, but open at the bottom, at which place it dipped under water contained in a cistern. The tube was filled with water exactly in accordance with the example of the mercury barometer discovered by Torricelli, and von Guericke's essential showmanship impelled him to float upon the upper surface of the water in the tube a diminutive human figure, which, of course, rose and fell according to the downwards pressure of the external air on the water in the cistern. Such was the world's first public barometer.

Boyles' original air-pump, the first mechanical air-pump to be made in this country. With his pump he made a large number of experiments upon the physical nature and properties of air

Otto von Guericke was the first to give a proof of the materiality of air. He weighed one of his copper globes, using for the purpose the most accurate pair of scales which he could command. Then he exhausted the sphere of air and weighed it again. The difference in the two weights represented, of course, the weight of the air extracted from the globe. In this manner definite proof was first afforded of the measure and weight of the air.

In another domain of practical science, von Guericke showed that heat was capable of making air expand and that cold would cause a quantity of air to contract. He made a number of thermometers, which consisted of large globes containing air, which, by means of a piston device, operated a string passing over a pulley. A small human or other figure attached to the end of the string manifested the expansion or contraction of the air within the globe by means of its movements.

The above, of course, did not constitute a true thermometer or heat-measure, since von Guericke's bulbs were also operated by the varying pressure of the atmosphere. Nevertheless, it added further evidence to von Guericke's discoveries concerning the materiality, weight, and mechanical power of the air. Indeed, our very ultra-efficient high-speed internal combustion engines are, viewed in one light, merely developments of von Guericke's glass bulb "thermometers," for they operate by thermal expansion and their fundamental principle of power derived from thermal expansion is the same as that utilised in an infinitely gentler manner by the energetic Burgomaster of Magdeburg.

Large-scale Experiments

Von Guericke, it would seem, generally devised his experiments on the largest scale possible. A water barometer 30 ft. in height possibly appealed to him much more than a 30-in. mercury barometer. So, also, did teams of horses and men fruitlessly endeavouring to pull apart the component sides of his exhausted globes.

It was from Guericke's experiments that Robert Boyle, of England, took his cue, and from the worthy Burgomaster, too, the earliest of the steam-engine experimenters derived their inspiration.

Von Guericke, it would seem, never clearly grasped the fact that just as air could be dealt with like water in many of its properties, so, also, could steam be treated like air in regard to its essential thermal expansibility. Had he had any inkling of these fundamentals, one may depend upon it that the Burgomaster would have turned them to something spectacular.

His Death

In 1681, von Guericke, having held the office of Burgomaster of Magdeburg for some thirty-five years, resigned it and went to live with his son at Hamburg, in which city he died in 1686, at the age of 84.

Otto von Guericke was one of the world's earliest practical experimenters and mechanical constructors. As we have already recorded, his work gave inspiration to many, and it still forms a perennial source of interest to those who have the leisure to devote to his strange and curious writings.

In 1672, a decade before his retirement from active work, Guericke published his curious and entirely fascinating book, from whose illustrations the pictures accompanying this article are chosen. The book is entitled "Experimenta nova Magdeburgica de Vacuo Spatio." The work is excessively rare, but it is still to be come across in some public libraries, and it is well worthy of examination if only in view of its more than ordinarily interesting illustrations.

Modern Detonators and Their Action

Explosives Have Their Peace Time Uses Equally as well as Their War Time Applications

MOST of us are apt to connect the idea of explosives with that of modern scientific warfare. Whilst it is only too true that no country could possibly hope to successfully engage in war without an adequate supply of efficient explosives, it is also equally true that very few modern industrial nations could make normal progress in times of peace without the aid of high-power explosives for the winning of minerals and for other industrial purposes.

Explosives, therefore, have their peace-time uses equally as well as their war-time applications, nowhere more than in the sphere of blasting and explosive agents has applied chemistry made more spectacular strides during, say, the last half-century.

Curiously enough, the explosives which are employed in modern times are by no means the most powerful blasting agents known. Nitrogen chloride is a material which is very readily made and which is far more powerful in its blasting effects than ordinary dynamite or picric acid. But substances such as nitrogen chloride are far too sensitive to be of any commercial application at all. Sometimes, indeed, they explode almost spontaneously, say under the extremely slight shock caused by a speck of dirt falling into them, or by their undergoing a sudden rise in temperature. Obviously, therefore, such explosive agents, efficient though they may be, are far too sensitive for any ordinary purposes and hence their powerful properties must perforce remain unutilised.

A rock face showing holes drilled ready for the insertion of detonators

Fairly Stable

The one common characteristic of commercial explosives the world over is that, under normal circumstances, they remain fairly stable substances which only release their main disruptive effects when compelled to do so by the action of an initiating compound which we call a detonating substance or, more briefly, a "detonator."

A detonator has been aptly compared to a key or a trigger mechanism which serves to release the energy of a high explosive. All that the detonating substance does is to give a short, sharp shock to the explosive material, whereupon the latter, unable to resist the powerful although strictly localised influence of the detonator immediately releases its contained energy, thereby giving rise to the powerful explosion which is characteristic of it.

Exactly how the detonator exerts its action upon the relatively stable explosive is even nowadays not known with any certainty. Some chemists consider that the detonating effect is simply due to the vibrational shock or "lines of force" which it creates in or around the explosive proper. Others explain the detonator's action by attributing it to the heat-produced by the localised gas-compression which it creates in the explosive material, whilst still other scientists consider that the actual sudden heat generated by the detonator suffices to set the atoms of the explosive proper into disruptive decomposition. No matter, however, upon what precise principle the detonator acts, there is no gainsaying the fact that if it were not for the small number of comparatively stable detonating materials, modern explosives could not be so extensively used, or, at the least, would only be able to be employed with great danger to the users.

The very first detonating material used for releasing the energy of high explosives was mercury fulminate which was first introduced in 1867 by Alfred Nobel, and which, until very recent times, has been practically the only detonating material in common use.

Lead Azide

Owing, however, to the fact that supplies of mercury are not always obtainable in time of war, several countries (particularly Germany) have striven to discover a satisfactory substitute for this fulminate of mercury. Such a substitute has been forthcoming in recent years in the form of a salt of lead—lead azide. It was found, however, that lead azide was not quite so easily ignited by a flame as was mercury fulminate. To meet this difficulty, a material known as "lead styphnate" (which is the lead salt of trinitroresorcinol) has been employed mixed with lead azide, and this admixture, it is found, will generally ignite with the extreme ease of mercury fulminate.

Silver azide is another newly-introduced detonating substance. So, also, is (particularly in America) a synthetic material known (at present) by its severely chemical name of "dinitrodiazophenol," which is a derivative of ordinary phenol or carbolic acid.

Now all these detonating substances give rise to a short violent explosion (or "detonation," as it is called) when either they are struck sharply (as in the case of the firing pin of a rifle) or when they are suddenly heated or caused to come into contact with flame.

Whilst, as in the instance of an ordinary rifle or gun cartridge, we can so arrange matters that the impact of the rifle's trigger hammer causes a small amount of mercury fulminate contained in the percussion cap of the cartridge to set the cordite within the cartridge into the state of explosion and so eject the bullet, it is quite impossible to bring about this mechanical detonation in the case of a blasting cartridge or a high-powered military explosive.

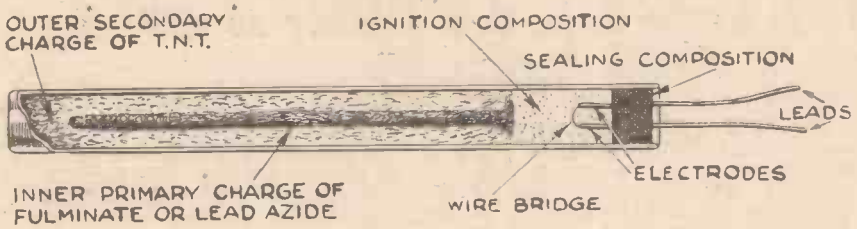
In all such instances, resource is had to the heating of a material (known as the "ignition composition") which is placed above the detonating material in the explosive cartridge or shell. This being done either electrically or by means of an ordinary slow-burning fuse.

Two Main Classes

Detonating devices nowadays can be divided into two main classes, viz. "plain" detonators and "electric" detonators.

The ordinary detonator as used for inserting into the blasting cartridges used in mining and quarrying operations consists

merely of a tube made of thin drawn aluminium or copper and sealed at one end. The detonating substance (mercury fulminate or lead azide or a special compound of these or other materials) is carefully packed by mechanical means into the bottom of the tube and above this is placed a little of the "ignition composition" which is merely a material which ignites at a relatively low temperature. Copper acetylide usually fulfils this role of "ignition composition," although, nowadays, it has its competitors, like everything else.



Showing the make-up of the modern "electric" detonator used in wiring and other operations

The slow-burning fuse which consists of a thin tube of some flexible material (e.g., gutta percha) containing slow-burning gunpowder is inserted into the upper end of the detonator tube above the ignition composition and is held securely and tightly in position therein by the simple "crimping" or "nicking" of the upper end of the tube.

The detonator to which the fuse is attached is simply inserted into the primer cartridge which is placed in the bore holes, further sticks of explosive are also placed in position after the primer, the hole is stemmed, and the fuse lit. The resultant spark travels up the fuse, fires the ignition composition which detonates the mercury fulminate or other compound. The latter, of course, initiates the explosive reaction of the main charge.

In "electric" detonators, the principle of construction is not dissimilar from that of the plain detonator, with the exception that the slow burning fuse is omitted, its place being taken by a length of twin wire connected to a battery and switch at one end and terminating within the detonator in a very fine length of wire bridging two electrodes and itself surrounded by the copper acetylide or other ignition composition.

Electric Detonators

With such electric detonators, the completion of the electrical circuit by means of the external switch arm or switch button causes the fine wire within the detonator to glow. This at once inflames the ignition composition, which sets the mercury fulminate or lead azide into detonation, thus initiating the action of the main explosive.

Frequently, however, more complicated types of detonators than the above are employed, it being found that if the detonating charge of the detonator is divided up into a "priming" charge and a more powerful "secondary" charge it is possible to set relatively very large masses of high-powered explosive into action with only a single detonator.

Such detonators, therefore, contain: (*a*) the "ignition composition" of copper acetylide or some other material; (*b*) the "priming" charge consisting of mercury fulminate, lead azide or mixture of these two and/or other materials; (*c*) a "secondary" charge which may comprise a small localised charge of T.N.T. (trinitrotoluol) or "Tetryl" (trinitrophenylnitroamine).

Shells, bombs, mines, etc., which explode on percussion simply have a nose cap containing mercuric fulminate or other detonating substance. This, exploding upon percussion or friction, usually sets into action a "secondary" charge of T.N.T. or Tetryl, which latter brings about the explosion of the main charge.

Thus, the explosion is brought about, not all at once, but in a series of steps, namely, sudden combustion setting up a detonation, the detonation creating a small localised explosion and the latter bringing about the enormous release of energy which results from the explosion of the main charge.

Although the ordinary type of detonator has the decided advantage of simplicity and robustness, such as serves well the purpose of ordinary rock blasting, it is now being out-numbered, even for peaceful and commercial uses, by the electric detonator, whose detonation is consequent merely upon the completion of an electrical circuit.

Coal Mines

In coal mining especially the electric detonator is useful, since in fiery mines, the ordinary detonator used in conjunction with fuse which has to be lighted with an open flame cannot be used. In recent years, too, a special form of "permitted" electric detonator for coal mines has been devised. This contains as the sealing-off composition a special variety of non-inflammable chlornaphthalene wax, which, when the detonator and cartridge is shattered by the force of the explosion, does not take fire in the manner in which the former sulphur compositions did and so give rise to the risk of the burning sulphur igniting any inflammable gases present in the colliery workings.

Efforts at the improvement of the detonator and at the devising of new detonating materials are going on in all countries. Waterproof, gas-proof, non-inflammable and many other types of detonators have been produced for specialised commercial (to say nothing of military) purposes, but the ideal all-round detonating device has yet to be found.

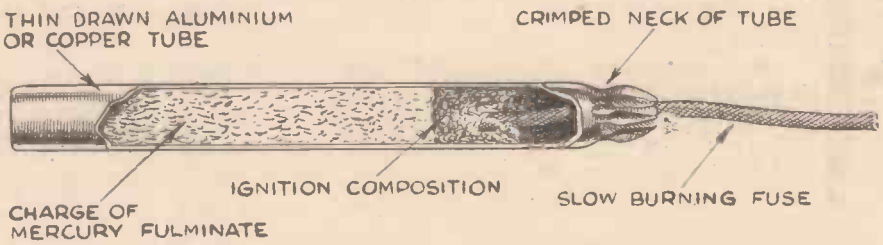


Diagram showing a simple form of "plain" detonator used for exploding rock blasting charges

IRRIGATING THE STEPPES

New Canal and Dams to be Built

IN order to irrigate the steppes of Stavropol a 31 miles long canal is being built. In spite of the fact that the abundant waters of the Kuban River flow through these rich and fertile steppes, there has always been a shortage of water there. A 410 ft. ferro-concrete dam is being built across the Kuban. Before starting this, an earthen dam was constructed across the narrow part of the river to direct the Kuban waters leftward into a new channel. When the ferro-concrete dam has been completed, the waters of the Kuban will again be directed through their old channel, yielding at least two-thirds of their volume to the canal. Another dam, half a mile long, will be constructed along the left bank, to prevent the river from turning aside. The canal will run through a tunnel in the Nedremennays mountain. This tunnel, which will be the biggest in the Soviet Union, will be four miles long, 17½ ft. high and 16 ft. wide. It will allow for the passage of 962 million gallons of water daily.

The new canal will irrigate 23,000 acres of land cultivated by the collective farms on the banks of the Egorlyk River, and 2½ million acres of land in the Manych hollow. When the first section of the new system is in operation it will irrigate 111,000 acres of land in the Orjonikidze region; over 44,500 acres in the Rostov Province; 50,000 acres in Kalmykia and more than 17,300 acres in the Krasnodar Region. The waters of the canal will also be used for the production of electricity. Two hydro-electric power stations are to be built. These will be able to supply cheap power to the industries of Voroshilovsk, Nevinnomyssk, and Armavir. Four more power stations are to be built later. It is expected that the Nevinnomyssk Canal will be completed by the end of 1941.

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Mechanical Salesman

IT goes without saying that efficient salesmanship requires a considerable amount of talking. This can now be done mechanically, if a talking projector equals what is claimed for it. The machine is light in weight and easily carried in a compact case. Films are exhibited on a screen illustrating the article for sale and a recorded persuasive description of the goods accompanies the show. The projector is electrically operated. It may enable even a dumb salesman to take orders.

THE MONTH OF SCIENCE

Dr. R. Goranson, of Washington, D.C., with his "cascade bomb" with which he has created a pressure of 3,000,000 lb. per sq. in., claimed to be the greatest pressure ever to be created by machine. This feat was accomplished at the Geophysical Laboratories of the Carnegie Institute.

The Bofors Gun

THE Bofors gun is designed to combat low-flying enemy bombing attacks. The gun is very easily transported and has considerable manœuvrability. The fire power is heavy and accurate. It is small compared with the 3.7 and 4.5 anti-aircraft guns, which are most effective against high-flying aircraft. A stream of small high-explosive shells are fired from it, each one capable of doing serious damage to an aeroplane. In order to keep a high-speed, low-flying bomber in focus the sights in the gun are made very large. The gun can be transported quickly over rough ground, and runs on four heavy-duty balloon tyres.

New Farm Implements

A DEMONSTRATION was recently carried out at the Ford Motor Company's farm near London with some new types of farm implements for use attached to Ford tractors. The devices were invented by Mr. H. Ferguson, an Englishman, and are known as the "Ferguson system." The system consists of the attachment of farm machines such as the plough, cultivator, and harrow, to a tractor by a simple arrangement of bolts, and in such a way that implement and tractor form a single operating unit. Apart from reduction of costs, an important advantage of the new mechanical arrangement is that the attached plough or cultivator can be lifted over an obstruction such as a large boulder by a finger movement which the farmer performs whilst remaining seated on the tractor. The idea is to replace horse with tractor equipment which could be used economically even on small farms.

Parachute Troops

IT would appear that the German method of landing troops by means of parachutes is a technique that has been carefully developed. It is thought that Germany has four main parachute schools and that a standardised method is used by the men for their operational descents. One of the chief difficulties with a parachute descent is to land at a predetermined spot. Wind strength has to be gauged, and if a mistake is made the parachutist will land a considerable way from where he intended. The German usually jumps from a height of 3,000 ft., but they have jumped from as low as 600 ft., which is about the practical limit. It is possible to "steer" the parachute to a certain extent by pulling on the shrouds. In this way the parachutist can spill the air from one side of the parachute so that it will side-slip in the required direction. With the ordinary type of emergency parachute, the parachutist alights on the ground with an impact similar to jumping from an 18 ft. wall, but the German troops, with their heavy loads of ammunition and equipment, use a larger canopy and therefore fall more slowly.

New Piston Ring Alloy

A NEW silico-aluminium suitable for piston rings has been perfected in America. Age-hardening constituents are included in its analysis and its use has led to a considerable improvement of piston performance.

A Big Engineering Feat

THE engineers of the London Transport have recently completed one of the largest and most difficult tasks they have ever undertaken. This is the modernisation of the Central Line which they started 3½ years ago. The chief difficulty was that the work had to be done outside traffic hours and therefore the engineers could only work 3½ hours a night. The work necessitated the replacing of 10 miles of track, and to do this they had to break up 20,000 tons of concrete, remove 1,500 tons of old rail and 20 miles of longitudinal sleepers. They then had to instal 1,500 tons of new rail and 27,000 new sleepers.

Air Minefields

ENEMY raiders may soon have the unhappy experience of running into a minefield whilst in the air, as we learn that an effective method of "sowing" the mines in the sky has now been devised. Inventors are always thinking up some ingenious weapon or counter-weapon to win the war and some of the latest discoveries being developed by Britain's scientific headquarters are: "unsinkable" battleships; bombs which can be controlled by radio to explode at a given signal; anti-aircraft rockets; heavy guns that can be fired by remote control and submarine tanks which may roll out of the sea on to an enemy shore.

"Flying Dark-rooms"

ONE of the latest war planes which will soon be available to the Allies is a machine designed for rapid reconnaissance work known as a "flying dark-room." The extensive equipment of these machines enable photographers not only to take pictures from the air but to develop and make prints from the negatives whilst the aeroplane is still in the air. Only four minutes elapse from the click of the camera to the production of a well-processed print. Another advantage of these flying studios is that the prints can be sealed in tubes and dropped direct to given objectives. Thus, photographs can be delivered without the pilot having to land for the purpose.

A New Bridge

THE bridge spanning the river Periyar at Alwaye is now nearing completion, and when it is finished it will have the longest span in South India. It is claimed that it will also be the widest bridge in Travancore.

Surface-Hardening Metals

AN interesting development in the metallurgical world is a small device, invented in Russia, for surface-hardening metals. It uses a gas pressure of 10 cm. of water, and by its means steels and non-ferrous metals can be given treatments corresponding to nitriding, carbonising, cyaniding and bright annealing. The invention comprises all the equipment necessary to give the requisite gas mixtures.

New Sparking Plug

AN American tyre and rubber company has developed a new sparking plug in which polonium is used. Polonium is a rare element which costs about £400,000 an ounce. It is stated that polonium is so full of energy, that its equivalent of one gallon of petrol would drive a car 1,000,000 miles, if it could be properly harnessed. Some of this energy applied to the air inside a sparking plug maintains the air in constant readiness

for an electric spark. The ignition system works, with the first turn of the engine, as though the engine had been previously running for some time.

Coalless Steelworks

THE president of the Iron and Steel Institute, Mr. J. Craig, says that in time we shall have a coalless steelworks. He stated that there is a superabundance of water power in Scotland which could be used to develop the electric blast furnace. Raw fuel has been practically eliminated from the steelworks, and coke-oven and blast furnace gas was now being used to melt the steel and to raise steam to produce sufficient electricity for all the plant required to finish the steel ready for the market. He went on to say that he believed that the abolition of raw coal even for the steam locomotive was in sight, as there appeared to be no reason why it should not be fired with compressed coke-oven gas.

IN THE WORLD OF INVENTION

Steam-Driven Planes

THE La Mont boiler is a controlled circulation steam generator which was invented some years ago by an American engineer, Walter Douglas La Mont. It is extremely compact in design and uses nearly 50 per cent. less material than other high-pressure steam generators. It could thus be used for steam-driven aircraft. The La Mont Steam Generator, Ltd., introduced the La Mont boiler into this country about four years ago, and more than forty boilers of this type are now at work in England. The London Power Company have one of these boilers, evaporating 350,000 lb. of water per hour, at work in their Deptford Power Station.

Hemp and Resin Bicycle

A BICYCLE has been made at Allessandria, Piedmont, from hemp and resin. It weighs about 30 pounds and can carry a weight up to 240 pounds and hemp and resin were used for practically every part of it. The experiment has proved so successful that the Italians are considering making other mechanical equipment from these strange materials. But if little Willie wants to start making himself a bicycle from string and glue he must be gently but firmly told that it will not work.

Flying Searchlights

THE German Air Force have been experimenting with searchlights for aeroplanes, the idea being to illuminate a bombing area to assist aiming. It has also been suggested that a fighter fitted with a small searchlight would be able to locate the enemy in the dark and then attack it. The obvious objection to this would be that the plane fitted with the searchlight would also be exposed to attack, but no doubt the beam would dazzle the enemy's gunner. It will be remembered that the Germans have for some time been experimenting with coloured searchlights which are supposed to penetrate clouds more easily than the ordinary white light, but so far they have not proved very successful.

New Bombing Invention

IT is learned that William P. Lear, an American radio engineer has perfected a device to enable mass bombing raids to be carried out in weather conditions which screen the bombing planes from enemy pursuit pilots and anti-aircraft fire. Mr. Lear who is an internationally-known inventor, demonstrated his invention before Allied military experts. The device consists of a radio set having a dial fitted with a pointer which indicates from which direction radio signals are received, and a second indicator which is "tied" to the North Pole. A miniature gyroscope is fastened to the second indicator, and this indicator keeps pointing in the same direction regardless of any turns an aeroplane may make. Thus, provided the pilot of a bomber knows his direction and distance from a target, all he needs to do is fly a given length of time at a known speed and signal his crew to release bombs when his watch indicates that he has arrived. The test flight was extremely successful.

Banana Meal

A CUBAN plantation manager has perfected a new process for manufacturing meal from bananas. This meal may be combined with flour for making bread. The Cuban Minister of Agriculture estimates that enough meal could be produced by this new process to establish an export market.

New American Plane Engine

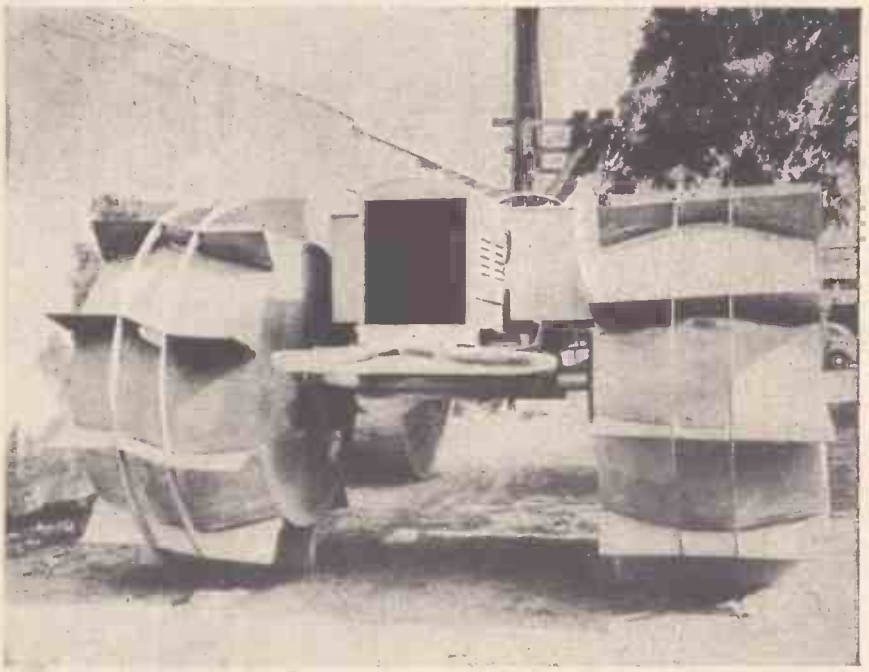
DELEGATES of the American Society of Mechanical Engineers in New York, have been given details of a new fighter plane engine. This giant engine is estimated to be capable of attaining speeds of 400 miles an hour. It is described as a "new high-powered, liquid-cooled engine with 42 cylinders."

Pipe Smokers' Thermometer

THE claims that tobacco manufacturers make about the coolness of their blends can now be put to the test by pipe smokers. A new type of pipe is fitted with a midget thermometer on the side of the bowl. It can be seen while the pipe is being smoked.

Electrically-driven Tugs

THE Central Institute of Research in River Transport in the Soviet Union have recently been carrying out experiments on the Ladoga Canal with the idea of propelling canal tugs by electricity. It was proved by experiment that wires stretched along the bank of the canal could supply the current to drive the tugs. A special contact wagon which feeds power by cable to the tugs, has been designed by E. Yanovskaya, a woman engineer employed at the Institute. As the boat moves along the wagon slides along on wires. The usual method of propulsion for tugs is steam or diesel engines, but the fitting of electric motors will mean a considerable reduction in the cost of the vessels, as well as lower overhauling and repair costs. Moreover, steam power costs twice as much as the cost of electric traction.



All steel, even to the tyres, this "Marsh Buggy," constructed by the Stanolind Oil and Gas Company in their Dallas shops, is the latest thing for transportation and exploration in swamps or marshy sections. The buggy will travel on dry land, water, or a mixture of both. The buggy itself weighs 10,000 pounds and will carry a 6,000-pound load. It is 21 feet long and 15 feet wide overall. The wheels are huge, arc-welded steel drums, water-tight and buoyant.

We are indebted to the Postmaster-General for the information and illustrations contained in this article

The Teleprinter—How It Works

—PART 2

(*Concluded from page 404 of Last Month's Issue*)

A front view of the teleprinter from the left-hand side

Receiving and Selecting

The electro-magnet is fitted at the right-hand side of the machine as shown in the above illustration. The unit consists of a powerful permanent magnet having laminated pole-pieces, which are shaped so that they practically enclose the operating coils and the armature. The armature, also constructed of laminated soft iron, is pivoted at its centre, and is capable of small lateral movement between the pole-pieces.

The Electro-magnet Link couples the armature to a lever on the trip shaft and also engages the starter-trip lever. The movement of the armature in response to incoming signals causes the link to turn the trip shaft into one of two positions corresponding with the received signals.

The trip shaft, which is shown in Fig. 7, moves under the control of the electro-magnet armature in response to the incoming "marking" and "spacing" signals to either of two positions. This shaft carries two levers near one end and by means of one of them it is coupled to the electro-magnet link. Through the other lever it is connected to the receiving cam pawl abutment link. Two functions are performed by the trip shaft : (*a*) To control the rotation of the receiving cam, by engagement and disengagement of the pawls through the action of the receiving cam pawl abutment; (*b*) To guide the finger-setting blade, so that the correct selection is made on the comb setting fingers in accordance with the incoming signals.

In Fig. 7, T1, T2, T3, T4, and T5 are the receiving cam tracks. T1 has five indentations which actuate the finger setting lever, which carries the finger setting blade. T2 has only one indentation into which the type-hammer lever rides and causes the hammer to strike the selected type. T3 has a double bend in it which gives the traversing lever a reciprocating movement. T4 has one indentation which actuates the bellcrank lifting lever. The one indentation in T5 actuates the comb setting lever, to which the selecting fingers are linked.

There are five receiving combs which can be seen in Fig. 7. Their purpose is to select the required bellcrank, or latch, which will cause the type corresponding to the incoming signal to be printed. They are mounted on a stationary cylinder, known as the combination-head body, through the centre of which passes the typehead spindle. The receiving combs are free to turn slightly about the cylinder, and are retained in position by metal collars. Indentations are cut into the periphery of each of the receiving combs. They are so arranged that, for every position into which the combs are moved by the comb-setting fingers, a space is provided beneath one pair of adjacent bellcranks. One of the bellcranks of each pair to a "letter" character and the other to a "figure" character.

Turning again to Fig. 7, the bellcrank lifting lever will be seen. During its movement inwards toward the combination head, it lifts the bellcranks, or latches, from

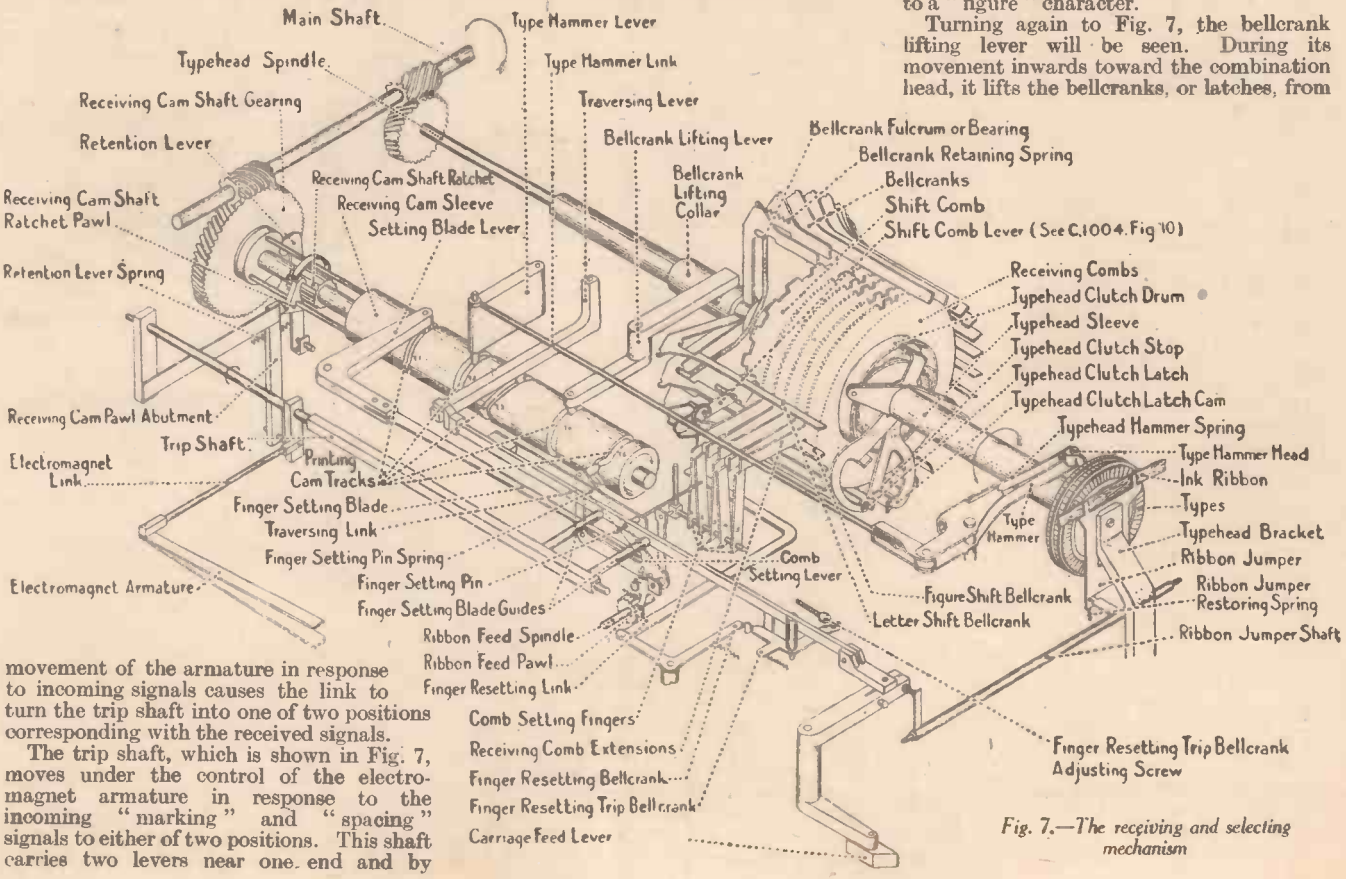


Fig. 7.—The receiving and selecting mechanism

the edges of the receiving combs. The bell-crank employed for the previously printed character is withdrawn from engagement with the typehead clutch, which commences to rotate again. The receiving combs are restored to their normal position by restoring springs. When the receiving combs are reset for a new character, by the selecting fingers pressing upwards on the receiving comb extensions, the bellcrank lifting collar moves outwards, allowing the bellcrank for a new character to be drawn into the longitudinal slot prepared for it by the alignment of the receiving combs.

The Printing Mechanism

The type hammer is actuated by the Hammer Lever through the action of the Hammer Link, and is held in its normal position by a spring. In order to avoid the possibility of damage to the type pads due to the hammer being actuated during the time in which the typehead is rotating, the type hammer is pivotally mounted.

As previously mentioned, the ink ribbon mechanism used is similar to that of a typewriter. The ribbon is lowered after the printing movement, so that each line of printed characters is visible to the operator. The ribbon is accommodated on two small drums.

If it is desired to change from page printing to tape printing, the teleprinter can be readily adapted for this purpose. The platen is a rubber-covered metal roller over which the paper is passed during the printing operation. A rotary motion is imparted to it by means of the pawl acting on a ratchet attached to the platen spindle which passes through its centre.

The carriage is normally returned mechanically by the action of the carriage return mechanism. It can, however, be returned manually by means of the carriage return key fitted at the left-hand of the unit.

When the "carriage-return" signal is received, the Carriage Return Control Lever acting on the Carriage Return Dog, raises it into engagement with the clutch cross-head. The Pawl Throw-out Lever is pivoted near its upper end and its lower end engages with a pin, fixed on the carriage release link. As the clutch cross-head moves to the right, the bottom end of the throw-out lever is deflected, and the upper end depresses the Feed and Retention pawls, disengaging them from the carriage spring drum. This permits the carriage spring drum to rotate and return the paper carriage to the right for the next line of printing. A shock absorber is fitted to minimise the shock of impact as the carriage is returned.

Automatic Start-Stop Switch

When the "start" signal, which is in the "spacing" direction is received, the armature of the electro-magnet is moved and the spindle, which is free to move longitudinally, is thrust by the starter trip lever against the tension of the thrust spring. This withdraws a weight-lifting pin from the worm wheel and the weight is allowed to drop forcibly on the switch operating lever.

The "Answer Back" Unit

In order to enable the calling operator to verify his connection with the "called" operator an "Answer Back" unit is fitted. The advantage of this unit lies in the fact that if the circuit at the distant end is unattended, messages can be transmitted with the certainty that they are being sent to the correct subscriber.

The unit is brought into operation by depressing the key, at the transmitting end, which is labelled. "Who are you?" A drum spindle is mounted at right angles to the comb bars, and in close proximity to their right-hand ends. At the end nearest the comb bar assembly, the drum spindle carries thirteen rows of projections or wards fixed radially, like the spokes of a wheel, and parallel to the axis of the shaft. The purpose of these is to engage with certain of the comb bars. Each row of wards is arranged to represent one of the signal combinations to be transmitted when the unit is brought into action.

The driving gear wheel is driven continuously through worm gear while the motor is running, and engages with a friction clutch. The drum spindle is prevented from revolving by the detent which is normally held in engagement with a notch in the drum spindle by the detent restoring spring.

When a "Who are you?" signal is received, the relative bellcrank or latch on the combination head is drawn inwards toward the centre of it, and the "Answer Back" release shaft follows up the movement of the bellcrank. The detent is withdrawn by the pull of the release shaft restoring spring from the notch in the "Answer Back" drum spindle which thereupon begins to rotate.

The comb bars instead of being pre-set by the depression of keys as in normal transmission, are controlled by the combination predetermined by the position of the projections or wards on the "Answer Back" unit drum spindle.

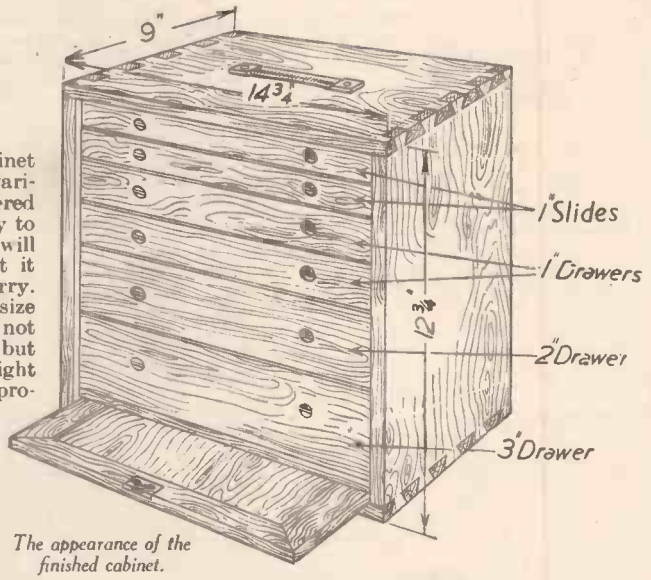
Making A Tool Cabinet

A Portable Tool Cabinet for Engineers

THE basis of all cabinets is the body, consisting of back and front, top, bottom and two sides. The sides, top and bottom are dovetailed together, and care should be taken to arrange that the dovetail pins are on the top member for otherwise the box will pull apart when lifted by the handle. Dovetails should be plain, cut at a bevel of 1 in 6 or 7, with a half-dovetail, which should be the full width of a dovetail at each end. The sharp edges of the joints should be rounded off to a radius of ⅛ in. at least.

Size of Body

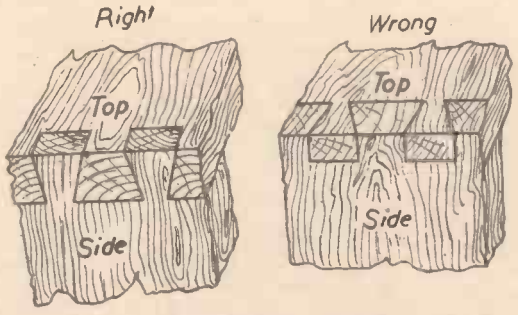
The size of the body will depend on the tools it has to contain, but minimum width is 14¾ in. With ⅝ in. for thickness of sides and ¼ in. for thickness of drawer sides, this allows full-length drawers which will just accommodate an engineer's foot-rule, and are amply wide enough to take a 12 in. protractor set, a 10 in. slide rule (in case) and a 10 in. vernier; which are usually the longest tools in the craftsman's kit. However, a 12 in. vernier calipers or height-gauge will necessitate drawers of 15¾ in. internal diameter, and sides of ¾ in. stuff. It may be better to make separate cases for the longer instruments than to increase the size of the cabinet, unless fewer drawers and a body of 1 in. stuff are provided, when a longer, but lower cabinet will result. This latter variation must be remembered because it is all too easy to make a cabinet that will hold so many tools that it will be too heavy to carry. As a general guide, the size of the cabinet should not exceed one cubic foot, but the width, depth and height may be varied, in any proportion within this limit.



The appearance of the finished cabinet.

Number of Drawers

The depth and number of the drawers must next be determined, and, in designing this portion of the cabinet, it is well to decide whether the drawers are to be on runners with a rail between each drawer, or whether the sides are to be grooved for sliders. This latter system allows a greater number of drawers, or drawers of a greater depth to be fitted, since no height is lost by the insertion of a rail and runners beneath each drawer. While this is excellent for shallow drawers, and is the usual practice in tool-cabinet making, there are disadvantages. Drawers so constructed must have sides of ½ in. stuff; and it is usual to plough out grooves in these sides to take the bottom, instead of "slipping" the drawer as in ordinary cabinet-work. This makes a narrower drawer internally, or adds ½ in. to the width of the cabinet. Then the bottom must be of very thin plywood, and this is not always advisable, especially when it is remembered that the deeper drawers will have to accommodate such heavy tools



The right and wrong method of dovetailing the top and sides.

as a surface gauge, angle-plates, a small surface plate and large parallel cramps.

Fitting a Muntin

If this system is adopted, it would be well to strengthen the bottom by fitting a muntin across the centre of the drawer. What is more, when the sliders wear, the drawer drops, and binds on the one beneath. This fault often affects the sliding front, which is immediately beneath the deepest drawer containing the heaviest tools. With a drawer on runners and a rail, wear does not affect anything beneath and for this reason, all drawers containing heavy tools should be so constructed. So must rows of small drawers, unless they are very shallow, when the division rail may have a slider fixed on each side, and be fastened to the top of the body by screws driven in from the underside.

Size of Drawers

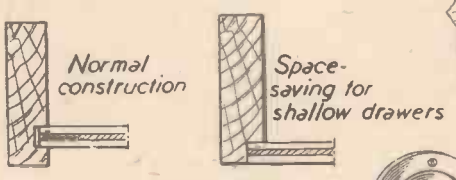
Except for one drawer, which should be 2½ in. or 3 in. deep, to take angle-plates and other larger precision tools, and another 2 in. deep, to take the foot of a height gauge, no drawer need be more than 1 in. deep internally. Indeed, this height can usually be reduced by making slides of 1 in. stuff, recessed out to take such tools as taps, dies (with wrenches and stocks), punches, small chisels, reamers and the like, which form the bulk of the craftsman's kit, and which are all too often shot haphazard into a drawer. So too with drills, which are often kept in utter disorder in tin boxes, when five minutes of "milling up" is always necessary before the required drill can be found. Simple slips of wood, or mild steel, bored to take the drills with the size stamped opposite to each, are great savers of time, and can be hinged on to the sides and front of a drawer, or if preferred, just slipped in. This principle can be carried further, and guides or recesses can be fitted in the drawers for every tool of importance, such as micrometers, verniers, sine-bars, precision squares and straight-edges. They may consist of blocks screwed to the drawer bottoms, or outlines of the tools can be cut in plywood, and similarly fixed. For all such, velvet is better than baize as a covering. By fitting recessed slides, ½ in. of height is saved on every shallow drawer, which may permit another slide to be fitted, or allow for a rail and runners on the bottom drawer, or the deepening of a drawer to allow a shallow sliding tray to be fitted therein.

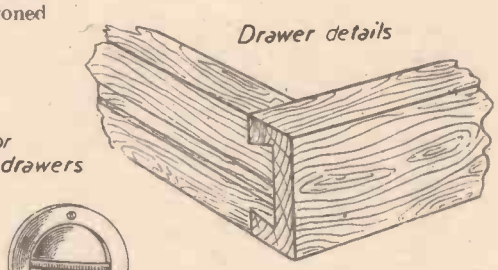
Back and Front

Finally, there is the back and the front. To save weight, they are usually framed up out of 1 in. x 1½ in. stuff with a plywood panel. The back can be screwed or buttoned into place from the inside, when the drawers and stops have been fitted : it being necessary to remove the drawers in order to insert the screws. The front is fitted with pine hinges working in grooves in the sides or, better still, in brass guides let into the sides. If desired, a solid back and front may be fitted, when the thickness can be somewhat reduced. The edges must be clamped or mitre-clamped, and the inner surface of the front worked down with a router, or rebate-plane, or its edges may be merely lipped to take the baize covering, remembering that it is necessary to plough shallow grooves about 1 in. or so in from the edges that are not clamped, before commencing to clean out the sinking. There are times, however, when a detachable front is of considerable use as a safe surface for precision tools or slip-gauges—especially if one is working away from the bench at a large surface-table or on a machine. This end can be achieved by fitting small flush-bolts as shown in the sketch instead of pin hinges. When shot, the bolts act as hinges, and when withdrawn, the front can be lifted out without any hindrance, thus making it sliding, or detachable, at will.

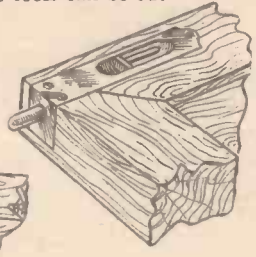
Depth of Drawers

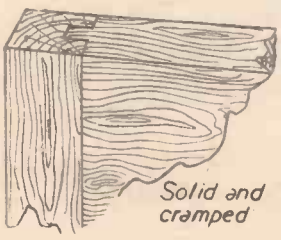
Before concluding, the depth of the drawers from back to front deserves some notice. Interiorally, it should not be less than 6½ in., preferably an inch or even two more, otherwise squares, large calipers and dividers may have to go in askew, or lengthways, and thus waste some valuable space. To this must be added ⅝ in. for the thickness of the drawer front, ¼ in. for the thickness of the drawer back, another ¼ in. as clearance between the drawer and the back of the cabinet, which latter will account for another ½ in. to ¾ in., making a minimum total of 8⅛ in. for the overall depth of the cabinet, excluding the thickness of the front and the allowance for the drawer handles, which brings the grand total to something in the neighbourhood of 9 in. or 10 in. Flush handles, as shown in the sketch, should now be fitted.

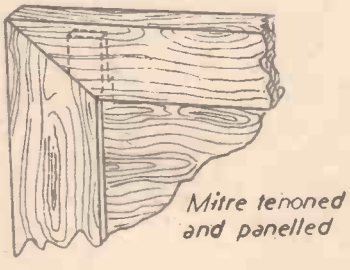




Constructional details of the drawers and handles







Details of the sliding front of the cabinet

The Sun's Energy

ENGLISH and American scientists have at last completed their experiments regarding the mystery of the sun's apparently inexhaustible store of energy, without which life on earth could not exist. A "cosmic phoenix"—carbon for ever being devoured in flames of hydrogen and yet resurrecting itself in its full original state to start the cycle all over again—has been proved to have existence within the sun, and the stars as well.

So great is the amount of atomic energy contained in the sun's hydrogen, that it is held that it will keep the sun radiating for another 12,000,000,000 years.

A Plastic Aeroplane

AFTER Colonel Stromme, of the United States Army Air Corps had witnessed tests of a new plastic plane which had been poured, pressed and baked, he said: "We see demonstrated the possibility that aeroplanes soon may be turned out of moulds swiftly and at comparatively low cost. This may start a new era in mass production of military and commercial aircraft."

The Timm Aircraft Corporation, at Van Nuys, California, have produced the plastic plane which is made of a new material which is 20 per cent. lighter than present plane materials. It is made by saturating and binding thin strips of spruce with liquid plastics. Bolts and rivets are dispensed with as the fuselage parts are simply pressed together.

It is claimed that the plane has higher fuel capacity, can carry heavier loads and has a better performance than other types of plane.

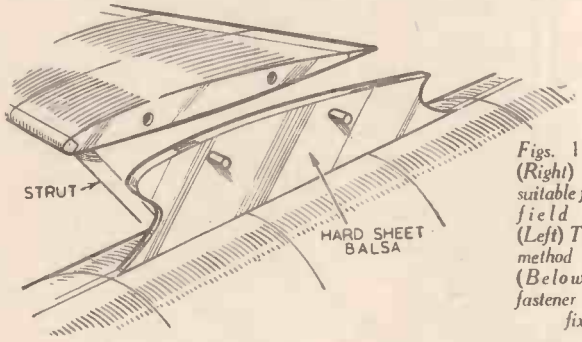
A Sensitive Detector

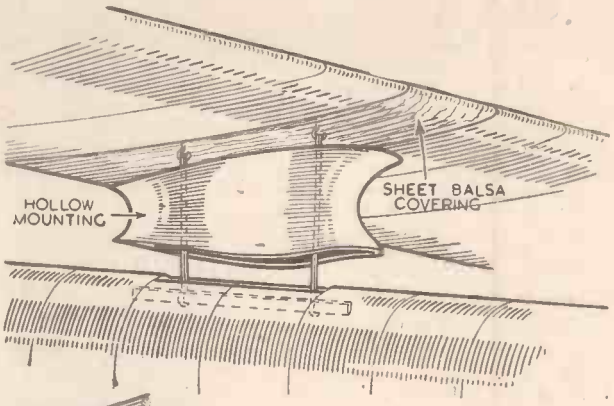
A DETECTOR, so sensitive that it can find approaching aircraft at distances more than fifty miles away and so give defending forces about a quarter of an hour to get ready for them, has been perfected by the United States Army. The device is being kept a secret, but it is understood to use light waves and to be capable of penetrating any degree of darkness or fog. The detectors will cost about £13,750 each.

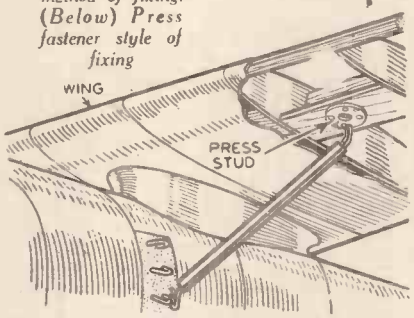
MODEL AERO TOPICS

Wing Fixing Methods

If you have Been Pondering over how to attach the Wings or Tail to your Model you will find a Solution to your Problem in the Methods Described Here







Figs. 1 to 3.—(Right) Fixtures suitable for Wakefield models. (Left) The French method of fixing. (Below) Press fastener style of fixing

ONE of the most important details of model design concerns the wing fixing. In the tuning up stages it is particularly necessary that the wing should be easily adjustable yet reasonably rigidly fixed. It must, moreover, be able to take a wing tip landing without damage. Particularly, is this necessary with a petrol model, and so aero-modellers have been especially ingenious in devising various wing fixing methods which combine these important desiderata.

It has not taken long for us to develop the modern contest model to a fairly high degree of streamlined perfection. We are using circular or elliptical section fuselages of good outline, with spinners and foldir g airscrews, low-resistance undercarts, or

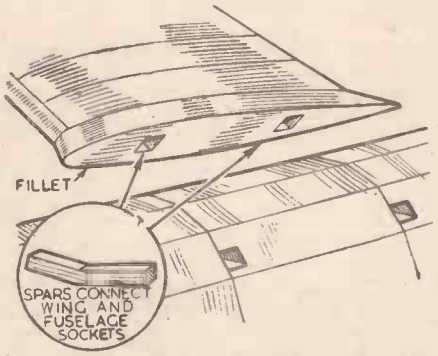


Fig. 4.—A permanent style of wing fixing

even retractable gears, and well-shaped wings and tail surfaces.

The only parts left to improve, it seems, are our structures for holding the various components together. The wing for instance presents rather a problem, when it has to be sufficiently flexible to "give" in a crash and yet to be fixed in such a way as to preserve the streamlining.

The Parasol Wing

Of the streamlined class, the parasol wing model seems to be the most popular, and so we will take this type first. Fig. 1 shows a mounting which has been used on a Wakefield model, and which, it is believed, causes less interference between the wing and the fuselage than any other type.

There are no external fittings, the wing rubbers being enclosed in the mounting itself, yet it allows full flexibility and the wing position is adjustable. The actual seating is made from two balsa blocks, shaped, hollowed out, and glued together. Rubber hooks are attached to the wing spars, and to a hard balsa beam inside the fuselage.

French modellers seem to favour a central fixing, and struts on parasol models. Such a fixing is shown in Fig. 2. It has the advantage of easy construction, and if the model has conventional V-dihedral, this may be adjusted by use of several strut hooks on the fuselage in different positions.

Reed-Cane Struts

Unless reed-cane struts are used, which bend easily under shock, it is suggested that "snap out" connections be used, as shown in Fig. 3. The wing strut hook is made from the "spring" half of a clothing snap (press stud), and is firmly glued and bound to the under surface of the wing. The wire end of the strut, which should be of about 22 s.w.g. is then bent over, so as to form a snap fixing with the press stud.

The fit should be just tight enough, only to come apart when subjected to a sharp knock on the underside of the wing. Should the model on landing "turn turtle" the wings will be exposed to a downward thrust, and the fuselage strut hooks will then disengage.

Fig. 5. — Another style of wing fixing

Some of the best streamlined models produced in this country have been shoulder wing monoplanes, and whilst the construction difficulties surrounding this type are, perhaps, greater than most, the finished product is usually worth the extra work involved.

A Disadvantage

Theoretically, the only aerodynamic disadvantage is that considerable filleting around the wing roof is necessary to ensure a good smooth passage of air around that point. The comparatively low position of the wing should be an advantage, since it places the centre of drag more directly in opposition to the thrust line.

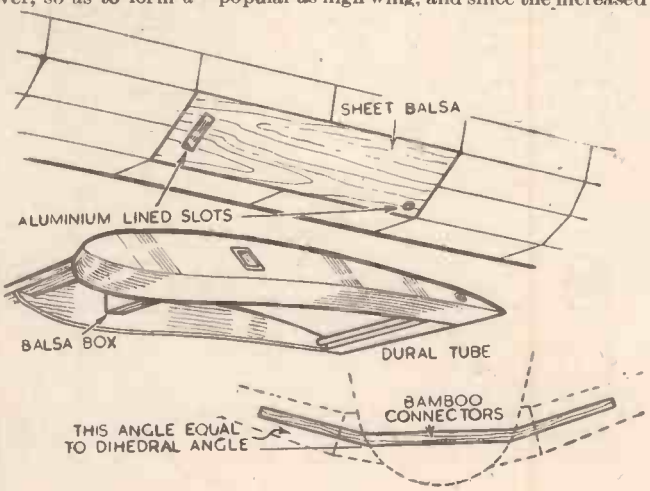
The constructional disadvantages are, of course, that it is difficult to make the wing adjustable and flexible yet preserve the streamlining at the same time.

The best way of getting over this problem is definitely to fix the wing position and angle of incidence whilst the model is in the design stage, and should it be necessary to adjust the centre of gravity when construction is completed, do this by means of a trimming weight.

A fixing along these lines is shown in Fig. 4. The fairings may be cut from soft balsa and hollowed out, being fixed to either the wing root or fuselage. The short connecting spars are also of balsa, so that on a heavy impact they would snap, leaving the wing unharmed.

Low Wing Models

Low wing models have never been so popular as high wing, and since the increased



weight rules for Wakefield models, this type seems to have been even more neglected.

Possibly this is because considerable difficulty is experienced in mounting the wing on a circular or elliptical section fuselage. In Fig. 5 is shown the method of attaching wings which, besides being shock absorbing (each wing-tip will flex 2 in. in an upward direction and can be knocked right out in a head-on collision), the fairings provide good streamlining, and the angle of incidence may be adjusted.

The secret is to keep the bamboo connecting spars as thin as possible, for as well as providing good flexibility these will then break first under heavy stress, and thus prevent more extensive damage.

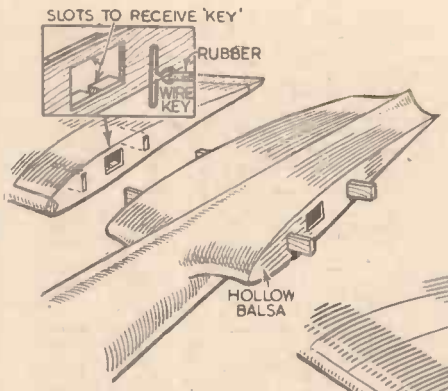
The fuselage slot will allow two or three degrees of adjustment for wing angle of incidence, without becoming exposed. If necessary a short rubber band may be passed across the bottom of the fuselage, and secured with small hooks to the wing roots.

Tail Surfaces

Now we come to the tail surfaces. Some designers prefer to use a detachable tail boom, with the rubber built integrally. This is shown in Fig. 6. The stabliser is mounted on the rudder by a central dowel and tube fixing, and is adjustable by means of a very small nut and bolt at the leading edge.

The whole assembly is easily knocked off in the event of a collision, but during the take-off this is prevented by the tension of the rubber motor.

For those who prefer twin rudders, especially if no tail boom is used, the assembly shown in Fig. 7 will be very good. The fairing blocks are built on to the end of the fuselage, and are hollowed out for



Figs. 6 and 7.—(Right) A detachable tail boom. (Left) Fixing for twin rudders

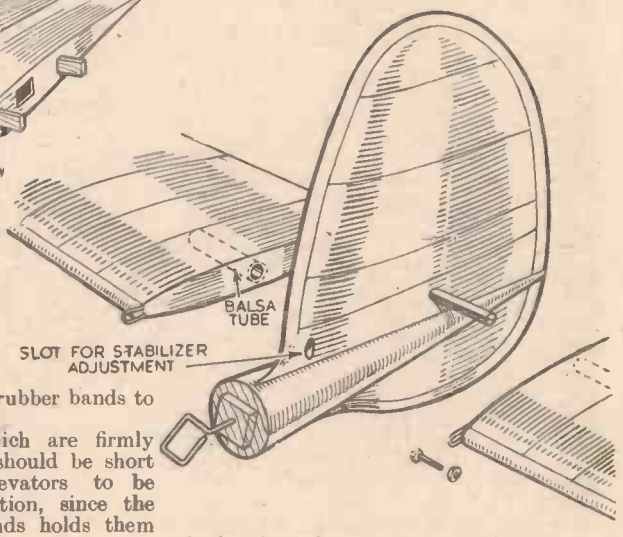
lightness, and to allow the rubber bands to pass through.

The bamboo plugs, which are firmly fixed into the tail block, should be short enough to allow the elevators to be knocked off in any direction, since the tension of the rubber bands holds them rigid during flight.

Twin rudders are best built on to the stabiliser, since this will obviate all chance of them becoming out of adjustment, and thus acting against each other.

Connecting the Elevators

To connect the elevators, the wire "key" with the rubber attached is drawn through the tail block and passed in a horizontal position through the hole in the root tib of the elevator. It is then turned to a vertical position and the tension of the rubber allowed to pull it into the slots and draw



the bamboo plugs into their sockets.

Although this type of tail attachment does not permit adjustment, it is very flexible and lends itself to fine streamlining.

NEW INVENTIONS

Automatic Fire Alarm

A NEW automatic fire alarm signal should act as a faithful sentinel in hotels and factories. It would prove useful also in the homes of the people, especially as it is not very costly. The *modus operandi* of this warning device is literally striking. At a temperature of 160 degrees, fusible material is melted; a pin strikes a percussion cap on a blank cartridge, and this explodes in a combustion chamber. There is a report like the firing of a pistol, which naturally calls immediate attention to the conflagration.

Portable Hat Rack for Ladies

AN American lady has contrived and patented a hat box for travelling purposes. It contains a rack with holders, one above the other, for about half a dozen hats. When the box is being carried, the handle directly supports the rack. In shape the box resembles a vertical cylinder. I imagine it is designed to accommodate the fair owner's repertoire of holiday headgear.

Helmet With Mobile Crown

THE steel helmet continues to variate. Its latest development has appeared in the United States, where a patent has been granted for what is styled an armoured helmet. This is a two-piece head covering comprising a brim and a separate crown. Resilient means connect the brim and crown and normally join them. But the connecting means can be extended, permitting the crown freely to move on the brim, in the event of anything striking it. It is evident that the steel helmet worn by our soldiers, police, air-raid wardens and others is definitely rigid. In the case of being struck by a missile, it does not give but obstinately resists the impact. On the contrary, the resilience of the new armoured helmet qualifies it to modify, like a bumper or spring buffer, the intensity of any violent contact.

Patent Bricks

THE war has put the skid on the wheel of building operations except in those cases where they concern the military situation. Still, I note that more than one current application to the British Patent Office relates to building materials.

Suitable for air-raid shelters, an invention of this kind comprises a number of cast or moulded hollow bricks. These bricks —which can be filled with sand or gravel— have alternating projections and recesses enabling them to fit together, so that no bonding is required.

The inventor of another device has set himself the task of producing a synthetic material for building purposes, which will resist moisture and the deleterious effects of changing atmospheric conditions.

This synthetic material may be used in the making of what are commonly termed artificial stone blocks, jointless floors, partition walls and other structures normally made from concrete, tiles or plaster. The process includes a synthetic resin which is capable of being hardened. And, to lend enchantment to the view, the material may be coloured by the use of aniline dyes or pigments.

BOOKS RECEIVED

"Capstan and Turret Lathes." By E. T. Westbury. Published by Percival Marshall & Co., Ltd. 112 pages. Price 2s. net.

THE object of this handbook is to describe in a practical way the design and uses of capstan and turret lathes as employed in modern engineering works. The subject is treated in a manner calculated to be of direct assistance to the lathe operator, tool-setter, apprentice, or engineering student.

"Pattern Making." By T. Spedding. Published by Percival Marshall & Co., Ltd. 84 pages. Price 1s. 6d. net.

THIS book is intended as an introduction to the skilled craft of pattern making, and contains much useful information for the engineering student and draughtsman. The book, which is well illustrated, should also prove of service in the small general engineering shop and the home workshop.

"Man of Power." By Ivor B. N. Evans. Published by The Scientific Book Club. 288 pages. Price 2s. 6d. to members.

THIS book contains the life story of the great scientist, Lord Rutherford, O.M. Little is known of his work outside his startling discoveries concerning the atom, and the book tells the story of his remarkable achievements, and their value to humanity. The book also reveals the human side of Rutherford, and shows him as a man of simple tastes. It describes his life as a boy, as a student at Cambridge, and as a professor in Montreal, Manchester, London, and, finally, Cambridge again. The author is himself a scientist and was one of Lord Rutherford's greatest admirers.

A Telephone Clock

This clock has been Designed by the Bell Laboratories and is Intended to Symbolise the Importance and Time Measurement in the Engineering and Operation of Telephone Plant

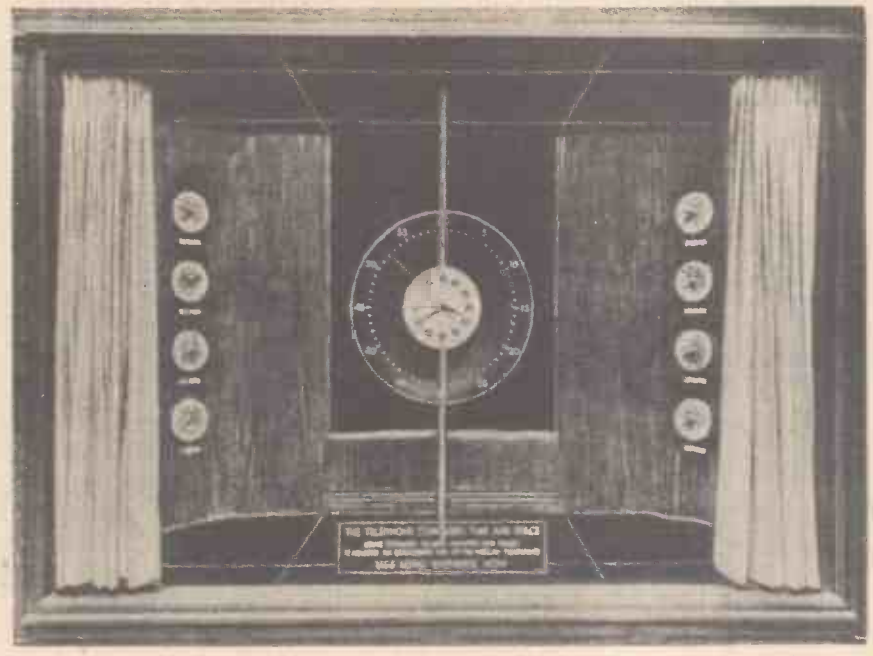


Fig. 1.—The "Telephone Clock" and its eight companion clocks

THE new "Telephone Clock" in one of the Broadway windows of the American Telephone and Telegraph Company headquarters building has aroused considerable interest by its accuracy and striking appearance. Designed by the Bell Laboratories, it is intended to symbolise the importance and time measurement in the engineering and operation of the telephone plant.

The accuracy of the clock is emphasised by a large dial on which the sweep-second hand moves in a graduated circle nearly 3 ft. in diameter. Hour and minute hands move in smaller circles at the centre in order to allow an unobstructed view of the precision dial. Mechanisms for driving the clock from current accurately controlled by the Bell System Frequency Standard, and for synchronising the motion of the hands with signals from the New York Telephone Company's Time Bureau, are mounted compactly in a hemispherical case behind the inner dial. The prineiple of operation is illustrated in the schematic diagram, Fig. 5; only the basic elements are represented, the alarms, power facilities, and some details of the control system being omitted for clarity.

The "Real" Clock

Control of rate originates at the Laboratories, where the primary frequency standard is maintained. Here, in the clockmaker's sense, is the real clock—the element which takes the place of the pendulum in the usual precision clock being a vibrating crystal of quartz, so carefully constructed and so precisely controlled that, when used to measure time directly, it is accurate to less than one-hundredth of a second a day. Precise submaster oscillators, supply sixty-cycle constant-frequency current to the clock and to the New York Telephone Company's Time Bureau. The current is so regulated that synchronous clocks operated continuously from it will deviate less than one-twentieth of a second from Naval Observatory time. The performance is checked frequently and precisely at the Time Bureau by comparison with radio time signals received via Arlington. The sixty-cycle supply is carried over two separate cable pairs following different routes. As long as either circuit is complete the clock will continue to function normally, so that a high degree of reliability is assured. Even if both of these circuits should fail, the clock will continue in operation, because an automatic switch not shown in the diagram will substitute an input from the commercial A.C. power supply, which in New York City is normally adjusted from the same constant-frequency source that supplies the Time Bureau and the clock.

Two Motors

The clock contains two motors. One of these, having two similar windings, is used for the regular drive and is constructed so that sixty-cycle current from both or either supply circuit operates the hands at the normal rate. The other motor also has two windings, so arranged that they will produce forward or reverse rotations respectively; it is geared to the clock mechanism in such a way that while in operation it produces a change in rate of about one per cent. The two motors are geared to the clock through a differential, the reversible one being used for preliminary manual setting and for precise automatic synchronisation.

Fig. 3.—A rear view of the clock showing the cam and sapphire pallets and the two mirrors

Synchronisation of the clock with signals from the Time Bureau is accomplished through the use of contacts operated from a cam mounted rigidly on the same shaft with the second hand. Four times each minute four sapphire pallets drop in close succession from raised portions on this cam. The operation of the first pallet opens a circuit normally closed, and the operation of the second pallet closes a circuit normally open. During a brief interval both of the circuits are open. A short pulse, generated at the beginning of each signal from the Time Bureau, is normally received in the interval between the functioning of these two contacts. But if it should arrive before the first contact has opened, or after the second one has closed, it is directed to a relay which starts the reversible motor in the appropriate direction to restore normal operation. Thus at all times the second hand should indicate the same time as that distributed by the Time Bureau; the departures from synchronism are expected not to exceed one-hundredth or two-hundredths of a second.

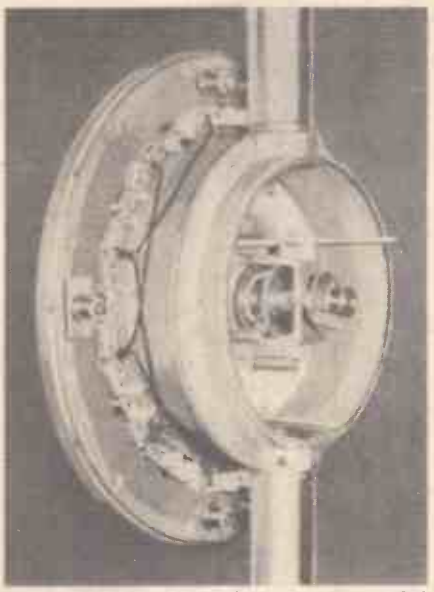


Fig. 2.—Partial assembly of the clock without dial, photographed from the back

Trouble Tracking

Provision is made to call attention to incipient trouble which might in time affect the operation of the clock. One indicator shows whether the power is removed from

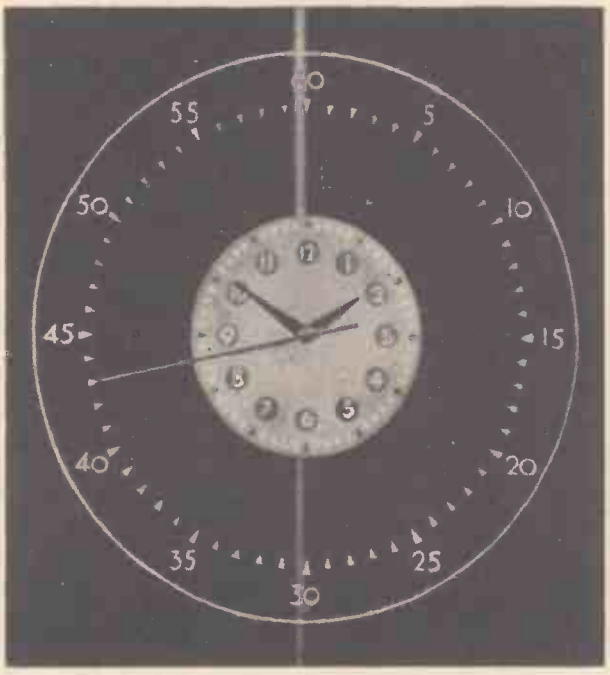


Fig. 4.—A close-up view of the clock shown in Fig. 1

any part of the system. Another calls attention to the omission of synchronising pulses from the Time Bureau in case of circuit failure or any other irregularity. Others operate if the synchronising device is called upon to function more often than is normal, if any part of the standby equipment is called into action, if the voltage of constant-frequency supply falls below normal or if, for any reason whatsoever, the clock should stop.

To ensure continuity of operation, the standby equipment is arranged so that adjustments may be made on any part of the system, exclusive of the clock itself, without affecting the accuracy of the indicated time. Valves can be changed in the amplifiers. the regular power source may fail, or either control circuit may be interrupted, with no more effect than to light a lamp which localises the irregularity and to ring an alarm bell calling attention to it.

The Glass Dial

The mounting of the seventy-pound glass dial was accomplished in an interesting way. A metal ring was made having a diameter somewhat less than that of the inner dial circle, and to it were attached twelve thin-walled steel tubes at positions corresponding exactly to the five-minute markers. These tubes were machined to fit snugly into small holes drilled through the glass behind the markers. As they are somewhat flexible, the weight of the glass is distributed more or less equally among them. The dial is held fast to the metal ring by steel screws which go through the tubes and into the metal five-minute markers. The ring, in turn, is fastened to the main supporting casting by a separate set of screws inserted from the rear.

The dial is illuminated by a set of twelve small lamps supported in holes drilled through the glass behind the metal discs bearing the hour numerals. By the use of special mirrors, not visible from the front, nearly all of the light is directed laterally into the glass so that it does not appear until it strikes surfaces which reflect it in other directions. Thus the engraved graduations and numerals at the outer edge of the glass stand out effectively as though made of self-luminous material. Most of the light not used in illuminating the dial from within escapes from the edge and makes an effective luminous border. The effect of this lighting method is enhanced by the use of crystal-clear optical glass having only a small fraction of the absorption of ordinary plate. Although the chief scientific interest centres on the large clock because of its unique accuracy, considerable attention has been drawn to eight smaller clocks adjusted to indicate the time in various places throughout the world.

These eight clocks are structurally all alike, and all operate from the previously mentioned commercial power supply. They differ only in the setting which permits them to indicate the hour, the day of the week, and if it is morning or afternoon in any selected locality.

Reproduced from the Bell Laboratories Record.

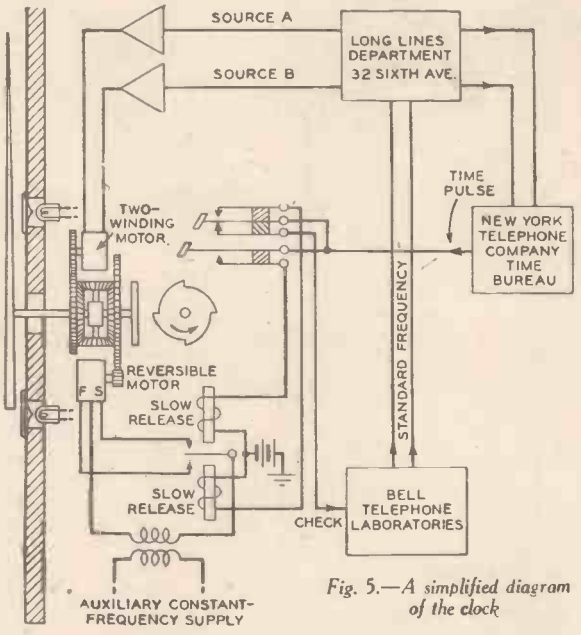


Fig. 5.—A simplified diagram of the clock

Textile Mill Equipment

A Device for Variable Speed Control and a New Shuttleless Loom of the Automatic Type

A YORKSHIRE engineering firm has marketed a new device for variable speed control. It has a simple lever control and an infinitely variable speed ratio of 7½ to 1. The variable speed pulleys operate with standard V ropes and the variation in speed ratio is made by the movement of a lever through an arc. By this means the V ropes running in two sets of interlocking variable speed pulleys are pulled tighter and slackened off respectively, the pulleys automatically adjusting themselves to the changed position of the V ropes.

New Type of Loom

A new model of the shuttleless loom is an automatic type for the weaving of woollen and worsted fabrics. It has the remarkable property of being able to run with any one of a battery of seven different colours or qualities of weft yarn wound on cones. Below these are seven other cones and the ends of the upper row are tied to the beginnings of the lower. When a cone runs out the lower one is moved up to the place vacated and a new cone placed below and tied up as before. Each of the seven weft ends is threaded through a tensioning guide bar and is maintained in position ready for the indication by the pattern chain that that particular colour is required.

The Gripper

The weft is fed half-way across the shed by a light metal arm with a gripper end. This gripper releases the yarn to the grip of another arm operating from the opposite side of the warp and then returns to the operating position again ready for its next pick. The weft is drawn the remaining distance by the receiving arm, after which the pick is beaten up in the ordinary way The selection of colours is by means of a separate pattern chain incorporated in the dobby.

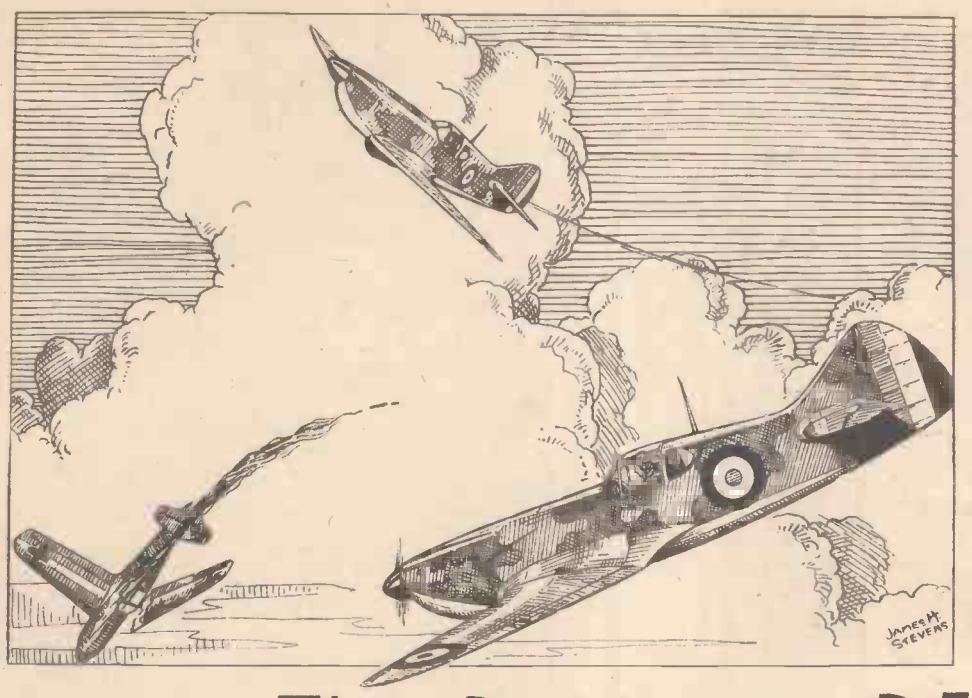
BOOKS RECEIVED

"1,001 Mechanical Facts Made Easy." Edited by Percival Marshall, C.I.M.E. Published by Percival Marshall & Co., Ltd. 108 pages. Price 3s. 6d. net.

THIS handy pocket volume, which is primarily intended for the non-technical reader, contains over 500 paragraphs and numerous illustrations explaining in a very clear manner the basic principles of mechanics and engineering processes. The book is well illustrated with line drawings and half tones.

"How to Work Sheet Metal." By H. J. Dyer. Published by Percival Marshall and Co., Ltd. 142 pages. Price 2s. 6d. net.

THE worker in sheet metal will find much useful information on the tools used and processes employed in general sheet metal work, within the covers of this small volume. The book is divided into 15 chapters, covering amongst other subjects, Metal Used; Hollowing and Blocking; Edging and Seaming; Beading and Swaging Machines; Riveting; Soldering and Tank Construction. Numerous clear-cut illustrations are a feature of the book.



SCALE MODEL AIRCRAFT No. 4.

The Dewoitine D520

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

A Single-Seater Fighter which is the Fastest Machine of this Type in Service with the French Air Force

THIS is the fastest fighter in service with the *Armée de l'Air*, at the time of writing, and the information that it had come into service was only released in April of this year. It is a more recent machine than the familiar and successful Morane 406-C1, as it was designed to a replacement specification for that type and is, naturally, considerably faster. It might be as well to clear up one point about the Dewoitine. Although it bears the name of a designer whose firm has long been famous for its single-seater fighters, the D520 is the product of the *Société Nationale de Constructions Aéronautiques du Midi* This apparent anomaly arises from the fact that the old Dewoitine company was "nationalised" in 1936 under the compulsory legislation of the late (unlamented) "Popular Front" government, by which the firms of the military industries were organised into groups for areas, i.e. Midi, Ouest, Nord, etc.

Development

The D520 may be considered as the logical development of the D500 and D510, which have been in use in France for several years, as well as being on active service with the Republican Air Force in the Spanish Civil War. The prototype D520 was first flown in the autumn of 1938 and, although it was not actually shown, details were first released at the Paris Salon in December of that year. Early in 1939 several development versions appeared and they were rigorously tested with a view to eliminating all the "bugs" before the arrival of the production type in service. In the summer of last year a special version, known as the D530, was being cleaned up and fitted with an extra high-powered engine for an attempt to break the speed record of 469 m.p.h. set up by the Messerschmitt Me. 113R, in April of that year.

Ease of Production

The chief feature of the D520 is that it has been specially designed for rapid large-scale production. Although it is a far more advanced machine than its predecessor (the D510), being more carefully streamlined and faired, with extra equipment and the complication of retractable landing gear, the manufacturing time has been halved. The makers claim that the working time is 7,000 man-hours per machine. Two examples of where time has been saved are in the making of the main spar and main-plane ribs, which now take 324 hours and 60 hours respectively, against 1,993 hours and 1,360 hours for the older machine. This improvement in production time arises partly from the use of refined and modernised manufacturing technique and partly from improved and simplified structural design. The maximum use has been made of such labour-saving devices as automatic riveters and, where strength considerations permit, electric welding machines.

PRINCIPAL CHARACTERISTICS
Dewoitine D520
900 h.p. Hispano Suiza 12 Y-crs*

Span	33 ft. 5 in.
Length	27 ft. 0½ in.
Wing area ..	150 sq. ft.
Weight loaded ..	4,850 lb.
Wing loading ..	32.33 lb. sq. ft.
Max. speed (13,120 ft.)	329 m.p.h.
Landing speed ..	70 m.p.h.
Climb to 13,120 ft.	3 min. 58 sec.
Service ceiling ..	34,440 ft.

* These figures are those released for the prototype at the Paris Show in December, 1938. It can be taken that they have been *considerably* improved for the production machine.

The Simple Main Plane

As may have been gathered from the preceding figures, the greatest structural improvement has been effected with the main plane. This is of simple form in plan although its front elevation is slightly complicated by a thickening of the section towards the root. The wing, which is built in two halves, bolting directly to the fuselage, is of a single-spar type. The spar, which is a simple I-section unit (in strong contrast to the complicated built-up box of the earlier D510) forms the base of the wing to which main and leading-edge sections are attached. The web of this simple spar is a heavy-gauge light-metal blank, to which, on each side, heavy top and bottom flange sections are riveted. The plain surface of the web is stabilised at intervals by riveted angle-section shear members. The spar is situated about 30 per-cent. of the chord from the leading edge, so that it lies approximately at the centre of pressure of the wing. The part of the wing ahead of the spar is fairly large and is built up as a unit, with a stress-bearing skin riveted to flanged-blank ribs. Once this section has been attached to the spar, it forms a strong "torsion box" and is the main strength of the wing. Similar flanged and lightened sheet-metal ribs are attached to the rear face of the spar and connect it to the light rear spar—the latter being little more than an anchorage for the flaps and ailerons. The whole of the wing is covered with a stress-bearing light-alloy skin.

Contrary to usual practice in fighters, the flaps, which extend from the inner ends of the ailerons to the fuselage fillets, are of the slotted type. The ailerons are fabric-covered structures and are mass balanced.

The Semi-Monocoque Fuselage

The fuselage is an oval-section semi-monocoque structure, with good lines, somewhat reminiscent of the Spitfire, but characterised by the rearward position of the cockpit and the rather less refined nose shape occasioned by the bulk of the Hispano Suiza engine. The nose, it will be noticed, is somewhat pigeon-chested and the spinner does not have the "fairline" usual with modern British liquid-cooled installations, but the lines of the rest of the fuselage easily make up for any deficiencies in the nose. The clean sweep of the cabin fairing into the long, thick fin is particularly fine. The pilot's cockpit has the usual transparent covering, with a front panel of armoured glass.

The original engine of the D520 was the 12-cylinder vee, liquid-cooled Hispano Suiza 12 Y-crs, *moteur canon*, of only 900 h.p. The first of the development machines, which appeared in February, 1939, was fitted with the 1,100 h.p. 12Y-51 engine, which gave it a maximum speed of 340 m.p.h. A three-bladed controllable-pitch airscrew is fitted as standard. The radiator is mounted in a ducted cowling beneath the fuselage. The main fuel tank is carried in the fuselage and is one of the several French "fireproof" designs; provision is also made for jettisoning the petrol in cases of emergency.

The "Moteur Canon"

A word about the famous Hispano Suiza engine-mounted gun may be of interest. This first made its appearance about ten years ago, although numerous experiments with operating small-bore guns from aeroplanes had been made in the last war. The gun in question is enabled to fire forward without an interrupter gear, because it is mounted between the two banks of cylinders and the shells pass through the hollow shaft of the spur gear and the airscrew. The gun weighs 106 lb., and the magazine of 60 shells another 55 lb. The muzzle velocity of the projectiles is 2,890 f.p.s., and the rate of fire about 450 rounds per minute.

The undercarriage of the D520 consists of two single-leg units which retract inwardly, the wheels lying in the juncture of the leading edge of the main planes and the fuselage. The openings for the legs and half of those for the wheels are covered by fairing plates attached to the legs themselves.

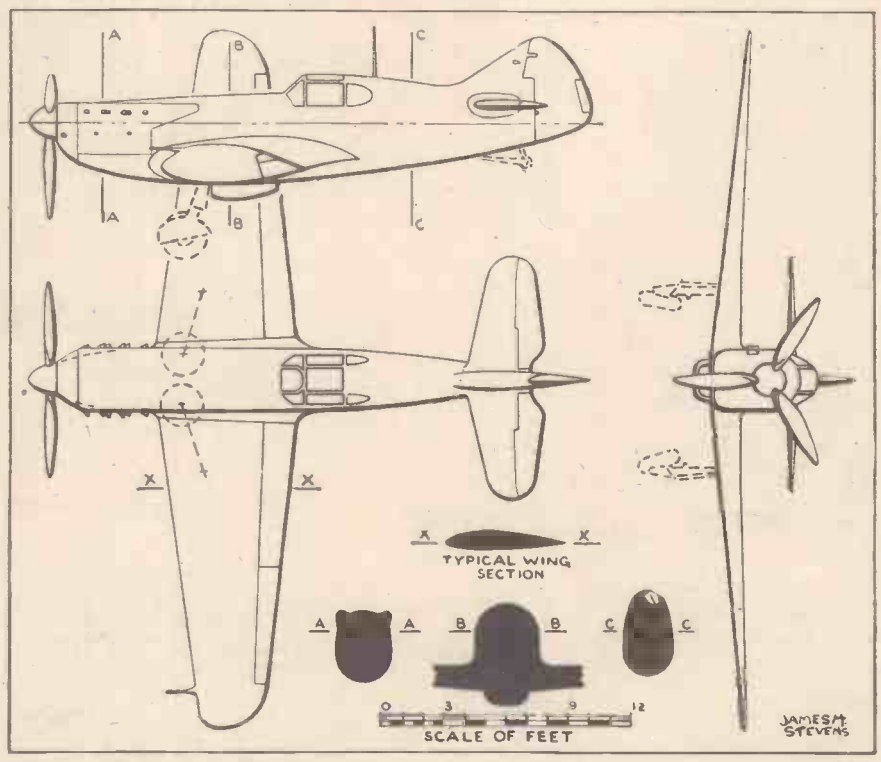
The tail unit consists of an all-metal fin built integrally with the fuselage, a cantilever stressed-skin tail plane, and fabric-covered, metal-framed, control surfaces. Both rudder and elevators are fitted with trimming tabs, mass balances, and aerodynamic balance portions. Details of armament have not been released beyond the fact that the prototype had two machine-guns in the wing besides the shell gun.

Identification

The aeroplanes of France have always been distinct from our own in not bearing cockades upon the fuselage sides until this year. Presumably because of the increased problem of identification with the high speeds and similarity of modern designs, cockades are now painted on the sides of the fuselages of the aeroplanes of the *Armée de l'Air*.

French camouflage is lighter than ours, consisting of smaller irregular patches of khaki and grass green. The under surfaces are a light French grey. The national markings are cockades on the wings and fuselage and stripes on the rudder; the rings are blue, white, and red from the inside to the outside, and the rudder is blue, white, and red reading towards the rear. A white number is painted under the wing and a squadron crest is usually carried on the sides of the fuselage. More precise details of colouring cannot, naturally enough, be divulged in wartime.

SIDE, PLAN AND FRONT VIEW OF THE DEWOITINE D520



MUSICK MEMORIAL TROPHY AWARDS

Award for the Outstanding Contribution to Trans-oceanic Air Transport

Robert J. Minshall who has been awarded the Musick Memorial Trophy.

ROBERT J. MINSHALL, vice-president in charge of engineering of the Boering Aircraft Company, Seattle, has been awarded the Musick Memorial Trophy for 1940, an international award given for the most valuable contributions to flight safety, particularly in the field of trans-oceanic flying.

The award was based on his "outstanding contribution to safety of trans-oceanic air transport through major engineering improvements in large flying boats." Minshall directed the engineering of the 74-passenger, 41-ton Boeing 314 Clippers which were introduced a year ago and placed in service on the transatlantic and transpacific routes of Pan American Airways.

First American

Notification of the final selection for 1940 was received recently by Major Lester D. Gardner, executive vice-president of the Institute of Aeronautical Sciences, New York, in a cablegram from the award headquarters in Auckland, New Zealand. Minshall is the first American to receive the trophy. It was awarded last year to Arthur Gouge of England, general manager and chief designer of Short Brothers, Ltd., as designer of the Short Brothers Empire Flying Boat.

Minshall, an engineering graduate of the University of Washington, Seattle, joined the Boeing Aircraft Company in 1918. He became design engineer in 1928, chief engineer in 1936, and vice-president in 1938.

Captain Edwin Musick

The Musick Trophy, in memory of Captain Edwin Musick and his six companions who lost their lives in 1938 while pioneering a new air route from the United States to New Zealand, was established in that year by the citizens of New Zealand. The recipient of the award is selected by a committee representing New Zealand, the Royal Aeronautical Society of Great Britain, and the Institute of Aeronautical Sciences for the United States. The trophy is awarded annually to the individual in the United States or Great Britain who, in the committee's opinion, "makes the most valuable contribution toward the safety of life in the air, with especial regard to trans-oceanic flying."

NEXT MONTH:
A special article on the formidable fighters of the R.A.F.

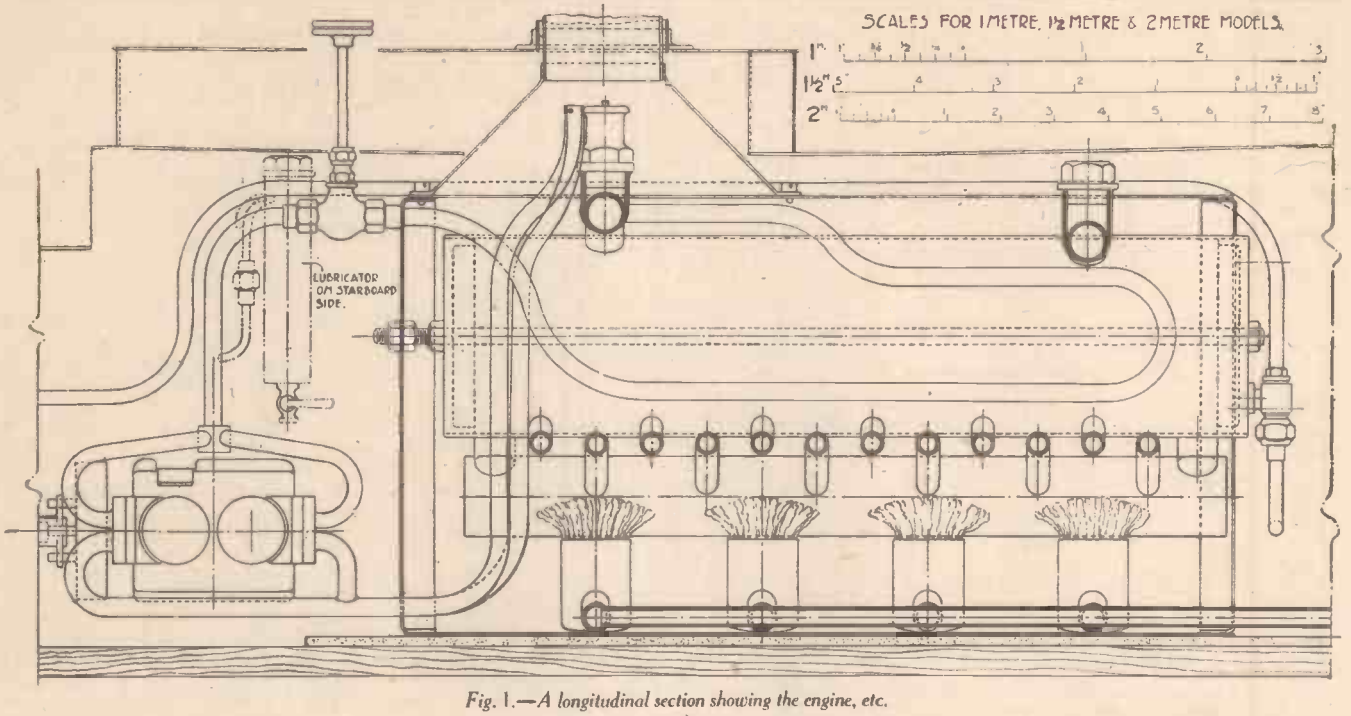


Fig. 1.—A longitudinal section showing the engine, etc.

A Boiler for the Model Cargo Boat

By E. W. Twining

Previous Articles on the Construction of the Model Cargo Boat appeared in the March and May issues

THE hull of the ship having been designed, its size or sizes and displacement all determined by Mr. Clifton, and his drawings reproduced in the pages of the last issue of "Practical Mechanics," it remains for me to fulfil my promise, made in the first article, to prepare designs for the steam generator and its accessories. The reader will appreciate the fact that the dimensions of a boiler of the utmost size and steam-making capacity could not very well be arrived at before it was known what space would be available for it within the hull, hence the reason for the engine being given first, then the ship which the engine shall drive and lastly the boiler.

Size of Model to Build

When I prepared the drawing for the four-cylinder engine I was inclined to advocate the larger size, viz.: the 1 in. bore and stroke, but since I have seen Mr. Clifton's drawings for the vessel I am more in favour of the one-and-a-half metre model hull, the engine for which will have cylinders ¾ in. by ¾ in. In designing the boiler therefore, I have worked with this in view and although I have appended scales to the drawings for both larger and smaller units the proportions of the plant throughout, including the Bassett-Lowke fittings, are those most suitable and best for the intermediate size, that is to say for the ¾ by ¾ engine and the five feet (nearly) hull. The reader will understand from this that in the event of his deciding upon either the smaller or the larger ship model some details in the boiler and in the water and spirit tanks may need slight modification, chiefly in the matter of thicknesses of plate, tubes and materials and sizes of some of the fittings. Amongst the last, which will be affected if another scale is adopted, will be the hand pump in the water tank and the spirit-control needle-valve in the fuel tank. The chief trouble with a metre-length hull will be to obtain these sufficiently small. With a smaller boiler too the water gauge may present a difficulty and a simple gauge with bent glass tube may have to be used.

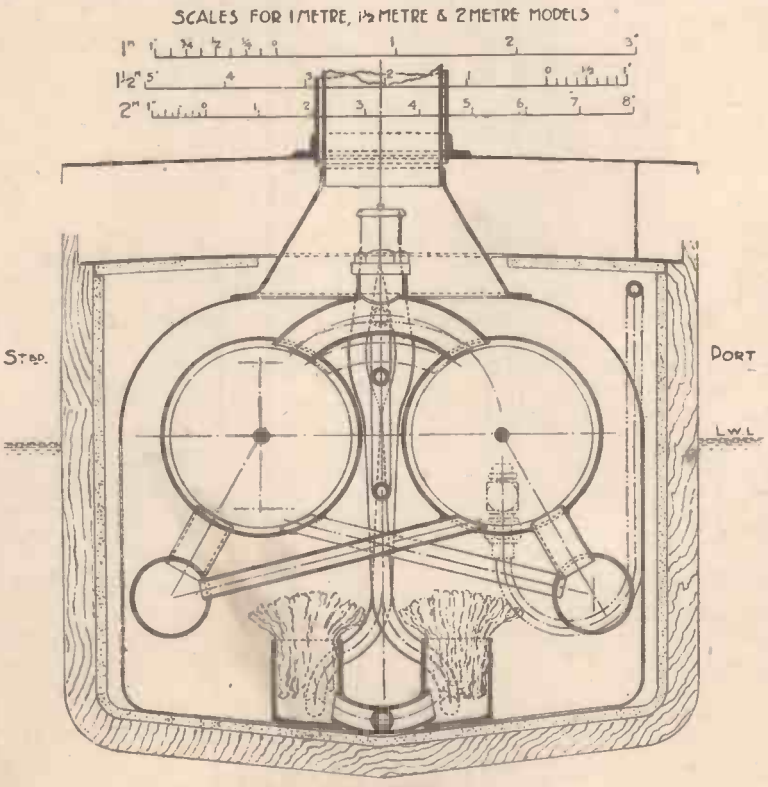


Fig. 2.—A cross section through the boiler

Should anyone make up his mind to construct a two metre model, that is to say one having a length on waterline of 6 ft. 6 ins., I recommend him to consider the question of the best method of fuelling very carefully, before adopting methylated spirit. Such a big ship calls for something more economical and I think that paraffin vaporising burners fed from a pressure oil tank would be the best scheme. On this point, with a view to finding out what burners and tanks are available, Messrs. Bassett-Lowke's catalogue may well be consulted. "Primus"

burners would be ideal for the job, but I am not sure whether these are obtainable at the present time.

Removable Decks

In his article Mr. Clifton provided for the upper deck being removable to gain access to the machinery. This is, of course, as it

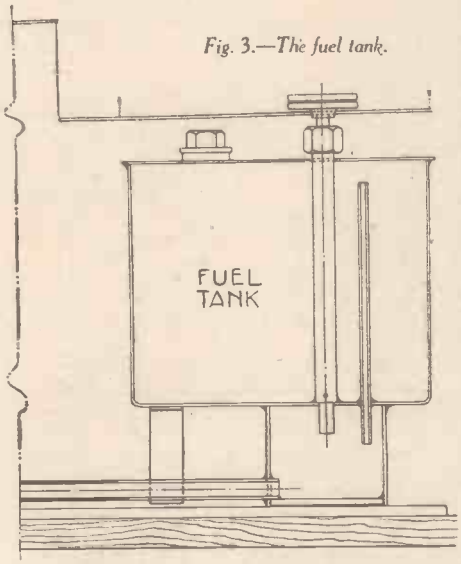


Fig. 3.—The fuel tank.

should be, but now that the full arrangement of the boiler and tanks has been set out I find that the tanks extend, both fore and aft, beyond the limits of this deck and consequently portions of the fore and after well-decks will have to be made detachable. Moreover these movable decks should be made of metal; that immediately over the boiler, at any rate, if not the whole of them for, although the upper deck is protected on its underside with a sheet of Asbestos, a wooden deck would not stand up to the heat which is bound to be radiated from the boiler casing without in time becoming distorted.

The removable decks are provided, and are fortunately only necessary, for the purpose of getting the several portions of the power plant into and out of the hull. The parts which call for frequent access, i.e., the steam regulator valve to the engine, the boiler water filling plug, the spirit needle-valve and the hand-pump lever have all been arranged to come under either cargo hatches or, in one case, the engine room skylight. This merely involves hinging these details so that they will open as small flaps.

The Boiler

This is of the semi-watertube type and consists of two large steam collecting drums, two smaller water drums, an arrangement of down-flow tubes and a series of steam generating water-tubes. The disposition of all of these is most clearly shown in Fig. 2 which is a cross section through the hull of the vessel and through the boiler on a plane taken through the centre-line of the funnel.

Fig. 1 also is a section, in this case taken longitudinally on the centre line of the ship and cutting through not only the water tubes but two curved pipes which arch over and connect the two steam drums together at the top. From the after one of these the steam pipe is led to the engine and upon the top of it the safety valve is mounted. Upon the other pipe the screwed collar of a filling plug is brazed. This plug comes under the small cargo hatch on the upper deck.

The whole boiler should be built up of seamless copper tubing with ends to the steam drums of either flanged copper discs of No. 16 gauge or gunmetal castings as shown in Fig. 1. Whichever is used the ends will need staying with 3/16 in. hard drawn brass rods. The extended ends of these stays form the means of supporting the boiler in the casing at the after end. At the forward end both the steam drums are made to project a quarter of an inch beyond the casing through holes cut to receive them. Support is thus provided at this end also. It is at this, the forward, end of the boiler that the gauges and the check valve are fitted; the water gauge in the starboard drum, and the check-valve and pressure gauge in the port drum.

The boiler may be soft soldered together if desired but it must be pointed out that should the model become stranded in weed or shallow water beyond reach for a considerable length of time and the boiler run dry much damage may be sustained. It will therefore be far safer and make the stronger job if all joints in the boiler proper are silver-soldered.

It will be noted from Fig. 1 that the steam pipe is led, from a point near the safety valve, forward and downwards before being returned aft to the wheel valve and the engine. It thus provides a simple means of superheating the steam.

A Pressure Gauge reading to 100 lbs. should be fitted and the working pressure may be anything the reader chooses up to about 75 lbs. It is very likely that 40 lbs. per square inch will be ample to drive the boat at sufficiently realistic speed.

The Boiler Casing

This is made up from soft iron or steel plate of about No. 22 S.W.G.; one end may be riveted in and the other — since one end must be removable—screwed by tapping holes in the flange. The conical smoke-box must also be held down on the casing by screws. From the upper end of this cone an inner funnel extends nearly to the top of the outer, painted, funnel. This inner funnel can be made from a piece of thin brass tubing. It must be given a rake, aft, equal to the angle of the outer funnel. There is, of course, no connection between the two, so that when the upper deck is lifted the outer funnel will come away with it leaving the inner funnel standing up from the boiler casing.

The Spirit Burners and Tank

The furnace is provided by eight burners of Asbestos wick fitting into short lengths of brass tubing all connected together by cross tubes, see Fig. 1, and to the tank by a copper pipe, as shown in Fig. 3. At the tank end the pipe enters a sump which is fed from the tank through a needle-valve which, operated by a knurled knob, regulates very finely the flow of methylated spirit to the burners.

The sump can be made from brass tubing and the tank of either tinned steel plate or sheet brass, all soft soldered. The filler cap should be screwed and, as before mentioned, access to it is by the fore deck cargo hatch.

The width of the tank athwart ship is not indicated: it may be made square in plan or, if a greater quantity of spirit is required to be carried, it can be made to extend right across and fit up against the inside of the hull. If it is narrower than the hull it will be necessary to provide some means of holding it in position and in any case it will be as well to solder a couple of strips of plate on to its under side to serve as legs which, with the sump, will provide a three-point support.

The Water Tank

This is a simple box of sheet brass and will, definitely, extend right across the vessel and be screwed, through lugs, to the wooden sides of the hull. As shown in Fig. 4, it contains one of Bassett-Lowke's pumps of the pattern which is normally used in locomotive tenders. This pump is connected to the check valve at the forward end of the boiler by a pipe, run along, outside of the boiler casing, on the port side.

No Filler Cap

No filler cap or plug is shown on this tank, the top plate of which must be made removable, because it is usually possible to fill with water through a tin funnel inserted in the slot through which the handle of the pump passes. If desired, however, a half-inch of brass tube may be soldered in another part of the plate and a cork fitted into this.

The Lubricator

Obviously some arrangement must be made for sending tiny quantities of oil to the engine continuously, whilst it is working, and the simplest way of doing this is by a lubricator of the displacement type. Such a lubricator can be made from a piece of brass tubing, a filling plug fitted at the top and a straight nose cock at the bottom. A one-eighth-inch pipe is led into the top of the lubricator from the steam pipe and passes down through the oil to within an eighth of an inch from the bottom, another pipe of the same diameter is led from the top of the lubricator and is made to enter the steam pipe lower down, see Fig. 1.

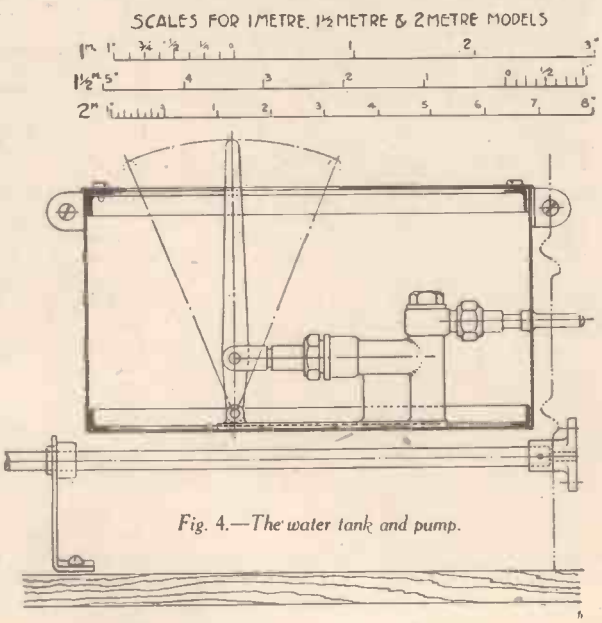


Fig. 4.—The water tank and pump.

This lubricator may well be fixed on the starboard side of the ship.

As a precaution against fire, or the affects of heat, the whole hull is lined with Asbestos from the engine to as far as the forward end of the spirit tank.

Facts About Metals

(*Continued from page 399 of June issue*)

Liquid Gold.—Many of the so-called "liquid golds" consist merely of a paint made up with tin sulphide, which has a lemon colour. True liquid gold, however, consists of a resinous compound of gold dissolved in a mixture of essential oils. When coated on to pottery and fired in a high-temperature furnace, it produces a brilliant and imperishable film of gold, the exact colour of which can be varied by altering the composition of the gold compound.

Likewise, aluminium paint is sometimes spoken of as "liquid" silver, true liquid silver (or, more correctly, liquid platinum) is a similar compound to the above but containing platinum instead of gold. When fired in a furnace it gives on pottery a brilliant, lustrous layer of metallic platinum.

Lithium.—Metallic element. Chemical symbol, Li; At. No. 3; At. Wt. 7; M.P. 180° C.; B.P. 1400° C.; Sp. Grav. .534; Sp. Ht. .941; Elec. Cond. at 0° C. (Mercury=1) 10.69.

Occurrence: in many spring waters, and in a few minerals such as Lepidolite or Lithium Mica. The metal was first prepared in 1818 by Davy after its oxide, lithia, had been discovered in the previous year by A. Arfvedson. The metal was named by the chemist Berzelius from the Greek, *lithos*, a stone, in significance of the hard stony minerals from which it had been extracted.

Lithium is a silvery-white metal when freshly cut and having a slight yellow cast. Lithium metal is distinguished not only by being the lightest of all metals, but, also, by constituting the lightest solid material known. It floats on petrol which itself floats on water. Lithium can be cut by a knife, but it is harder than its related metals, potassium and sodium. The metal may be pressed into wire, and two pieces of the metal may be made to adhere at ordinary temperatures by pressing them together. At a temperature above its melting point, Lithium takes fire and burns with a white light. The metal decomposes water at ordinary temperatures, evolving hydrogen and forming lithium hydroxide. Hence, when exposed to moist air, it quickly becomes covered with a film of hydroxide. It is normally stored under oil. Heated in nitrogen, it forms lithium nitride.

Lithium metal is without use at the present day. Some alloys of the metal with beryllium, aluminium, etc. have been made, but these are also useless.

Lutecium.—Metallic element. Chemical symbol, Lu; At. No. 71; At. Wt. 174. An extremely rare metal discovered in 1907 by G. Urbain, and named from *Lutece*, an old name for Paris. It is a grey metal, similar to Ytterbium, but little is known about it.

M

Mackenzie's Amalgam.—This is a curious amalgam, for, although it is normally solid at ordinary temperatures, it becomes liquid by friction.

It is made by melting 2 parts of bismuth and 4 parts of lead in separate crucibles. The molten metals are then thrown into two other crucibles each containing 1 part of mercury. When cold, these amalgams are solid, but they will melt when rubbed against each other.

Magnalite.—An aluminium alloy of the composition: aluminium, 94.2%; copper, 2.5%; zinc, 0.5%; magnesium, 1.3%; nickel, 1.5%. It has a tensile strength of about 30,000 lb. per sq. in. and a specific gravity of 2.8. It is a light alloy, similar, in some respects, to "Y" alloy, and is of American origin.

Magnalium.—The name given to a group of aluminium-magnesium alloys containing from 2 to 10% of magnesium. It is lighter than aluminium, and has mechanical properties somewhat similar to brass.

The alloy is less corrodible than pure aluminium and it can readily be turned. It has a greater tensile strength than aluminium.

Magnet Steels.—Previous to 1930, the steels which were able to be magnetised the most powerfully were those containing various amounts of cobalt, the "cobalt steels." In 1930, however, a new series of magnet steels was discovered in Japan, the principal alloying ingredients of which were aluminium and nickel. Many of these special steels were made and investigated, the most important one containing 13% of aluminium and 25% of nickel alloyed with steel. Such steels, however, are now being superseded by the new aluminium-nickel-cobalt steel named "Alnico" (which see).

Magnolia Metal.—A white metal alloy for bearings. Has been used chiefly in marine and railway work, since it stands well up to heavy bearing pressures. Composition: lead, 78%; antimony, 16%; tin, 6%. The metal takes its name from the trade-mark of its original manufacturers—a magnolia flower.

"Tandem" metal has a similar composition.

Malleability.—The degree to which a metal can be flattened out in all directions by rolling or hammering. The malleability of a metal depends upon its toughness and, also, upon its tensile strength. Metals having coarse crystalline structures are not malleable. Hence, any impurity in a metal or any mechanical or physical action to which it is subjected which results in an increase of its coarseness of grain or crystalline structure will decrease its malleability. Some metals increase in malleability with increase in temperature. Gold is the most malleable of all metals, it having been beaten into sheets no more than .000004 in. thick.

The following well-known metals are arranged in order of decreasing malleability: gold, silver, copper, tin, platinum, lead, zinc, iron, nickel.

The relative malleability of metals is a measure of the thinness to which they may be reduced from the same thickness.

(From the Latin, *malleus*, a hammer, in reference to the hammering or beating of malleable metals.)

Manganese.—Metallic element. Chemical symbol, Mn; At. No. 25; At. Wt. 55; M.P. 1245° C.; B.P. 1900° C.; Sp. Grav. 7.3921; Sp. Ht. .1217.

The metal was first prepared by Gahn about the beginning of the last century. It was derived from *magnesia nigra*, or "black magnesia" (as manganese dioxide was then called) and, accordingly, the new metal was given the name of "manganesium," which was afterwards shortened to "manganese" to avoid confusion with "magnesium," another new metal.

The chief ore of manganese is pyrolusite or black manganese dioxide, MnO_2.

Pure manganese is a white-grey, lustrous metal having a slight reddish tinge. It is harder than iron and will take a high polish. The metal is brittle and is superficially oxidised when exposed to moist air. Heated in nitrogen or ammonia gas, it forms manganese nitride. The metal is soluble in inorganic acids.

Added in small amounts to steel, manganese exerts a very pronounced hardening and toughening effect, hence the nowadays numerous "manganese steels." The pure metal itself, although by no means rare, is more or less a curiosity at present. Its best-known compound, manganese dioxide, has been used since the times of the Romans for decolourising or "bleaching" glass. Potassium permanganate is another well-known compound containing manganese.

Manganese Bronze.—This is a form of brass containing about 60% of copper and 40% zinc, together with a little manganese and iron. Typical composition: copper, 56; zinc, 41.5; manganese. .25; aluminium, .25; iron, 1; tin, 1. It has a tensile strength of about 30 tons per sq. in. and is, therefore, as strong as mild steel, in addition to being tougher and more resistant to corrosion. It is sometimes (although less accurately) known as Manganese Brass.

Manganese Copper.—Also known as Cupromanganese. Name given to a number of copper-manganese alloys of varied proportions. They are silvery-white in colour, have great hardness and fair ductility. The best manganese coppers containing from 10% to 30% of manganese. A typical manganese copper contains: manganese, 25%; copper, 75%. Other varieties of this alloy contain small amounts of tin, zinc and nickel. It often serves as an addition to copper or copper alloys in order to impart greater strength and density to them.

Mannheim Gold.—One of the many "imitation golds." Composition: copper, 83.1%; zinc, 10.0%; tin, 6.9%. The composition of Mannheim gold varies considerably, and sometimes the tin is left out. It has a reddish tint.

Also known as "Similor" and "Prince's Metal."

Martensite.—Name given to a solid solution of carbon in that variety of pure iron known as "beta-ferrite." It is a typical constituent of steel which has been hardened by quenching. Called after A. Martens, the metallurgist.

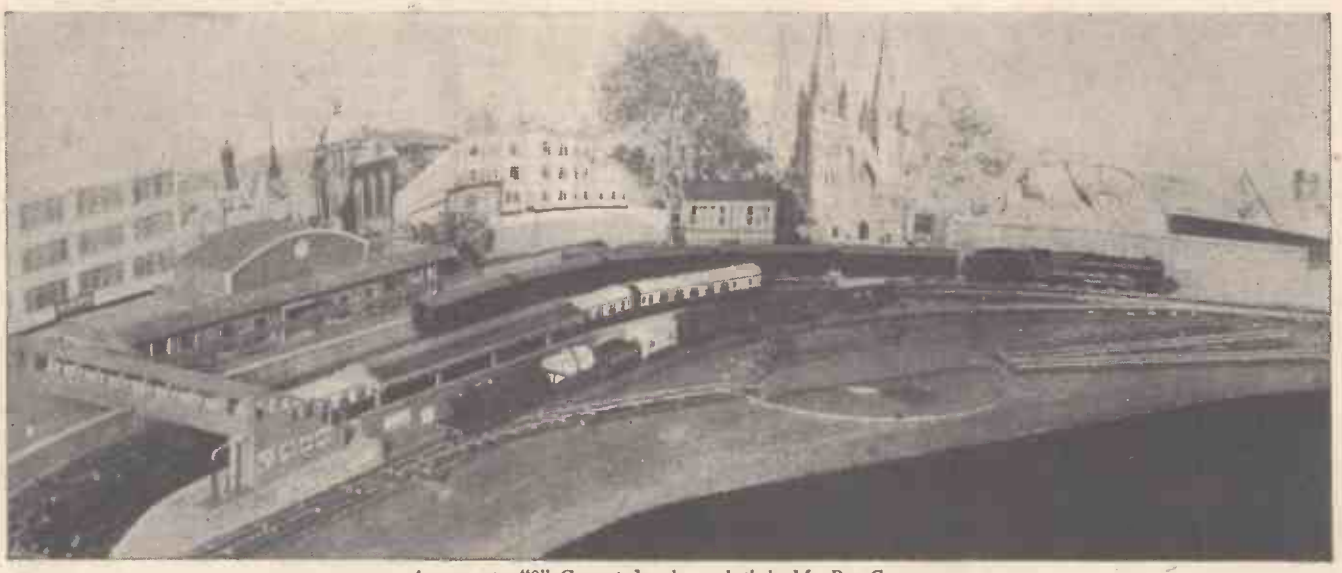
(*To be continued*)

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

"MOTILUS" PEEPS INTO THE



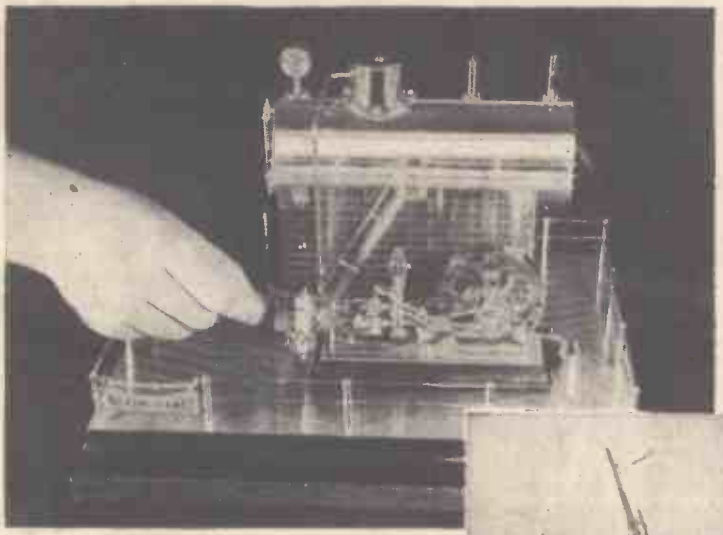
An attractive "0" Gauge indoor layout built by Mr. Ray Coomer

An Actor and His Hobby

WHEN in Northampton recently, Mr. Bruce Carfax, the well-known singer and musical comedy star, was able to renew acquaintance with an old hobby of his—that of model railways. With several other interested members of his company, including Miss Doris Francis, who plays Nadina to his Bumerli in *The Chocolate Soldier*, Mr. Carfax spent an afternoon at the Bassett-Lowke model works, and took a keen interest in the technicalities of model-making. During his visit he related quite a few model railroader's yarns. A few years back he owned a flat in Hampstead which was practically bought so that he could plan out a model railway. A room 23 ft. by 18 ft. 3 in. was devoted to it, in which he devised a most extensive system, which ran up two levels, so that the trains circled three times round the room before mounting to the highest point of the railway. Among its novelties were a starting hump and three attractive stations. One was designed on the lines of the Manchester Exchange station, while another—his prize piece—was over six feet in length and built specially to follow the curve on the "second floor" of the system.

The railway was gauge "O" electric, with steel permanent way, and for four years it gave him, and quite a number of his friends, a hobby to be enthusiastic about.

Mr. Carfax remarked on the surprising number of actors who are interested in models. He mentioned Owen Nares, Gene Gerrard, and also Jack Hulbert's gauge 1 garden railway, which is, incidentally, quite famous throughout the profession.



A miniature steam engine built by Mr. C. Mansford, a watch-maker

A Fine Layout

Visiting the south coast of England recently I came across a very fine gauge "O" indoor layout in the basement of the Tarrazona Hotel at Boscombe. It was built by Mr. Ray Coomer, son of the proprietor, and the layout consists of 75 ft. of double track with twelve points, a through station, girder bridge constructed from curtain rail, a five-foot tunnel made of a wooden frame and covered with a sugar sack and coated with a plastic material, suitably coloured. The turntable is electrically operated and is automatic, and the whole layout is on baseboards bracketed to the wall, four feet high from the floor. There are three express locomotives, G.W.R. King George V, L.M.S. Princess Elizabeth, and L.N.E.R. Flying Scotsman, and also one G.W.R. 2-6-2 tank and a Union Pacific Diesel electric, these being 20 volts a.c. Among his rolling

A model of S.S. Cynthia constructed entirely of scrap metal

MODEL WORLD

Aircraft Models; Working Miniatures; Models From Scrap; A Railway in a Hotel Basement

stock, Mr. Coomer owns five G.W.R. coaches, which when hauled by the "King" make a model of the Cornish Riviera, the whole being illuminated, including the loco with scale headlamps and fire box glare. There are also five L.M.S. coaches, hauled by the Princess Elizabeth, and 35 goods wagons. A most interesting feature of the line is the application of a scenic background. This has been cleverly built up from cut-outs from various posters—mostly railway posters, and although the items which appear in the background have no real relation to each other in topography—the *tout ensemble* is very attractive but those who are sticklers for accuracy of situation will understand that although Lichfield Cathedral appears near the cliffs of Dover, it is just a matter of artistic licence!

Mr. Bruce Carfax, the well-known actor, who recently paid a visit to the Bassett-Lowke model works. He is a keen model railway enthusiast

A Miniature Steam Engine

A friend of mine from Minneapolis, knowing my penchant for models and photographs, has sent me an illustration of a miniature steam engine. It was built by Carl Mansford, a watch-maker, of brass, bronze and steel, and can be operated either by steam or compressed air. It is amazing when you think that its small boiler is strong enough to withstand at least a 30-pound pressure. There is a gauge on the boiler registering up to 20 pounds, and the engine reaches 250 revolutions per minute at average speed. The base is 13 in. by 9 in. The boiler is 4 in. by 8½ in. and the engine is ¾ in. bore by 1¼ in. stroke. There are 7 jewelled bearings in the engine, five in the governor and two in the pressure gauge. The engine itself is gold plated and contains between 450 and 500 pieces altogether—a wonderful example of the craftsman's art in miniature.

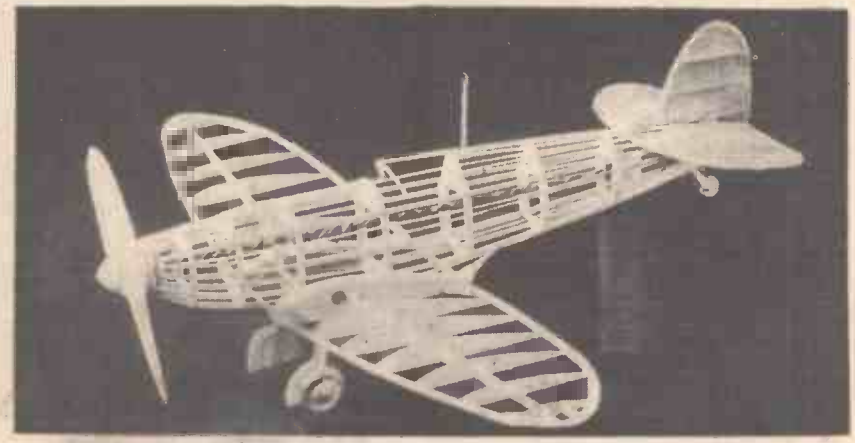
A model "Spitfire" built from an Aeromodels kit

Model from Scrap Metal

The model of *S.S. Cynthia*, illustrated, is the work of a Chelmsford amateur, Mr. J. L. C. Dickson, and is unique in that it is constructed entirely from scrap material. It is 2 ft. 9 in. overall by 5¼ in. beam width and 4¼ in. to shelter deck. The shell plating, the whole of which is riveted to side frames following closely the orthodox type of passenger cargo vessel, was made from old tins. There are two bulkheads fore and aft of the midships section. The rivets were from brass as used by boot repairers. The three-bladed propeller was shaped from an old brass sink plug! The ports are brass washers riveted through shellplate and glazed with old film negative, as likewise the saloon windows and chart-house. The ship's bell is hand-made from solid brass. The crew's accommodation in the forecastle is fully furnished, as is the officers' and passenger accommodation on maindeck and poop. The masts are of wood, the funnel of copper tube and all fittings are made from scrap. The owner has handed the model over to the Essex Comforts Fund for the period of the war and it is on view to the public in the vestibule of the Public Library.

Model "Spitfire"

An illustration of an R.A.F. Spitfire, modelled to scale from an AEROMODELS kit (as shown on this page). It is the work of a young school-boy amateur, who started the hobby only seven months ago. He has built mainly duration models and the "Spitfire" is his first attempt at a scale model. It took forty-five hours to build and is camouflaged khaki and green for ground protection, and the underside is painted silver, which would make the prototype more difficult to follow when in the air. This "Spitfire" model can either be built with large propeller as a working model, or as in the illustration, with scale propeller, for display.



Showing the model "Spitfire" ready for covering

LIGHT-GIVING MINERALS

Some Curious and Little-known Experiments with Luminescent Minerals and Crystals

Examples of fluorspar, which becomes strongly luminous when heated

THE fact that certain chemical substances are capable of giving out a peculiar "cold light" of their own is a well known one. Phosphorus, for instance, has long been famous for the ghostly greenish-blue light which it emits in the dark, and nowadays, of course, certain light-giving materials, notably the sulphides of calcium and zinc, have obtained considerable commercial importance in the manufacture of luminous paints, and other phosphorescent preparations.

In spite of the fact that many of these self-emitters of "cold light" have been known for very long periods, their inherent mode of action still constitutes one of the minor mysteries of science. We do not know for certain why calcium and zinc sulphides fail to luminesce when they are perfectly pure but shine often with considerable brilliance when they are intimately mixed with certain traces of contaminating substances.

Most of the common luminous materials from which the various phosphorescent paints are made seem to act as accumulators of light. When exposed to a bright light, they appear to take in a large amount of light energy, and to give it up again in the form of their characteristic luminescence over lengthy periods. If, however, such light-activated materials are permanently kept in the dark there comes a time when their luminescence fails, such materials having apparently given up all their stored light energy. But when these substances are again exposed to strong light for two or three minutes they become, as it were, re-charged with light energy, and, as a result, they are once more able to shine in the dark with their accustomed brilliance.

"Luminophores"

Materials of this nature have, within recent times, received a new categoric name—"luminophores." Thus calcium and zinc sulphide are typical luminophores, since they are, in some strange, and as yet not satisfactorily explained way, able to store up light and afterwards to re-emit it in the form of luminescence.

Calcium sulphide (which has been known for upwards of two centuries as "Canton's phosphorus" was at one time obtained by strongly heating a mixture of two parts of flowers of sulphur, and one part of finely crushed oyster shells. It may still be prepared in this manner, although a better result will be obtained by heating to red heat a mixture of two parts of sulphur, one part of finely powdered lime and approximately one-half part of starch. These ingredients should be intimately mixed before heating, and a trace of bismuth nitrate should be added to the mixture. The mixture is best heated in an old tin which, with its lid on, is placed in the middle of a bright-red fire. A small vent should be made in the lid of the tin in order to permit the escape of the surplus sulphur fumes.

A creamy-coloured powder will result from the above operation. After being exposed to sunlight or to a strong artificial light, it will luminesce with a violet light. By substituting lead acetate or lead nitrate for the bismuth salt in the above formula, the luminescence of the finished product will be yellow-green, whilst traces of uranium, manganese or zinc, give bluish, orange or greenish luminescences respectively.

Calcium sulphide luminous powder prepared in the above manner may be incorporated into a paint or varnish, the proportion of the luminous powder in the paint being from 5 to 15 per cent. The paint should not contain any white lead, otherwise the luminescent property of the calcium sulphide will rapidly deteriorate. Usually, clear varnishes of the cellulose type are the most suitable for making up these calcium sulphide luminous paints, and if such a paint be brushed on to a surface which has previously been painted with a leadless white paint the maximum degree of luminescence will be forthcoming.

Making luminous powder by heating lime, sulphur and starch in an old tin held in the fire, as explained in the text

So much, therefore, for the subject of luminous paints. It is a subject to which much scientific attention has been paid in recent times and although many excellent types of "luminophores" are now on the market, the ideal long-lasting brilliantly luminescing material has yet to be found.

Quite apart, however, from the well-known variety of luminescence described above, there are several other types of light-emission by minerals and crystals which are not generally known, but which, although they are, perhaps, incapable of being commercialised, present, at least, a field of interesting experimental activity to the amateur investigator of such phenomena.

Fluorspar

Perhaps the most remarkable type of mineral luminescence is that exhibited by the well-known mineral fluorspar, which, under the name of "Fluorite," "Blue John," and other titles occurs in several localities of Britain.

When almost any variety of fluorspar is powdered up in the dark it emits a bright purple light, which, now and again, may be seen lingering over the mineral as a luminous haze, even after the powdering operation has been completed.

A better way to observe the luminescence of fluorspar (and that of some other types of minerals, as well) is to fling the powdered material on to an iron plate in the dark, the plate being heated to a temperature just below that of dull-red heat. On making contact with the heated plate, the powdered fluorspar will emit a brilliant phosphoric light which will usually be a vivid violet in colour. Certain varieties of fluorspar, however, will, under the above conditions, give forth an orange, blue and even a pinkish light, although the average fluorspar specimen will produce the characteristic livid violet luminescence which will last for several minutes before it dies away completely.

Other minerals besides flourspar give similar results when thrown on to a heated plate in the dark. Certain varieties of *calcite* (calcium carbonate) and *calcareous spar* shine strongly with a yellow luminescence, whilst *anatase* will often give rise to an exceptionally striking effect, appear-

ing to burst into a white flame and to emit white flashes of light.

Zeolites

Some of the zeolites, such as *harmotome*, will shine under these conditions with a greenish-yellow hue, whilst the semi-precious gem, *topaz* gives a bright blue colour.

It is interesting to subject any mineral to the above test, since even the commonest of minerals will, at times, particularly when contaminated with certain metallic substances, give rise to vivid and striking results of a luminescent nature.

Exactly why and how these effects are produced no one knows. Nor do we know why some minerals emit light when they are merely struck with a hammer, and, in some instances, even scratched with a knife.

Certain varieties of zinc blende, a common enough mineral, will, when sharply scratched with a knife or powdered up in a mortar, produce a soft yellow luminescence, whilst many of the pebbles of milky or translucent quartz which are to be found in great numbers on almost every seashore will frequently give out a bluish light when struck or rubbed briskly together in a darkened room. It is a strange fact that this emission of light will take place even when the pebbles are sharply rubbed together under water.

Chlorophane

Chlorophane is not a common mineral but it is to be found in some districts. So sensitive is this mineral to heat, that it will actually shine in the dark when thrown into a basin of hot water. Furthermore, the green variety of chlorophane will sometimes become luminous merely by holding it in the palm of the hand in a darkened room.

Another interesting type of luminescence which is, as yet, altogether unexplained, is that exhibited by the mineral, mica. When mica is split up into its well-known thin sheets in the dark, it gives a faint yet clearly distinct glow at each cleavage of sheet from sheet. Certain of the *felspar* minerals produce a similar result, although not with the same constancy as mica. Even household sugar, when powdered in the dark, sometimes becomes luminous.

The native sulphide of antimony, known as *Stibnite*, will often become vividly incandescent when heated to a temperature just above that of red heat, although its related lead compound, *galena* (lead sulphide) invariably fails to show this effect.

Rochelle Salt

In the realm of crystalline substances there are to be found some very mystifying examples of luminescence. When, for example, Rochelle salt, which is sodium potassium tartrate, is dissolved to form a strong aqueous solution, and this solution is boiled in the dark, it will be seen to give off copious showers of violet-blue sparks. These sparks are, of course, quite cold, and they may be allowed to impinge upon the hand without harm.

Again, when ordinary boric or boracic acid is fused in a crucible and, after becoming almost red hot, is allowed to cool down in a darkened room, the molten mass solidifies, splits and cracks as its temperature falls. During these splittings and crackings, the acid will often be observed to throw up very bright flashes of greenish light which are, at times, almost electrical in their brilliancy.

Vanadic acid gives rise to a similar effect, but here the phenomenon is more intensified, for, after fusion, the material shines with an orange-red light which persists through almost the entire period of its crystallisation.

Sodium Fluoride

Another exceedingly mysterious phenomenon of crystal luminescence is that exhibited during the crystallisation of sodium fluoride. This is a perfectly white substance which when dissolved in water so as to form a saturated solution and then set aside in a darkened room to crystallise, produces a brilliant luminescent twinkling or scintillating effect as each individual crystal forms from the solution. Few individuals have taken the trouble to observe this effect. Yet it is quite a brilliant one and, up to the present, it has never been explained.

Although none of the above luminescent effects have ever been satisfactorily accounted for, some attempt has, in the past, been made to classify them. Thus,

Dropping powdered fluorspar on to a heated iron plate in a darkened room in order to witness its production of luminescence

the luminescence of minerals caused by heating is termed "thermo-luminescence, whilst that derived from the crushing or other mechanical disintegration of the mineral is known as tribo-luminescence." Certain types of luminescence brought about by chemical means are known as "chemo-luminescence," and there are, also, some varieties of luminescence known as "electro-luminescence." These latter phenomena are usually brought about by subjecting the mineral or crystal to the influence of an electric discharge. For example, if a quantity of barium sulphate has an electrical discharge from an induction or sparking coil transmitted along its surface, it will develop a very characteristic greenish-yellow glow. Potassium acetate crystals will, under these conditions, shine with a brilliant green light, whilst an ordinary rock crystal will develop a dull red light which will gradually become whitish.

In many instances, too, these effects do not cease immediately the current is switched off. On the contrary, they persist for several minutes after the exciting current has ceased to flow.

Exposed to X-, and, also, to cathode rays, a large number of minerals and crystals glow vividly in characteristic colours. Such experiments, however, are usually beyond the resources of the average amateur, and hence there will be little import in describing them further.

Yellow Phosphorus

The well-known luminescence or phosphorescence of yellow phosphorus is simply an effect of oxidation, the light being produced as a result of the element's slow oxidation by the oxygen of the air. Thus, if phosphorus is placed in a vacuum or in a gas devoid of oxygen, it at once ceases to glow. Curiously, also, if phosphorus is placed in slightly compressed oxygen, it also refuses to glow, and furthermore, it has been definitely proved that if perfectly dry phosphorus is placed in perfectly dry air, it will not shine in the dark.

Ordinary luminous paints which are, for the most part, composed of calcium or zinc sulphides, specially prepared and treated so as to heighten their luminescent powers, will glow undisturbedly under almost any reasonable conditions. Having been "activated" by exposure to strong light, they will thereafter continue to glow steadily in air, in a vacuum, under water, or in an atmosphere of an inert gas for many hours, until their absorbed light-energy becomes exhausted. Subsequent "re-activation" by again exposing them to strong light will re-charge them with light energy for another period, and, usually, provided that reasonable care is taken to prevent the "luminophore," or luminous material, from becoming contaminated by dirt or extrinsic impurities, this cycle of absorption and emission of light energy is capable of being repeated almost indefinitely.

Light Accumulators

Curiously enough, the above process represents the only means of actually storing-up light which we know of. It is thus extremely tantalising that it should be, in practice, so ineffective a mode of operating this fundamental principle, for were it possible to devise large-scale "light-accumulators" and, to charge them daily with the sun's light so that, in the dark, they emitted rays of equal intensity then the long sought-for solution of the problem of "cold light" would be at hand, and the necessity for utilising all our present-day types of electric and other artificial illumination would be no more.

Perhaps one day such a solution will be forthcoming. For, as the reader who has studied this article will now be aware, there are many rudimentary types of "mystic mineral light" whose inherent nature we are, as yet, unaware of, but the further examination of which may, at long last, implant in the mind of the serious experimenter that essential clue to the commercial production of an efficient and utilitarian "sunlight-accumulator" which will bring him certain fame and, also, very probable fortune.

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 sender. Send your queries to the Editor, PRACTICAL MECHANICS, Geo. Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2.

Anti-gas Paint

WHAT is the formula for the "anti-gas" paint used on the wooden pedestals that are dotted about the country?—A. D. (Luton).

THE "anti-gas" paint which is at present so widely used for painting on the tops of pillar boxes, etc., is more or less of secret composition. It turns red on contact with mustard gas, but, at the same time, other sulphur-containing organic substances will exert the same effect.

You may, however, prepare a similar paint by grinding up copper mercuric iodide with varnish. A mixture of cuprous (copper) iodide and mercuric iodide has a similar effect. All such materials may be obtained from Messrs. Harrington Bros., Ltd., Oliver's Yard, City Road, Finsbury, London, N.1.

Whitening Concrete

PLEASE tell me the preparation to whiten concrete pillars used in bay windows and the porch of a front door.—W. C. (Coventry).

ALMOST any white colour-wash may be used for the purpose you name. We presume, of course, that you do not wish actually to paint the stone surfaces, and hence we would recommend for your attention a good white distemper, such as may be purchased at any colourman's shop for about 2s. 6d. per 4 lb. tin. This quantity should be sufficient for the purpose you name.

If you do not wish to purchase a ready-made preparation, you can make up your own colour-wash by obtaining 2 lbs. of ceiling white and by mixing this to a thin paste with water in which a small quantity of size has been dissolved.

All preparations of this nature should be brushed on to the stonework thinly. It is better to apply two or even three thin coats than to apply merely one thick coat, which latter may flake off, and, in any case, wash off with the rain.

By brushing over your whitened surface with a solution of formalin (1 part formalin to 20 parts of water) the surface will be rendered almost completely waterproof.

Engine for Model Cargo Boat

IN the article on building an engine for a model cargo boat which appeared in our March, 1940, issue the cylinders are shown in the sectioned views, Fig. 1, with their inner ends merely passing into the crank-case. Actually the fixings should have been drawn in the elevations and plan, Fig. 2, and a correcting sketch is here given to put the matter right.

Each cylinder is provided with two lugs through which screws pass into the crank-case. Each lug should embrace at least a quarter of the circumference of each cylinder and should be silver soldered on.

Making Windows Splinter Proof

WILL a celluloid solution if painted on windows prevent splinters due to blast from explosions, and if so, what is the composition of such a solution?

Would such a solution "flake off" when exposed to the heat of the sun, and is it still inflammatory after application.

Would the cost be prohibitive?—W. S. (S.W.9).

IF the window-panes in question are situated just on the "effective fringe" of an explosion area, it is very probable that the presence of a celluloid layer on the glass would prevent the fracture of the latter. If, however, the panes were within the range of an explosion the celluloid layer would have no safety effect whatever, and we doubt whether it would even prevent the glass from shattering into splinters.

A suitable celluloid solution for application to glass can be made by dissolving scrap celluloid in a mixture of 2 parts acetone and 1 part amyl (or butyl) acetate. To the resulting solution, which should have the consistency of thin paint, a few drops of castor oil should be added.

The solution is, of course, highly inflammable, but, after drying on the glass, the resulting film of celluloid would hardly burn if ignited. The celluloid layer thus deposited on the glass will not subsequently flake off, provided that the solution contained the requisite very small amount of castor oil and, also, provided that the glass was scrupulously cleaned before the application of the solution.

The cost of treating the glass would not be prohibitive, and for an outlay of, say, 5s. in material, you should have enough solution to treat several windows. Amyl and butyl acetate, and also acetone can be obtained from Messrs. A. Boake, Roberts and Co., Ltd., Stratford, London, E.15. Scrap celluloid is available from most film renters, etc.

A "Wind Charger"

I HAVE a Morris 12 v. 4-pole dynamo-motor which I want to use as a "wind charger." Is it necessary to rewind the armature, and if so, what quantity and gauge of wire will be required?—L. G. (North Wales).

BEFORE it is possible to issue winding specifications for either dynamos or motors to give specified outputs, it is essential that the following details are given:—

(1) Size of armature (diameter, length, and number of slots).

(2) Particulars of commutator (number of bars).

(3) Number of field magnet poles, and their dimensions.

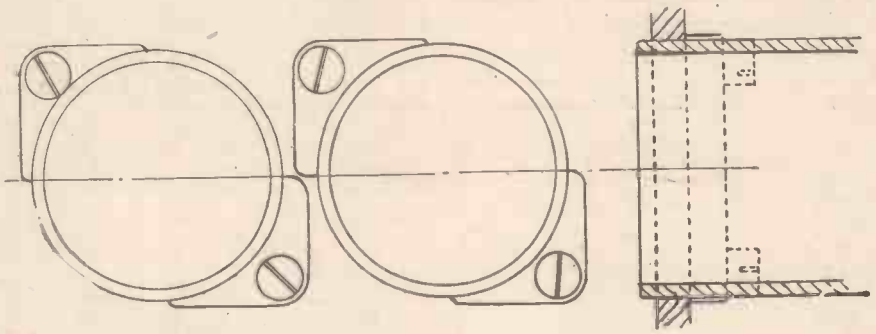
(4) Number of brushes, and their angular distance apart.

If these data are supplied a suitable winding can be got out to give the desired output.

An Electric Fence

HOW can I make an electric fence and how is the periodic impulse produced?—R. J. (Co. Kerry).

THE principle on which these operate is to employ a high-tension transformer of small output capacity, fed with current from a low-voltage accumulator. A slow-speed interrupter is used in the primary circuit, generally of the rotary balance wheel type, which gives periodic interruptions to the primary and causes a sharp shock to anything touching the communicating wires of the fence. The fence itself consists of plain wooden posts with a single wire in connection with the high tension side of the transformer, at such a height that the cattle can neither creep under nor jump over it without touching. No doubt a make-shift device could be developed using an old car ignition coil, but it would have to be fitted with a special slow-speed interrupter, either in the form of the balance wheel of a watch or with the usual oscillating motion slowed down to about 90-120 contacts per minute by counterweighting the trembler blade. The whole apparatus is marketed by The Harvest Saver & Implement Co., Ltd., 77, Queen Victoria Street, London, E.C.4.



Method of fixing cylinders of the engine for the model cargo boat.

Hydroculture

I AM interested in the new "tank gardening," and while I find there have been numerous references made to it in various publications, detailed information seems difficult to obtain.

I have a number of tanks each about a foot square and wish to grow tomatoes in them.

Could you tell me what chemicals would be required and in what quantities each should be used in a gallon of water? How

deep should the water be in each tank and should tomato seeds be sown or will plants suffice ?—J. S. (Teignmouth).

"HYDROCULTURE"—the growing of plants in water containing nutrient substances—is a fairly new branch of horticulture, but, so far, this form of "tank gardening" has not had very much practical success.

Seeds, of course, will not germinate successfully when placed under water; it is only with young plants or seedlings that the method of "tank gardening" is, in some instances, applicable.

Many varied solutions have been proposed for tank gardening. They all differ in the proportions of their ingredients. The following formula, however, will be found to be as good as any of them.

In two gallons of good clear water (preferably rainwater or water free from lime or chalk) dissolve :—

Ammonium sulphate	¼	oz.
Potassium sulphate	¼	,,
,, chloride	1/16	,,
,, carbonate	1/64	,,
Sodium sulphate	1/64	,,
Iron sulphate	1/64	,,
Magnesium chloride	1/64	oz.
,, sulphate	1/32	,,
Ammonium phosphate	1/32	,,
Sodium phosphate	1/32	,,
Potassium phosphate	1/32	,,

The resulting solution is the one in which the plants are grown. Only the roots of the plants should be immersed in the solution, and if the latter tends in any way to become mouldy, it should be thrown away and replaced by fresh solution.

Plants growing in liquids such as the above must be very carefully supported and must not be given too much sunlight, otherwise they will yellow and die.

Note, also, that solution-cultured plants, especially those of the very soft-stemmed varieties are very likely to contract diseases and to die on that account.

THE Cyclist
Editor : F. J. CAMM

VOL. IX JULY, 1940 No. 221

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'Phone : Temple Bar 4363.
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Comments of the Month

By F. J. C.

A Sign of the Times

IT is a sign of the times that signposts and milestones are, for the duration of the war, withdrawn. Our roads now take on an anonymous aspect, making travel difficult for the traveller unaccustomed to touring. Some of these old milestones are historic, and it seems a pity that they should be defaced by cement instead of being removed and replaced after the war. In most cases it will be impossible to remove the cement and thus these ancient milestones will be replaced by new ones. They provided a useful road measure for time trialists, and now that they have gone, the difficulties of time trials organisers have been increased. It means that more marshals will have to be employed to prevent riders straying from the course. Many instances have occurred already where fast riders have gone off the course and been put out of the trial. The obliteration of all signposts and direction signs will undoubtedly have a marked effect on touring, for individuals on bicycles who frequently stop to ask the way are likely to be suspected of fifth column activities. Still, it is in the interests of Home Security, to which the needs of sport must necessarily be subjugated.

War Effort and the Sport

ROAD sport is being affected in another way. Holidays have been cancelled, and some thousands of cyclists are working overtime each evening as well as Saturday afternoons and Sundays. This removes the opportunity for practice spins and makes it practically impossible to run week-end events. Already clubs are complaining of depleted entries. The R.T.T.C. has not given any lead to the clubs as to whether they should cancel their events in view of the Government decision to cancel holidays. The position seems to be that individual clubs will be left to organise events if they can. This is a policy with which we entirely agree. Some clubs have cancelled their events. The Bath Road Club will hold its famous "100" on the Sunday instead of August Bank Holiday.

Marguerite Wilson Again

MISS MARGUERITE WILSON, riding a Claude Butler bicycle with Sturmey-Archer hub gear, secured the Birmingham to-London W.R.R.A. record on Sunday, June 9th, beating the present holder Miss Biggs' record by nearly 7 minutes. This in spite of the fact that she elected to ride from London to Birmingham which provides a slightly more difficult course than riding from Birmingham to London. Miss Wilson's last two records were the Land's End to John O'Groat's and the 1,000 miles which she broke on the outbreak of war. Her present success demonstrates that notwithstanding the seven months' enforced inactivity from the record-breaking point of view, her skill remains. She proposes to attack the few remaining records which do not stand to her credit as well as to endeavour to beat her own 50 miles record. She is now acting as her own manager.

Materials for Bicycles

MANUFACTURERS are endeavouring to export 75 per cent. of their output, thus leaving 25 per cent. for home consumption. It is possible, however, now that most of the factories are manufacturing munitions, that materials may not be available within a short time for the manufacture of cycles. As from June 10th, the prices of bicycles were controlled by Government Order, and it is now illegal to sell bicycles and accessories at prices higher than those which obtained in August last, plus certain agreed war-time increases. Already manufacturers are well behind with deliveries.

Identity Cards

A REMINDER that cyclists should always carry their identity cards. They are liable to be stopped, especially at night, and it avoids complications if the card can be produced at once. In this connection it must be remembered that the police now have powers to detain anyone for inquiries for 24 hours.

Third-Party Insurance—Credit to C.T.C.

IN last month's issue when referring to the retirement of Mr. H. N. Crowe, we referred to the fact that one of the innovations for which he was chiefly responsible was the third-party insurance. We made this statement in common with other cycling periodicals, intending to convey that it was an innovation as far as the N.C.U. was concerned. They did not, of course, originate the scheme, for the C.T.C. several years before had introduced a scheme of free insurance for its members.

The Cumnock Rally

BY the time this appears in print the Cummock Rally will have been held. As we go to press we learn that a Dinner was held at the Hotel Royal on Sunday, June 30. The rally itself consisted of gala events, community singing, races, treasure hunt, bicycle polo, and speeches. In spite of the war, excellent support was received for the rally, which has done so much to foster interest in cycles and cycling.

Godwin Does It

TOMMY GODWIN, who, as mentioned last month, demonstrated that his daily wanderings for over a year of 200 miles a day had not affected his speed, rode the last lap of the 100,000 miles he set himself to do in 500 days, at the Paddington Track on Whit Monday. Owing to the cancellation of the meeting of which this last lap was to be an event, he restaged his last lap ride on the following Saturday. He actually completed his 100,000 miles in 499 days.

The Parachute Patrol Corps

OVER two dozen police constables have written to the N.C.U. in appreciation of their formation of the parachute patrol corps.

Aliens and Bicycles

UNDER a recent Order, aliens in this country may not possess a bicycle unless they are in possession of a special police permit. This new Order applies to all aliens over 16 years of age, whatever their nationality, and it orders them to be in their homes at 10.30 p.m. or by midnight in London. Apparently, the police are granting permits to aliens who satisfy them that a bicycle is necessary in connection with their work.

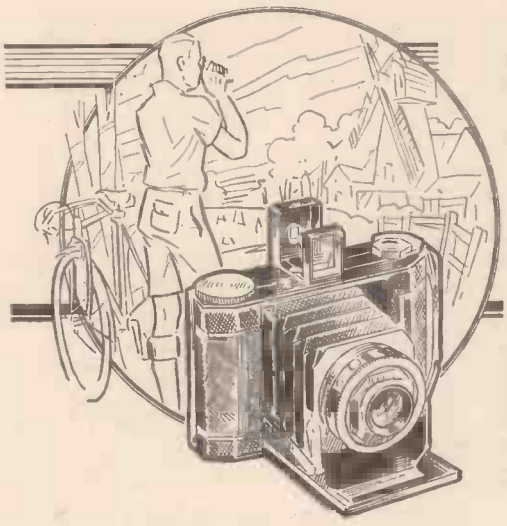
Another Jubilee

THE British Cycle & Motor Cycle Manufacturers & Traders' Union this year celebrates its Jubilee, for it was half a century ago that a few bicycle manufacturers, for their mutual protection, formed themselves into the Cycle Manufacturers' Trade Protection Association. It was some years later before its title was changed. The B.C.M.C.M. & T.U., has done an enormous amount of work in the interests of cyclists. They organised National Bicycle Week in 1923, and more recently the Keep Fit publicity scheme, on which they spent £25,000. During its history they have organised no less than 23 cycle exhibitions, and have given large sums of money to charity. They also were responsible for the formation of The National Committee on Cycling. They regard the interests of the users of bicycles as more vital even than the interests of manufacturers, and they have acted in conjunction with the C.T.C. and the N.C.U. on many occasions.

The Century Decision

BECAUSE the Century Road Club thinks that war conditions require it they have cancelled their road events and banned their members from competing in events promoted by other clubs. No club has the power to prevent its members entering "opens" run under R.T.T.C. or other recognised rules. It can, of course, prevent its riders from competing in unauthorised events, but the Century Road Club in this case is, in our view, out of order. We therefore advise any member of the Century Road Club, who wishes to compete in opens to do so, in the knowledge that his club has no power to prevent him doing so.

Incidentally, the badge of the Century Road Club advertises a particular journal, which is contrary to R.T.T.C. rules. Perhaps the secretary of the R.T.T.C. will make a note of this !



tyre, were 10 miles from home and had no money. Mr. Ford was able to effect a temporary repair which he learned afterwards saw the couple safely home; they came along to thank him and to buy a new tyre to replace the damaged one.

Parachutists

MR. J. W. BRYAN, director of the B.S.A. Company has made an appeal to cyclists not to leave their machines where they can get into the hands of parachute invaders.

Death of Mr. T. Sutton

THE death occurred recently of Mr. T. Sutton at the age of 65. When a young man he was one of Fenland's foremost skaters and was equally well known on the cycle racing track. He was recognised as almost unbeatable in 2 to 5 mile races and his racing opponents included such well known old-timers as Callagan, Fred Hawes, S. Greenhall, Kemp, Greenwood, Bamber, Stanford and W. Horn.

Bicycles and Machine Tools

IN his presidential address to the Birmingham section of the Institution of Production Engineers at the James Watt Institute recently, Mr. R. C. Fenton dealt with "Progress in Machine Tool Design." He said that the general public does not fully realise how important is the part played by machine tools in our civilised life. The production of almost any engineering product—as, for example, bicycles—is dependent entirely on the ingenuity and skill of the machine tool maker in devising the necessary machine tools for cheap production.

An American Victory

J. WALTHOUR and B. Thomas scored a victory for America in the recent six-day cycle race held at the Duquesne Gardens, Pittsburg. They covered a distance of 2,366.7 miles. "Torchy" and Douglas Peden, the popular Canadian pair, were second.

Paragrams

Current News Reviewed

A Bicycle Ballet

AN immense spectacle called "The American Jubilee" is one of the features of the New York World's Fair for 1940. Included in the Jubilee is a bicycle pageant in which 72 riders will appear on a stage 300 ft. wide. The cyclists will do trick riding and drill formations on ordinary stock bicycles and not on specially built machines which are generally used for trick cycling.

Spring Suspension

A SPECIFICATION has recently been published for yet another spring suspension for the fork-mounted wheels of pedal cycles.

"Quid Pro Quo"

THE manager of Currys Walthamstow branch, Mr. A. Ford, was recently concerned in a little roadside incident. He was returning from a visit to a customer in the depot van when he came across a couple walking and pushing a tandem. He pulled up and asked if he could be of any help and was told that the unfortunate cyclists had burst a front tyre, were 10 miles from home and had no money. Mr. Ford was able to effect a temporary repair which he learned afterwards saw the couple safely home; they came along to thank him and to buy a new tyre to replace the damaged one.

Cyclists and Cleethorpes Signals

COMPLAINT was made at a recent meeting of Cleethorpes Borough Council that the weight of a cyclist is insufficient to operate the town's traffic lights and men are often late for work because they have to wait for the lights. One cycling alderman also complained that the lights are almost invisible in daylight and said he thought they were red one day when they actually were green.

Tommy Goodwin at the Paddington track setting off on his last lap to complete his record ride of 100,000 miles. On the left is Charlie Davey and Mr. E. Coles-Webb is on the right.

NOTES OF A HIGHWAYMAN

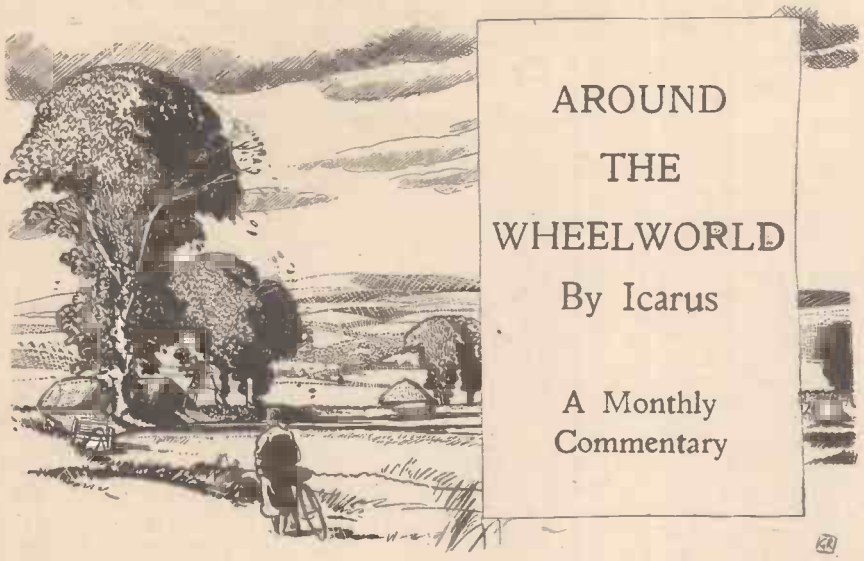
By L. ELLIS

WANTAGE is a pleasant market town in the Vale of the White Horse. It is celebrated as the birthplace of King Alfred in A.D. 849, but is singularly lacking in other historical connections. Alfred's Well and Alfred's Bath can still be pointed out but it is to be feared that little or nothing remains in Wantage as a memorial to a great king. His palace is gone and no trace remains of the manor that followed it. The greatest monument to his memory are the sites of his many battles with the Danes in the neighbourhood and it is said that the great battle of Assendun, or Ashdown, was fought on the chalk ridge near the town. Tradition goes on to say that the so-called White Horse at Uffington commemorates the victory and that the carving was executed by Alfred's orders. Most people are agreed however that this particular white horse was old before Alfred was born. There is a fine statue to Alfred in the market place and the inscription is even finer and very much to the point. It reads: "Alfred the Great, The West Saxon King, born at Wantage A.D. 849. Alfred found learning dead, and he restored it, education neglected and he revived it, the laws powerless and he gave them force, the church debased and he raised it, the land ravaged by a fearful enemy from which he delivered it. Alfred's name will live as long as mankind shall respect the past." In the market square there is a picture gallery known as the Victoria Cross Gallery.

The sundial and lock-up, Steeple Ashton, Wilts.

ONCE A CELEBRATED MARKET

THE village of Steeple Ashton, four miles from Trowbridge, gets its first name from the staple, or market, that once was held there. Market rights were granted by charter in 1387. An old market cross once stood in the middle of the street and it is said that its erection coincided with the date of the landing of William the Conqueror. The spot is marked to-day by a tall sundial, erected about two hundred years ago. Quite near it is a curious old round, or nearly round, house, once used as a village lock-up. Steeple Ashton was famous until the sixteenth century as the headquarters of a colony of cloth manufacturers and many memorials to their generosity may be found in the interesting church.



AROUND THE WHEELWORLD

By Icarus

A Monthly Commentary

Those Folding Bicycles

THE daily newspapers with that propensity for perverting facts for which they are renowned have been making a good deal of the alleged use of folding bicycles by German parachutists. The amount of equipment which these parachutists are alleged to carry would break something more than a camel's back. Our experts of the daily press would be better occupied as imaginative fiction writers, for the facts are that the parachutists' equipment is dropped in a separate container after their descent. A certain section of the press imagines that every ingenious device must necessarily be invented by a German. They have a comparatively short memory for British inventions, even if they have never heard of them. Folding bicycles were first produced in this country, and over 50 years ago. They were used to a small extent in the South African war, and to a somewhat greater extent by the Allies in the last war. Within the last five years the New Hudson Company produced the bolted-up bicycle, which could be quickly dismantled and packed into a case no larger than that required to pack two wheels.

In America the Westfield Manufacturing Company, who make the Columbia bicycles, have produced the folding bicycle illustrated. According to their claim it is America's first folding bicycle. Credit where it is due.

Electrically-Operated Bells

IN conversation with a friend in the trade recently, he suggested that as a goodly proportion of modern bicyles are equipped with a lighting dynamo the current could be used to operate the bell. On the face of it, this seems a practicable arrangement until we remember that the dynamo is only put into operation after lighting-up time, and easy running as most modern dynamos are, cyclists would not consent to trundle them round all day in order to provide the occasional electrical energy required to operate the bell. The scheme would work, of course. It would merely be necessary to incorporate on the stator plate of the bell a simple vibrator or trembler coil similar to an electric door bell. In view, however, of the comparatively small current output and the fact that most dynamos generate alternating current, there are other complications which put the idea out of count.

Magnetic Spokes

WHICH reminds me, that some time ago I took out a patent for obtaining light through the medium of magnetised spokes. Such a scheme would mean a considerable saving in weight. A test showed that it worked. It was, of course, particularly necessary to see that the north and south poles of each magnetised spoke were at the correct ends of the spokes. The coils were arranged around each limb of the front fork, but even so it was not found that a sufficiently brilliant light could be obtained, apart from other disadvantages.

The Course-Limit Factor

MOST handicappers are cursed by the handicapped. It is their problem to reduce a time trial by a process of arithmetic to an arrangement whereby each rider would finish in the same time. It never works out that way. A handicapper must essentially handicap on the riders' previous known time for the particular distance. Such a time may have been made on a good course or a bad one, and it is impossible for any handicapper to take an accurate account of that. Also, the time might have been made on a bad day when rain and/or a head wind or a following wind affected the time of the ride. The good handicapper will always allow a little for improvement on the part of the rider since his previous time was made. It seems to me that what is wanted is a course's limit factor which should be taken into account as well as the time.

Alec Horwood Escapes

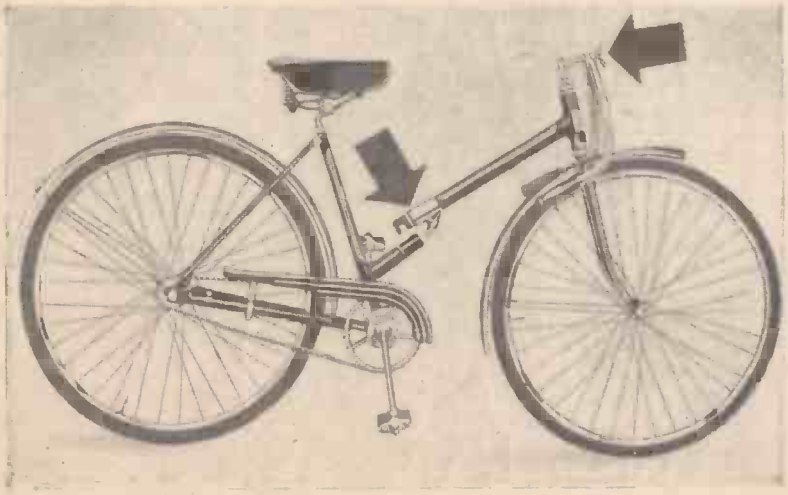
ALEC HORWOOD, previously captain of the Bath Road Club, and still a member of it was, I learn, made a prisoner of war but he escaped and is now in this country. Which reminds me that some consideration should now be given to the form of memorial for cyclists who fall in the present war. The Cyclists' Memorial at Meriden was erected to the memory of those who fell in the last. Obviously, something similar will be done when this present holocaust is over and we have given Hitler his quietus; but now is the time to think about it.

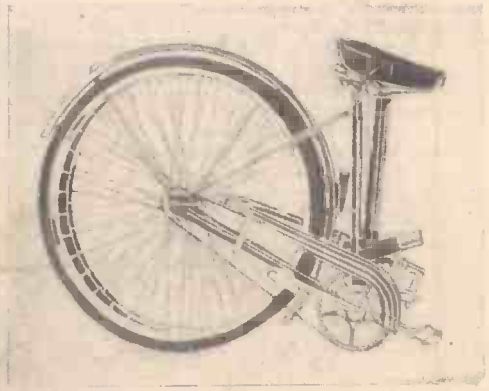
Useful Handbook

THE Farmhouse and Country Holiday Handbook for 1940-41 makes its appearance at 7½d. It is published by the Farmhouse Holiday Bureau, Salterns, Eashing, near Godalming, Surrey. This handbook makes the search for accommodation easy. It lists 350 farms and country houses in some of the most delightful parts of the country where holidaymakers will be welcomed and provided with comfortable rooms and good home-grown food.

The Poor Timekeepers

EVERYONE knows that time trials are run for the benefit of timekeepers. The abandonment of many events does not, we understand, meet with their approval !





The Columbia folding bicycle referred to by Icarus. It is of American pattern

WAYSIDE THOUGHTS

By F. J. URRY

Hints on Choosing a Bicycle

I WANT to make the readers of these notes feel that a cyclist is talking to them who has had practical experience of the road and the vehicle on which he has covered some 400,000 miles of our British and Irish highways in the last 51 years. Naturally, all of us have our own ideas as to the best method of using a bicycle so that we shall obtain from it the greatest value, either in ease of running or speed of travel, and longevity of service combined with reliability.

I came into the cyclist movement just on the threshold of the arrival of the pneumatic tyre. As a matter of fact, that article had not been marketed when I was given my first bicycle by an indulgent parent. Since those days, at the tender age of ten, I do not think I have been divorced from the saddle of a bicycle for a whole fortnight, and during those fifty years have bestridden every type of bicycle and tricycle marketed since 1890. Many of them are now completely forgotten, and some of them were impossible freaks.

Present-Day Conditions

After all these years, it is natural that I should have settled down to a type of machine that suits present-day conditions and my own particular notions of what a bicycle should be for comfort. The question of speed, as such, has long ago departed, and the translation of momentum, as far as I am now concerned, is purely a question of how easily I can cover the miles and gather an enjoyment of road roaming that seems to become greater and greater as the years roll by.

I do not intend, with the Editor's permission, to paraphrase the many and various books that have been written on the upkeep of a bicycle, or the best methods for the individual use of it; but rather to deal with the matters concerning cycling as they occur to me without tabulating their form or insisting that my point of view is the right one. Quite obviously there is a wide difference between people of a like mind in the matter of the convenience and the love of cycling, and the best methods with which to implement cycling's means of locomotion.

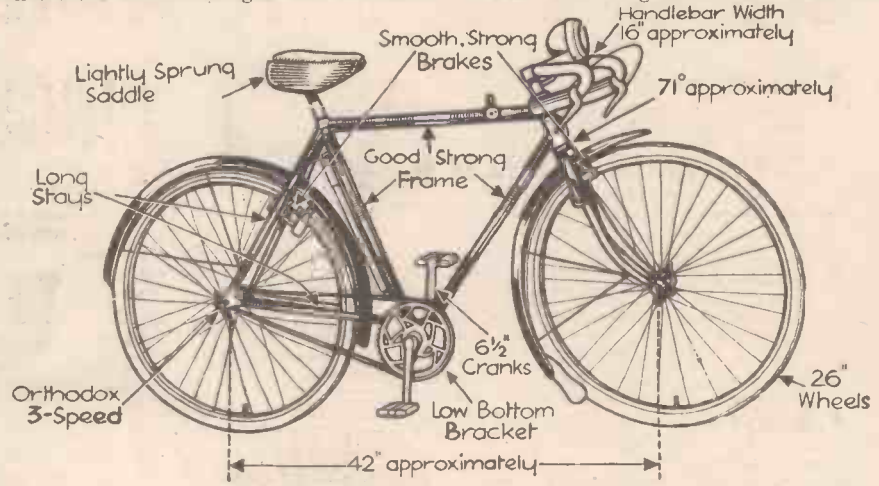
I imagine that I have been fairly catholic in my ideas, and all my bicycles, while of very similar specification, are variously equipped except as regards those matters of comfort which to me are paramount in bicycle specification if happiness awheel is to be attained and fully exploited.

Comfort Awheel

I have said on numerous occasions, and I make the statement again here, that unless an individual is comfortably seated awheel it is impossible to enjoy cycling, whether it is undertaken as a pastime or a mere matter of convenience. Therefore, it follows that I consider the most important part of the equipment of a bicycle is the saddle, for if you cannot sit comfortably and at ease under all conditions, then the handicap on enjoyment is a very serious one. Time and again I have tried most of the makes of saddle now on the market, and my own choice is for a leather saddle which is wide enough to sit on, long enough to shuffle on, and light enough not to be burdensome.

I have a leather saddle in service to-day that has been unchanged for over eighteen years, and the name stamped on the flap of the saddle has been entirely obliterated by the friction of the garment that comes in close contact therewith.

That, I think, is the first thing any cyclist, or would-be cyclist, should bear in mind. Unless you are comfortably seated, it is impossible to enjoy cycling, just as it is impossible to enjoy walking unless you are comfortably shod. It is an astonishing thing how many times in my life I have discovered individuals endeavouring to use themselves to the wrong type of saddle for their purpose, and always finding the process uncomfortable; whereas a change of saddle has worked miracles to their wheeling happiness.



Points to consider when purchasing a new machine

The Bicycle Itself

When this question of saddle has been satisfactorily settled (and, believe me, it is not an easy matter to bring home to the average rider the importance of the saddle and its relation to happy cycling), then the next thing to consider is the bicycle itself. This should be as small as possible, and its details of the simplest nature.

When I say the bicycle should be small, I mean that the need for high frames in these days has entirely departed. Even the tallest man should not need more than a 24 in. frame, since the leg length can be obtained by a long saddle pillar and handlebar stem.

It is obvious that the smaller the bicycle frame, within reason, the more rigid it must be as well as lighter, and those are the two main items in the construction of a good class, easy-running machine—rigidity and lightness.

I am aware that the modern tendency is for colourful finishes, and I can quite understand that the younger generation find these entrancing, particularly when the bicycle is in its pristine condition; but if you want a machine to last and look well at the end of several winters' hard work, then there is nothing to beat an all-black finish of rubber enamel without any shiny coat as generally given to the all-black bicycle.

A Lasting Investment

Indeed, I have a machine now in regular use which only takes the road when the weather is inclement because it is fitted with a perfect oil-bath case, and that machine is 22 years old, yet it could be taken as a modern example of perfect cycle engineering after it has had a sponge down. It is true that the only original parts of the bicycle left are the frame, cranks, chain (which has lasted all those years in its oil-bath case), handlebars, saddle, and hubs. The pedals have been replaced, the brakes have been replaced, the rims have been replaced, and I do not know how many pairs of tyres that machine has worn out, but it must run to at least something between six and ten.

I merely mention that bicycle to show that a really good-class bicycle, finished in all rubber black enamel, is a lasting investment, and far cheaper in the long run than a machine at a third the cost, as well as being much more reliable.

People must, of course, please themselves in regard to finishes. Generally they are optional, or at least there are many types of finishes which most of the manufacturers can supply, sometimes at the list figure quoted, but frequently at a small extra for special colours. These machines, I admit, make a gay procession along the road, but sometimes I have seen them when neglect has given them almost a discarded air, and made them appear but a sorry shadow of their younger days. That never happens in quite the same degree to the all-black finish, however neglected that machine may be.

The other important items of equipment are wheel size, which are now mostly 26 in., for the sake of obtaining a low bracket position, whereby the rider can always drop his foot to the ground for the purpose of easily obeying traffic or police signals.

(To be continued)

Gears and Gearing

By A. W. BRUMELL

Continued From Page 7 of Last Month's Issue

MANY and various are the different varieties now on the market. They can, however, be classed under two main heads, viz., hub-gears and derailleurs. The first are totally enclosed in the rear hub and obtain their results by means of pinions operating on the "sun and planet" principle. The latter, as its French name implies, gains its gear changes by derailing the chain and causing it to jump from one cog to another of different size.

Hub Gears

Until quite recently, the main arguments against hub-gears were that the differences between their various gear sizes were too wide and that it was necessary to back pedal slightly in order to cause them to change. These two disadvantages have now been completely removed. Though the wide-ratio hubs with their 33⅓ per-cent. jump upwards and their 25 per-cent. drop down from normal are still available, there also are models which provide 15 per-cent. and 7 per-cent. alterations respectively. The wide ratio is intended for tourists who wish to tackle all varieties of gradient; riders, that is, who prefer ease to mere speed. The medium ratio hub is designed for the club rider, those who at times travel fast over undulating roads, those, that is, who want comparatively slight changes of gear-size and are prepared to pay the price for it in harder pushing on the upgrades. The ultra-close hub with its mere 7 per-cent. change is meant almost exclusively for use by the racing man in time-trials over roads picked for their easy gradients. He requires only almost imperceptible changes. To alter his gear more than a few inches at a time would completely destroy the rhythm of his riding, while to drop his gear too low would give his opponents an unnecessary advantage. Used by itself this model is not of much practical use to the tourist—the difference between the top and the bottom gears being far too small to make much difference in one's ability to climb the steep hills invariably found in "real" touring country. Used in conjunction with a double chainwheel and a chain-shifting device, however, I have been able to obtain six gears which were so delightfully close together that I was not conscious of any alteration in pedalling rhythm or pressure required whenever it was necessary for me to change, yet, nevertheless, giving me a wide enough change between top and bottom to meet all gradients.

Massed-Start Races

The massed-start rider races, as a rule, over far hillier courses than the time-trialist, and hence requires a much lower bottom gear while still requiring the high ones. The needs of the average fast club-rider who must be always ready to counter the speed-moods and spasms of his club mates are very similar. For such as these, the 4-speed hub-gear has been designed. It is made in two types, the close ratio and the medium ratio. The former gives a high gear with a 9.1 per-cent. increase from normal, a normal gear taking the direct drive, an intermediate gear giving a 10 per-cent. decrease from normal and a low-gear giving a 25 per-cent. decrease from normal. The medium ratio model gives a 12.5 per-cent. increase for the high and 14.3 per-cent. and 33.3 per-cent. decreases respectively for the two low gears. Perhaps it will convey more if I quote definite gear sizes to illustrate the possibilities of the hub. With the close ratio, using a 44-toothed chainwheel, a 14 cog and a 26-in. wheel, one can get gears of 61.3, 73.5, 81 7 and 89.2—a very useful set indeed for the massed-start racing-man. Replace the easily removed, splined 14 cog by a 16 toothed one and the very useful combination for mixed touring and club-riding of 53.6, 64.3, 71.5 and 78.1 is obtained. For a rider more interested in touring the medium ratio type used with the same equipment and a 17 cog will offer gears of 45.2. 57.7, 67.3 and 75.7.

Two-Speed Hub Gears.

There are also 2-speed hub-gears. These are also in two ratios designed so to cover the needs of both the racing man and the tourist. For the former, the close ratio gives a low gear with a 13.46 per-cent. reduction from the direct-drive normal. This reduction is equivalent roughly to a two-teeth increase in the number of teeth on the rear cog. In other words, a time-trial rider could have a 77 gear for going out into the wind and an 89 for coming back with it. Added to this, by using either a free wheel or a fixed cog on the splined hub, he could use either a free or a fixed gear—a choice not open to him on any other type of change-speed gear. The snag is, of course, that very few courses are straight out and home into the wind and one might easily discover that a cross wind would find one without a gear to suit the occasion. Twelve inches is too big a difference nine times out of ten and most riders would prefer the little extra weight of a three-speed just for the sake of the handy middle-gear.

The wider ratio two-speed gives a low gear with a reduction of 25 per-cent. from normal, a difference, equivalent roughly to an increase of four teeth on the rear cog. Having used such a gear fitted with gears of 73.5 and 55.2 for several years before the three-speeds were improved to their present efficiency, I can vouch for its slick changing and useful performance. Nowadays, however, I require a wider selection both in number and size. Seventy-three is not high enough with a gale behind nor 55 small enough for a "1 in 5" hill! The much-vaunted "fixed or free" advantage is all very well for the racing man endeavouring to get fit and bent on using as much energy as possible in the shortest possible space of time.

(*To be continued*)

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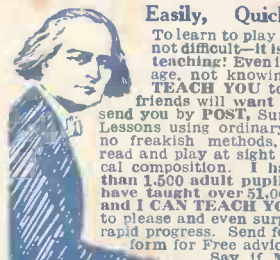

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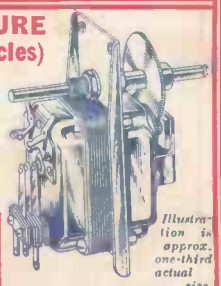

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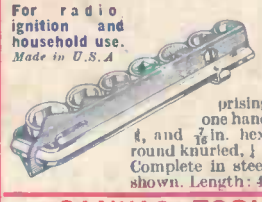

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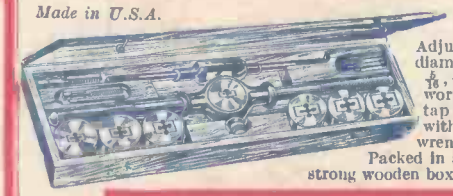

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