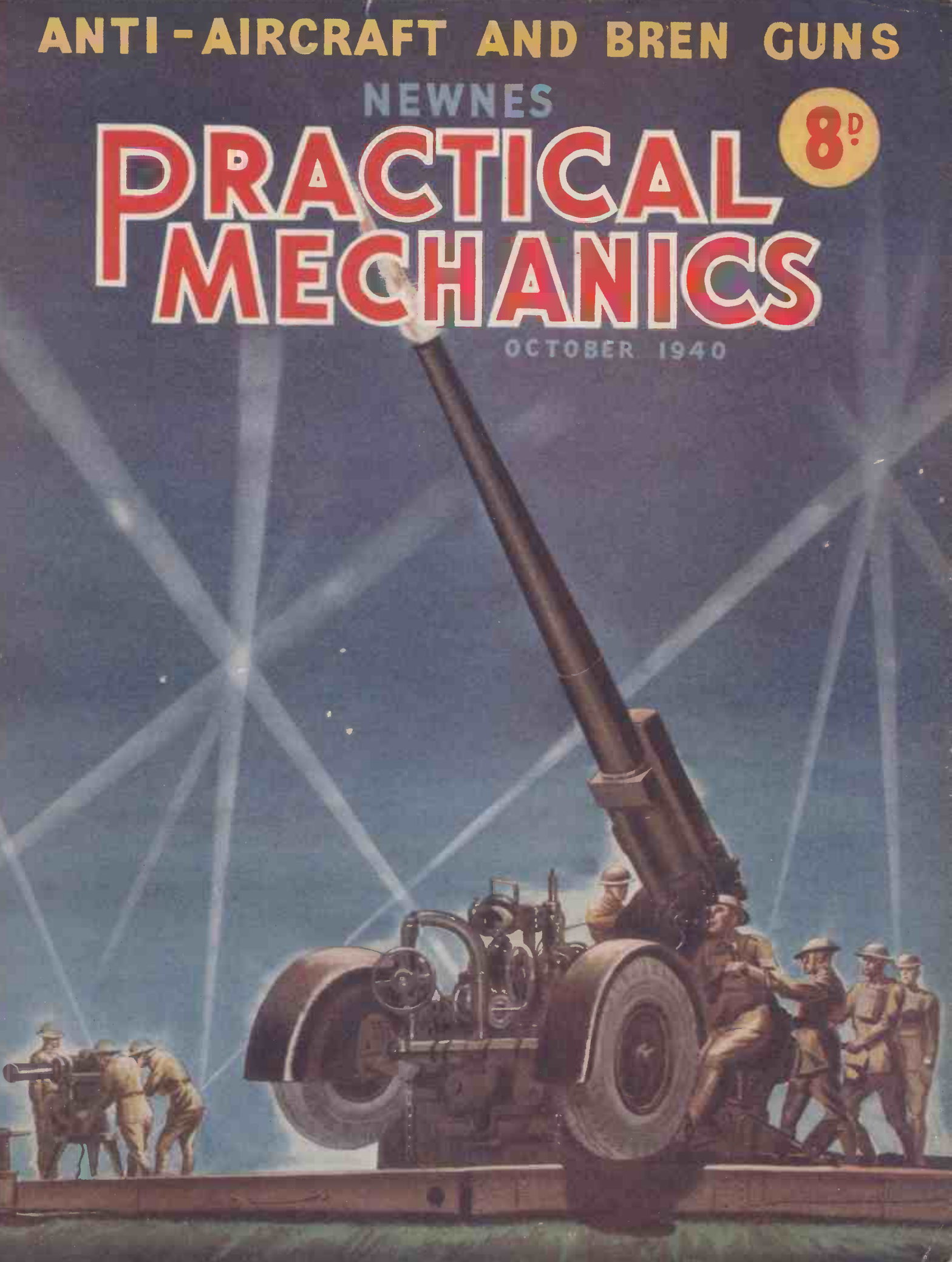
ANTI-AIRCRAFT AND BREN GUNS

NEWNES

PRACTICAL MECHANICS

8D

OCTOBER 1940



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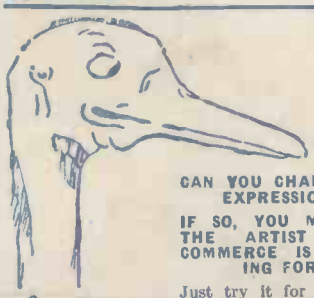

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Inland and Abroad 9s. 6d. per annum.
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Editorial and Advertisement Office: "Practical Mechanics," George Newnes Ltd. Tower House, Southampton Street, Strand, W.C.2.
'Phone: Temple Bar 4363.
Telegrams: Newnes, Rand, London.
Registered at the G.P.O. for transmission by Canadian Magazine Post.

PRACTICAL MECHANICS

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

Editor : F. J. CAMM

VOL. VIII. OCTOBER, 1940. No. 85

FAIR COMMENT

WANTED—MINISTRY OF IDEAS AND INVENTIONS

By The Editor

An Old Wish

EACH of us is acquainted with an individual who bemoans his fate and who is certain that he could do better "if he only had the chance." There are many of these who fail to recognise the opportunity when it arises, and whose lack of progress is due to that lack of recognition. There is a school of thought which presumes that a good idea brings its own reward, and that the whole world should acclaim the good idea and pay its financial tribute to the creator of it. The real skill is in the development and the marketing of the idea to the advantage of the one who conceived it.

An idea may seem good, but it requires considerable investigation experiment and development before the snags are found. It may be discovered that the idea is not original. There may be manufacturing drawbacks. An idea to be good must be successful, and to be successful it must be marketable.

Investigate Ideas

AS my years of experience in dealing with inventors grow, and the volume of correspondence increases, I am none the less forced to the conclusion that this country does not encourage inventive enterprise as much as certain Continental countries. What is wanted here is a Ministry of Invention and Ideas which will analyse and, if necessary, subsidise inventions, for the nation with the highest degree of inventive faculty must eventually survive. Inventors, in this country, are positively discouraged from pursuing their ideas because of the apathy of manufacturers in general, and the Government in particular. This particularly applies to poor people, who in many cases cannot even find the few pounds necessary to patent the idea. We require a panel of experts who can sift the value of ideas, if necessary patent them and make advances to the inventor with, of course, a State interest in the profits as a return. In Germany such a system has operated for years. It may be that some thousands of worthless ideas are investigated, but during the investigation the inventor is paid a sum of money to proceed with his experiments, and out of the plethora of worthless ideas and the refining furnace of investigation emerge really worthwhile ideas of value to the individual and to the State. And it is my view that the State should take control of its inventors, and not leave them to the thorny paths of penury and to the exploitation of unscrupulous speculators who buy up valuable inventions for trifling sums. Very few inventors are business people, and more often than not they are cheated of the rewards due to their labours. Many of them have, indeed, sold valuable inventions to foreign countries when they would have been of far more use to us.

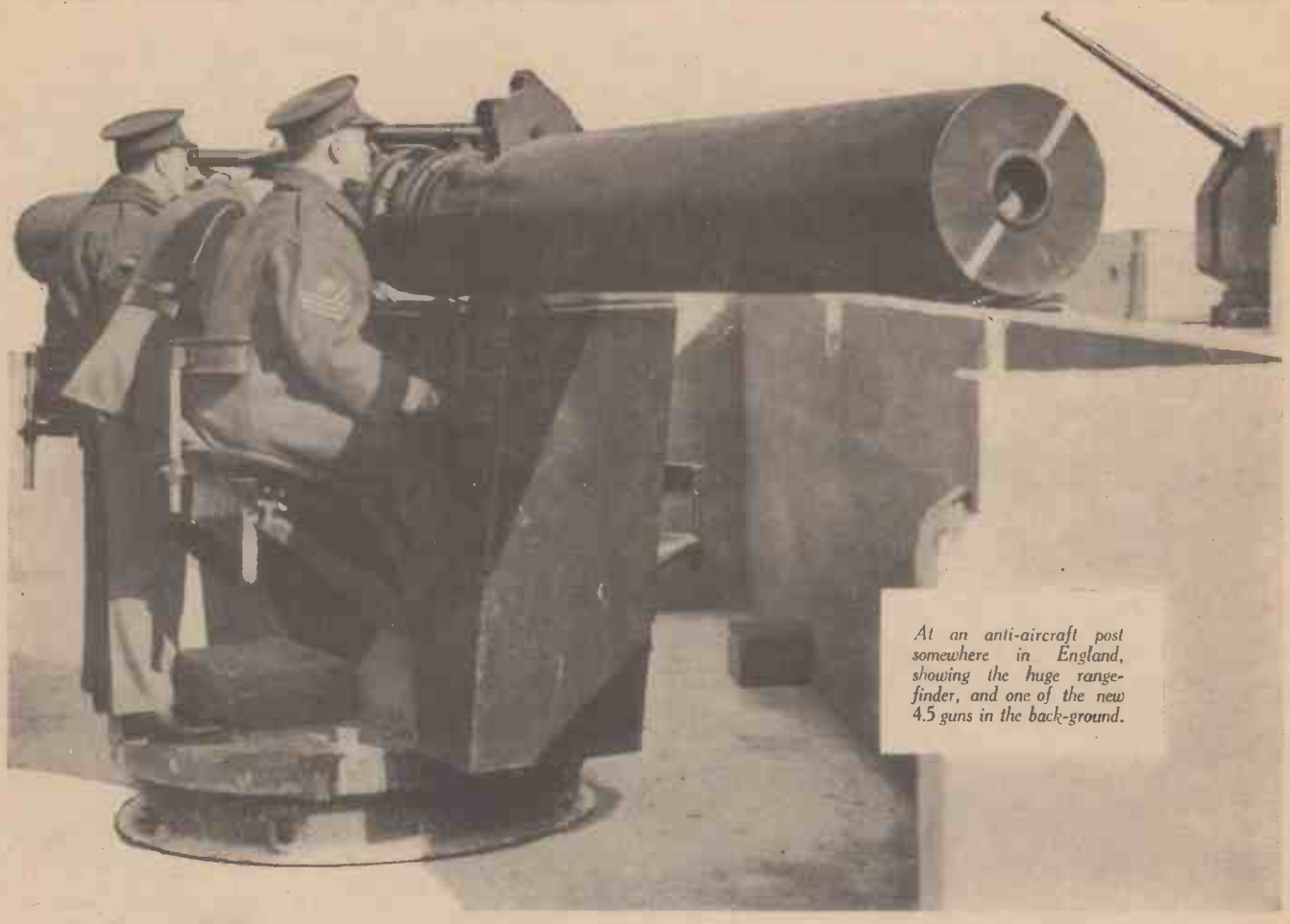
The Post-War Period

WHEN this war is over, there will be a boom in certain industries which will be hard pressed to make up for the lack of production during the war. There will be a boom in engineering and in building, in toy-making and in automobiles, to mention but a few of the industries which have to make up the production time lost during the war. Now is the time, therefore, to lay the post-war plans, to have the ideas ready; during the last war very few firms laid post-war plans, and when the war suddenly ended, as this one will suddenly end, many firms suddenly deprived of munition contracts went bankrupt. Our main concern must be to win this war, but equally we must remember that it cannot last for ever, and if post-war depression is not to deprive us of the fruits of victory we must now lay post-war plans. Inventors create trade. They must be encouraged and organised. We must regiment their ideas and exploit them to the national good. We must not, in future, allow valuable ideas to lie dormant for want of capital. It is essentially a job which the Government must tackle, particularly if we wish to capture foreign markets. The export trade of our enemies is at a standstill, and it should be the duty of some Government department here to lay such plans as will enable us, when the war is over, immediately to supply those markets. We are doing a fair amount now in that direction, but there are many (clocks and cameras, for example) untouched.

In the words of Mr. Morrison, let us Go To It—*Now!*

Carrying On

THIS issue has been prepared during a series of air raids which have taken place daily and nightly for a fortnight. But here it is, in your hands, punctually and, I trust, of unimpaired quality. London is, indeed, well in the firing line, and the crack of anti-aircraft fire and the dropping of the bombs in the vicinity leave the editorial staff undisturbed. We have a service to perform to our readers and, in common with all other journals and periodicals, we carry on during and in spite of the war. The public does not always appreciate the vast amount of work which goes into the production of each issue, and which they obtain for a few pence per month. The small service that we ask in exchange is that you should place a regular order with your local newsagent for its delivery to your door.



At an anti-aircraft post somewhere in England, showing the huge range-finder, and one of the new 4.5 guns in the back-ground.

Anti-Aircraft and Bren Guns

How Britain Defends Herself Against Raiding Aircraft

"AN enemy bomber was shot down by anti-aircraft batteries early this morning. . . ." Behind this formal statement that yet one more Heinkel or Dornier has been destroyed lies a story of intense but ordered activity by anti-aircraft units. First comes the message, brief and to the point: "Enemy aircraft approaching at position X. Height 12,000 feet. Warn all batteries in area." Within 30 seconds, the anti-aircraft crews are at their allotted stations. Guns are loaded. Quick-firing Bofors, 3.7's, and big 4.5's are ready to load the sky with menace. The gun layers swing their long barrels into the darkness, but as yet all is silent. Suddenly a searchlight shoots a long pencil of light into the sky, and soon a dozen searchlights are groping into the blackness above. From far up in the silent sky, faint but unmistakable, comes the sound of engines. In the beams of the searchlights, a speck is seen flying towards the east, and the enemy is "held."

The Predictor

Nearby is the predictor which is now ready to play its part. Its complicated collection of knobs, lenses and dials can do the work of four men, telling the gunners where to direct their fire. Dramatically and without warning, firing levers are rammed over, there is a reverberating boom and a shell leaps into the air, to explode with an orange flash thousands of feet in the darkness above. Other guns take up the challenge and soon the enemy is under heavy fire. The sound of exploding shells grows more distant, and again there is silence. A telephone rings and a voice says: "An aircraft, believed to be a Heinkel 111, reported down in flames in a wood about 12 miles from position X. Looks like one of your batteries. Good show!" That in brief is what happens every time raiders approach this country.

When the last great war started there were no British anti-aircraft guns in existence. In 1915 an anti-aircraft howitzer made its appearance and it was nicknamed "Archie." This gun was followed by a pom-pom gun firing a one-pound shell, but this proved unsatisfactory as its shell only exploded on impact. Next a 13-pounder mounted on a motor chassis for mobility made its appearance in 1916. This gun was the real "Archie" and it fired H.E. and shrapnel shells. From that time on very little progress was made in the development of the anti-aircraft gun.

Modern Guns

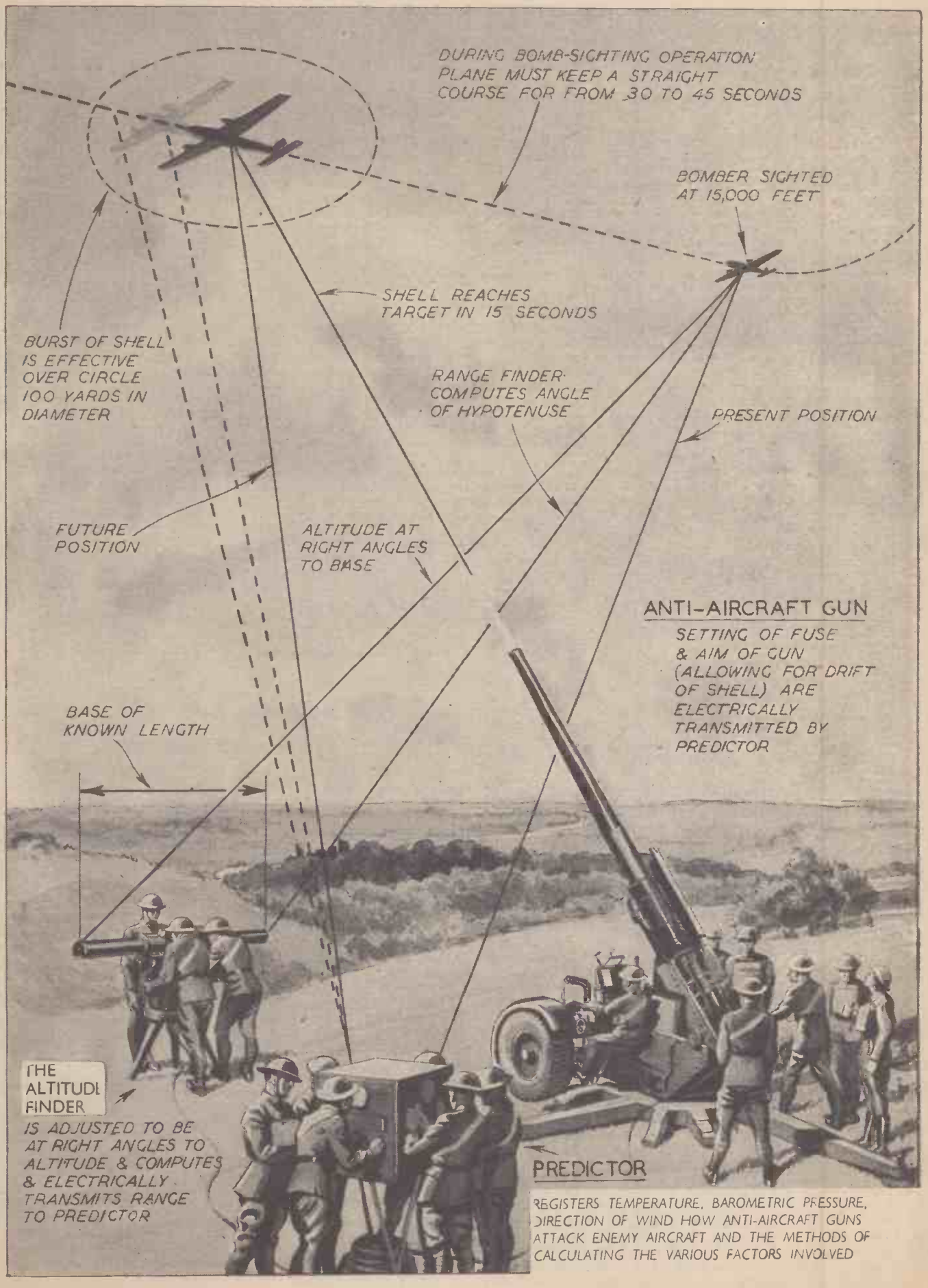
During recent years, however, inventors have concentrated on A.A. guns and now we have several types in use, each for a special purpose. The most familiar is the Lewis gun which is capable of delivering heavy bursts of fire and requires a small crew to operate it. It is used mainly for defence against low-flying planes and is capable of firing 150 rounds a minute. It is chiefly used for local defence purposes at search-light positions. A similar type of gun is the Bofors gun which is very effective against dive-bombers. It is small compared with the 3.7 or 4.5 A.A. guns, and fires a stream of tiny high-explosive shells, each of which can inflict serious damage to an aeroplane. A feature of the Bofors gun is the large sights which enable it to keep in focus any bomber flying at close range and high speed.

By simply turning a geared handle, the gun-layer can swing the whole gun round very rapidly, and the barrel can be raised or lowered equally swiftly. Clips of shells are fed in from the top of the gun.

The whole gun runs on four heavy-duty balloon tyres, which allow it to be transported quickly over rough country.

Guns With High Ceiling

A gun which has made its debut in this war is the now famous 3.7 which has a ceiling of over 30,000 ft. Messrs. Vickers-Armstrong carried out experiments nearly ten years ago with a view to producing an


DURING BOMB-SIGHTING OPERATION PLANE MUST KEEP A STRAIGHT COURSE FOR FROM 30 TO 45 SECONDS
BOMBER SIGHTED AT 15,000 FEET
SHELL REACHES TARGET IN 15 SECONDS
BURST OF SHELL IS EFFECTIVE OVER CIRCLE 100 YARDS IN DIAMETER
RANGE FINDER COMPUTES ANGLE OF HYPOTENUSE
PRESENT POSITION
FUTURE POSITION
ALTITUDE AT RIGHT ANGLES TO BASE
ANTI-AIRCRAFT GUN
SETTING OF FUSE & AIM OF GUN (ALLOWING FOR DRIFT OF SHELL) ARE ELECTRICALLY TRANSMITTED BY PREDICTOR
BASE OF KNOWN LENGTH
THE ALTITUDE FINDER
IS ADJUSTED TO BE AT RIGHT ANGLES TO ALTITUDE & COMPUTES & ELECTRICALLY TRANSMITS RANGE TO PREDICTOR
PREDICTOR
REGISTERS TEMPERATURE, BAROMETRIC PRESSURE, DIRECTION OF WIND HOW ANTI-AIRCRAFT GUNS ATTACK ENEMY AIRCRAFT AND THE METHODS OF CALCULATING THE VARIOUS FACTORS INVOLVED

efficient type of A.A. gun. The 3.7 was the result. It fires a shell weighing 28 lb. and loading is "semi-automatic." When the gun is first brought into action the breach is operated by a hand lever, but as the barrel of the gun recoils the breech opens of its own accord causing a spring to compress and eject the empty shell case. At the side of the bore is a tray for holding the ammunition and this tray is brought into line with the bore as the breech opens. A wire-operated ramming device is then used to ram the shell home, which is then fired by a lever.

On the top of the weapon is a device for taking up the heavy recoil of the gun. This takes the form of a compressed-air brake fitted in a metal cylinder. When in action, the gun is steadied by four metal feet which are fastened to the ground. It is capable of firing 15 rounds a minute.

Rapid assembly is one of the most important features of the gun, and it can be set up into position in a very few minutes. Electric batteries are carried by the gun, and the illuminated dials of its instruments enable the gun to be used during hours of darkness. It has a firing angle of eighty degrees, which is almost vertical.

Range-Finders

With this type of gun as well as our 4.5 A.A. guns a special predictor mechanism is used including long-distance range-finders. The earliest types of range-finders were extremely cumbersome but prismatic devices have now been introduced which have considerably reduced their size. At one time it was necessary to have a range-finder 100 ft. long to reduce possible technical error to 100 yards at 20 miles, or 10 ft. long for 100-yard accuracy at 10 miles. A number of these long range-finders are still used on warships, but a new type of "coincident" range-taker is now used for A.A. guns which is shorter and more accurate. Two prisms with accompanying optical group are used, one introducing a 90-degree beam to the observer, and the other showing an image at the eyepiece in a position that depends on the distance. It can be likened to the moving-image or double range-finders that are used on many cameras. Two pictures of the target are seen by the operator when he looks through the eyepiece, and they are brought together by moving a control. The correct range has been found when the two images merge into one and the distance is read off on a meter.

The Sound Locator

To further simplify the work of the gunner, a device known as a sound locator is brought into operation. This is a weird-looking machine fitted with a number of cup-shaped trumpets which act as giant ears. The locator is mobile and the operator and trumpets rotate around a common axis, the movement being carried out by the operator. When enemy aircraft approach, the operator, who uses a stethoscope, rotates the locator until the noise made by the engines of the approaching aircraft is equally heard in both earpieces of the stethoscope. The height and direction of the enemy aircraft can then be determined as soon as the "ears" of the locator are pointed directly towards it.

As time takes an appreciable period to travel over a given distance, allowance must be made for "time lag." The speed of sound is 1,100 ft. a second, therefore it would take 10 seconds to travel 11,000 ft., and this must be allowed for in the calculations sent to the gun crew.

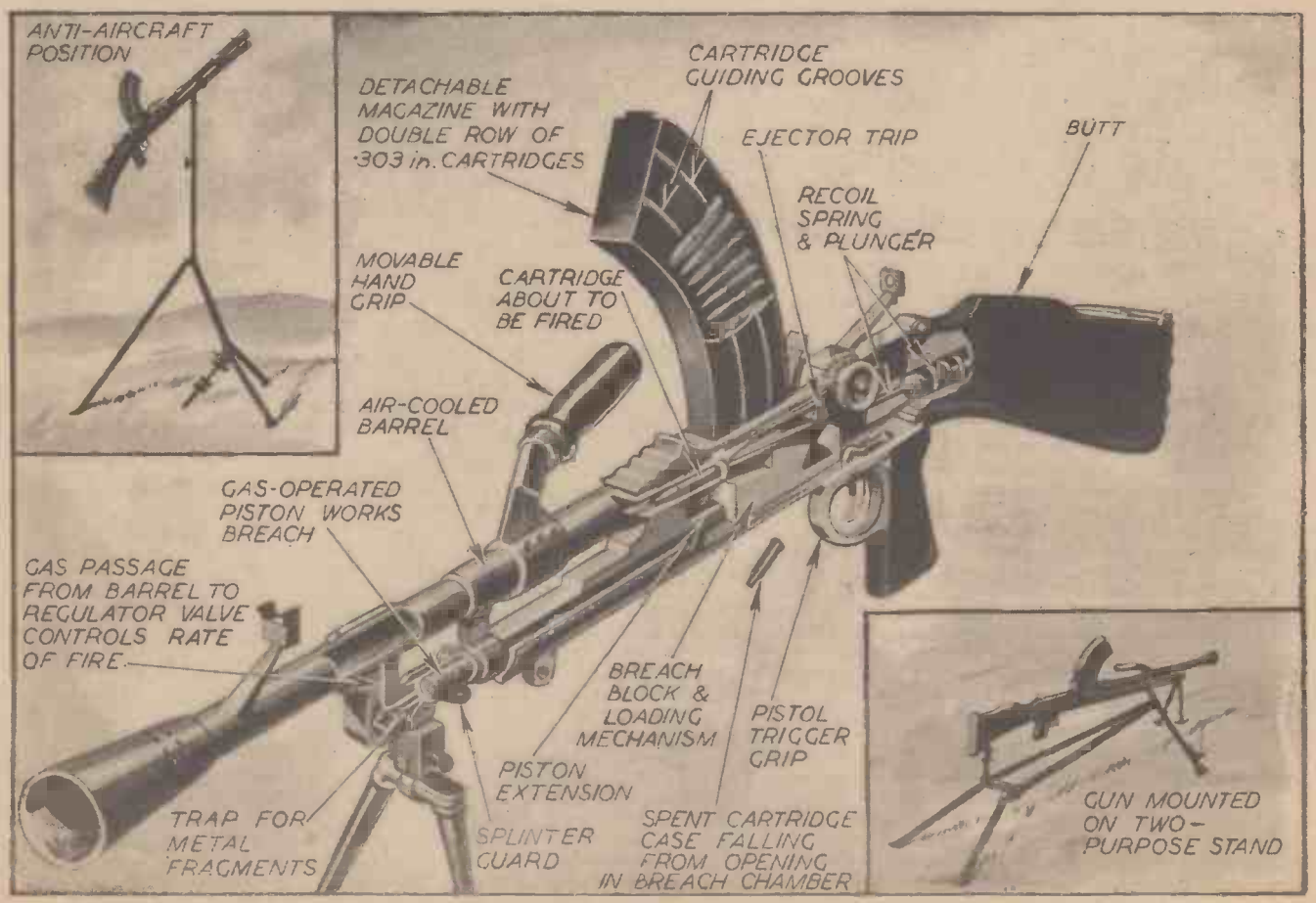
The Bren Gun

Yet another new gun suitable for low-flying aircraft is the Bren, named after the Czechoslovakian town of Brno, where it was invented. This light automatic gun is capable of firing 500 rounds a minute, and is possessed of a high degree of mobility. A bipod is under the barrel, behind the trigger is a fingergrip, and a folding shoulder rest is on top of the butt. A detachable handle for the left hand is on the underside of the butt, and this enables the recoil to be shared by the right shoulder and the left arm, thus reducing the effect of the kick.

The Bren is mounted on a tripod when used for prolonged fire, and the barrels are changed after every 300 rounds to avoid overheating. In addition to the "safety" there are two other trigger positions—"single shots" and "continuous." The last position is obtained by keeping the trigger compressed and the gun will then continue to shoot until the trigger is released or the ammunition exhausted. Weighing only 21 lb., the Bren is immensely strong.

New A.A. Gun

An A.A. gun which has recently made its appearance is a many-barrelled pom-pom gun which is suitable for use against dive-bombing. It is used in conjunction with a balloon barrage. The balloons keep the bombers high enough to prevent accurate bombing, and if the enemy planes come down to shoot at the balloons, the new gun can get them. It fires shells of 1-in. calibre which are so delicately made that they explode on the slightest contact.



The Bren gun, which can be adapted for trench or anti-aircraft work. A crew of four men can keep this gun constantly firing—two to work the gun and two to bring up the ammunition. The gun can be adjusted to fire single shots or for continuous automatic fire.

Submarine Minelaying

By COMMANDER EDGAR P. YOUNG, R.N. (Rtd.)

A Brief History Of The Submarine Mine And The Important Part It Plays In Modern Warfare

THE submarine mine is essentially just an explosive charge, contained in a water-tight case. It derives its name from the fact that it is an adaptation of a similar weapon used in land warfare, which is laid underground, a process which involves work similar to that in a mine.

As early as the sixteenth century it became a practice in naval warfare to use drifting explosive charges in the same way as fire-ships were already being used. Such drifting charges may, therefore, be regarded as the predecessors of the mine proper, which was used for the first time in 1777, by the Americans. Extensive and effective use was made of the new weapon in the American Civil War, and thereafter its use became ever more widespread, notably in the Russo-Japanese War of 1905-6.

Submarine mines were first used by this country in 1863, and were handled by the Royal Engineers—who are responsible, of course, for mining operations on land. It was not until 1904, moreover, and further developments of mining warfare at sea that the inconvenience of this arrangement became so great that submarine mining was taken over by the Royal Navy. Since that date it has been the responsibility of a special section of the Torpedo Department of that Service.

172,000 Mines Laid

Mine warfare played a very important part in the Great War of 1914-18, as may be judged from the fact that some 172,000 mines were laid by the Allies and some 44,000 by the Germans during the four years of that war. It is playing no less important a part in the present war, both belligerents having already laid large numbers of mines and being constantly engaged in laying large numbers more, though it is improbable that the numbers laid have yet reached such enormous figures as have been quoted above.

The object of the mine is to cause such damage to the more vulnerable, and less easily protected, underwater portions of an enemy ship as will bring about her destruction. In order to achieve this object, the mine must somehow be detonated when it is in contact with the hull of the enemy ship, or at least when the hull of the enemy ship is within the destructive radius of its explosion. It is evident, therefore, that, except in waters which are so shallow that the hull of a ship passing over the mine *must* come within its destructive radius, the mine must be buoyant. Furthermore, since a mine which floats on the surface can be seen and avoided, and since the effect of its explosion is greater in proportion as the damage inflicted is below the waterline of the ship, it is desirable that the mines should float at some given depth below the surface. What the depth should be must depend on the draught of the ships which it is intended to attack, on the method whereby the mine is detonated, and on the destructive radius of the mine.

Types of Mine

It must be obvious, of course, that the development of mine warfare has led to the production of various types of mine, for use in various circumstances and for various purposes. Before going into that matter, however, it might be well to have a general idea of the general design and construction of a mine.

The mine consists, as was stated at the commencement of this article, of an explosive charge, contained in a water-tight case.

The shape of the case is immaterial, but is usually cylindrical or spherical. The material of which it is constructed is usually steel, but in certain circumstances—as, for example, where the mine is to be laid by aircraft, or where it is a magnetic mine, aluminium, or some alloy of that light and non-magnetic metal, is used; for magnetic mines in circumstances where weight is not of importance, the case may be made of concrete—which is cheaper than aluminium.

Contained in the mine-case is the charge—of high-explosive. The explosive used should preferably be one which does not rapidly deteriorate with the passage of time or on account of humidity. Wet guncotton was the material which was originally used, and it is still used sometimes, but more common are ammonium perchlorate and amatol, the latter being a mixture of ammonium nitrate and tri-nitro-toluol (T.N.T.), which are less bulky than wet guncotton. Since, however, all nitrates are liable to deteriorate in the presence of moisture, a charge of pure T.N.T. is used for mines which, owing to the material of their case (e.g. concrete) or to the great pressure of water at the depth where they will lie, are liable to prove leaky.

Detonators

All these high-explosives require a detonator to set them off, and the material most commonly used for these detonators is fulminate of mercury. The detonating material, being very delicate, is enclosed in

a metal tube or container, which is detonated by mechanical or, more commonly, by electrical means.

The size of the mine is determined by various factors, among which the more important are the destructive effect which is required and convenience of handling. The former depends, of course, on the type of ship against which the mine is intended, and also, in the case of a non-contact mine (*see later*), on the destructive radius which is desired. As it is usually hoped that the mine will be exploded by a large ship, the charge within the mine is made great enough to bring about the destruction, or at least to damage severely, a well-protected battleship, subject only to the condition that it will fit within a case of manageable size (and, where the mine is to be laid by aircraft, that the total weight will not be excessive). Smaller mines may, however, and frequently are, made for various special purposes, being used, for instance, in conjunction with the larger mines, to prevent the latter being swept.

The majority of the mines which are used are of the moored type (*see later*). These have attached to the mine a considerable length of mooring wire, wound on to a drum within the mooring device, which is known as the "sinker." Drifting mines and non-buoyant mines obviously have not need of this appendage.

The types of mines in common use may be divided, for purposes of this article, under the following headings and sub-headings:—

(1) Moored mines	(*a*) Observation mines
	(*b*) Contact mines
	(*c*) Non-contact mines
(2) Mines without moorings	(*a*) Drifting
	(*b*) Fixed

Observation Mines

This type of mine is used for the protection of harbours, anchorages or channels which can be kept under observation. They are usually laid to float at such a depth below the surface that they will not normally disturb or be disturbed by, passing ships of any size, though they would obviously be disturbed if a ship were to anchor among them. They are wired up to an observation station, usually on shore, from which they can be detonated singly or in groups by electrical means.

Owing to the fact that, when they detonate, they are not actually in contact with the ship which they are intended to destroy, and since they can be laid in circumstances where ease in handling is not of predominant importance, they are usually larger than other types of mine, and have a larger destructive radius.

They are laid in fields, the contours of which are marked on secret charts and of which the exact position of each component mine is marked on a special chart fixed in the observation post in such a way that the exact position of any enemy ship can be projected on to it. The observer can thus know exactly which mine, or group of mines, he should detonate in order to destroy the enemy.

It is mines of this type which have recently been constructed and laid in suitable places round the coast of Eire.

Contact Mines

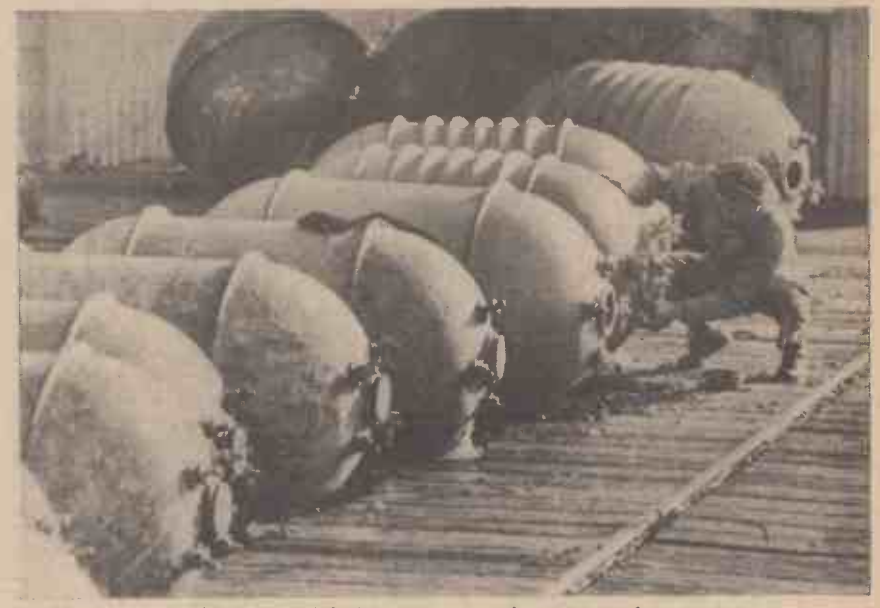
Where mines are laid in enemy waters, in the open sea, or in any other place where it is impossible to maintain an observation station, such mines must be fitted with some automatic device which will detonate them at the right time. The most obvious way to achieve this is to fit them so that they detonate when an enemy ship comes in contact with them, for that ensures that they will have the maximum of destructive effect.

In the earlier contact mines, detonation was effected mechanically, the passing ship causing a rotating arm to revolve until a spring plunger was released and would strike the detonator. In modern mines, however, the detonation is effected electrically in the following manner. On the exterior of the mine-case there are several lead-covered horns, each containing a glass phial of acid. If a passing ship strikes one of these horns and crushes it—*or, alternatively, if she causes the mine to heel through an angle of over 25 degrees*—the acid spills into a cup, completing an internal electrical circuit, which fires the detonator.

Mines of this type need a smaller charge than the observation mines which have already been described, or than any type of non-contact mine, such as will be described.

Non-Contact Mines

The earlier mines of this type were fitted with antennæ which radiated from them to a radius of 35 feet or more, and were fired when a passing ship came in contact with any of these.



Assembling and loading mines at a submarine mine depot.

Such mines did not prove very satisfactory, however, and the modern non-contact mine is fired by magnetic means when a steel ship passes within about 50 feet of it. The process by which this is achieved cannot yet be revealed for reasons of necessary secrecy.

It is laid down by the Hague Convention of 1907 that moored mines shall be provided with a safety device whereby they are rendered innocuous as soon as they break adrift from their "sinker." Such a device is not always fitted, however, and even when fitted it does not always operate satisfactorily, so it often happens that a moored mine becomes a "drifting mine."

Drifting Mines

The drifting mine proper, on the other hand, is a quite legitimate weapon of war, which is recognised by the Hague Convention of 1907 subject only to the condition that it must be so designed that it becomes innocuous one hour after it has been launched.

The simplest type of drifting mine is in effect merely a contact mine without any moorings and with the normal safety device either removed, or rendered inoperative.

Such mines may be useful as a weapon for use by a retiring fleet to weaken or to hold off a pursuing enemy or for floating downstream, or down tide, against enemy ships which are suitably placed to be so attacked. They have many obvious disadvantages, however, and are, therefore, likely to be used only by a fleet which does not intend to use the sea himself.

New Type

Floating, as they usually do, on the surface of the sea, they can be avoided if one is vigilant and manœuvres quickly. A type has been invented, however, and may subsequently have been developed, which has negative buoyancy and would normally sink to the bottom, but which is maintained at some given depth below the surface by a propeller beneath it driven by a hydrostatically-controlled motor inside the mine-case.

Fixed Mines

This is the most common type of magnetic mine. It has no "sinker," but sinks to the bottom and remains there, being detonated when a steel ship comes within about 50 feet of it

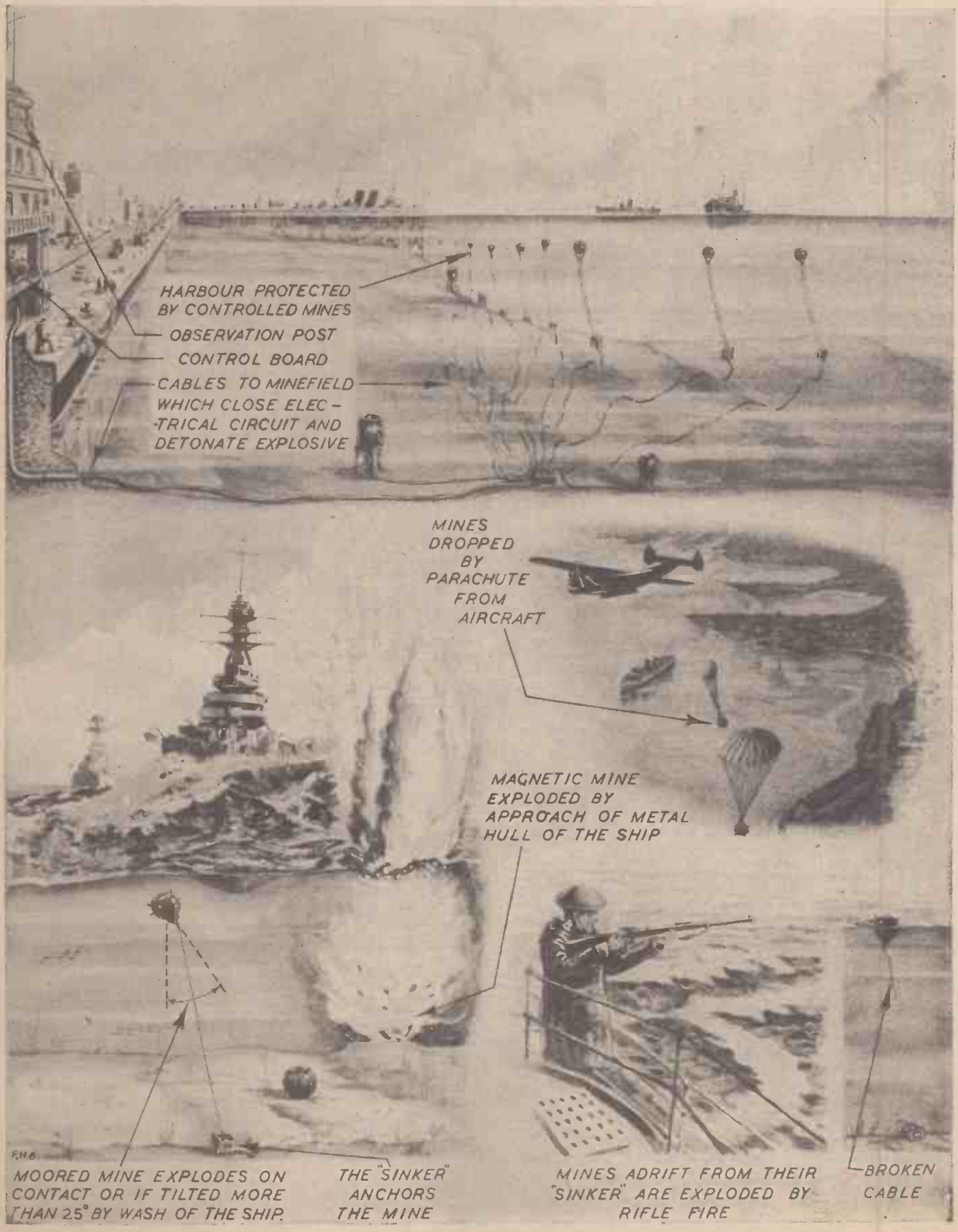
Such mines are obviously useful against surface ships only in comparatively shallow waters, and preferably in a narrow channel, but may be useful also in deeper waters against submarines, especially in places which are suitable for them to settle on the bottom for a rest or to escape detection.

Having dealt with the various types of mine, it might be useful, in conclusion, to deal briefly with the purposes for which they are, and the circumstances in which they can be used.

The original purpose for which mines were used has already been stated, in connection with the Observation Mine: for defending an anchorage, harbour or channel. Out of this has developed their use for the wider purpose of denying enemy ships the use of any part of the seas. When used for this purpose, they form, as it were, additional and highly dangerous new shoals, the existence of which is not always known and the locality of which, if declared, is always rather conjectural and approximate.

Mining of this type can be done only with moored mines, of course, and such mines can be used only in waters which are shallow enough for the mine to be able to support

VARIOUS TYPES OF MINES AND HOW THEY ARE DETONATED



the weight of its mooring wire, i.e., with a depth of not more than some 600 feet.

Setting the Sinker

When the mine is laid the depth below the surface at which it is required to float must be set on the sinker. It assumes that depth *automatically* soon after, or, if it is so desired, at a given period of time after it is laid, and then it remains *at that distance from its sinker*. Now it is obvious that in tidal waters any fixed distance from the sinker does not mean a fixed distance from the surface. The latter must clearly vary with the state of the tide, with the result that at one state only—usually at half-tide—is the mine at the ideal distance below the surface. It may happen, therefore, that at high water the mine is too far below the surface to be a danger even to the largest ship, while at low water it is exposed upon the surface. It may happen also, in places where the tidal stream is particularly strong, that the mine can float at its appointed depth only during short periods of time around slack water.

All these considerations must be taken into his calculations by the minelayer, and circumscribe to a great extent his activities. He must also bear in mind always that his success will depend largely on his being able to lay his mines unobserved. It is for this last reason that the laying of mines by aircraft, though quantitatively bound to remain of insignificant importance compared with the laying of mines by older methods, is being so actively developed by both sides in the present war.

One Hundred Octane!

A Super Fuel for Super Aircraft

ONE answer to the insistent call of aircraft designers, in their never-ending search for higher speeds and increased performance, has been found in the more powerful fuel now being produced by modern science.

The amount of power which can be wrung out of a single drop of petrol is largely dependent upon the degree to which the petrol vapour can be compressed in the engine without the engine "knocking." Recent advances in the technique of fuel refining have now produced fuels which permit enormously greater compression ratios. They are generally referred to as "high octane" fuels.

Modern Fuels

Modern fuels, both automobile and aviation grades, are given an octane number, according to their non-knocking qualities. The octane scale ranges from about 56 in straight run or low-grade petrols, 65 to 75 for "cracked" petrols, and 70 to 75 for high-grade fuel with tetra-ethyl lead, up to 100 in the latest aviation products.

To determine the octane value the petrol is compared, in a standard test engine, with various mixtures of two pure hydrocarbons. One of these, iso-octane, is practically non-knocking; the other, heptane, knocks very readily. The particular blend of these two ingredients which corresponds in knocking characteristics with the petrol being tested gives the octane number.

It has been calculated that high-octane fuel increases the power output of a modern aero-engine by something like a third or more. For the same power output smaller engines and consequently lighter fuel loads are required.

Extremely Valuable

Produced until recently only in small quantities, a 100-octane fuel was so valuable that it was used only for take-off, and special flights. Now in America, where roughly two-thirds of the world's petrol is produced, special plants planned for a production of many million tons of 100-octane fuel a month are being developed.

Two-Motor Trainer of the R.A.F.

How Pilots Are Trained in the R.A.F.

STANDARDISED methods of flying instruction have long been a strong point in the training of the pilots of the R.A.F. Integral with a standard syllabus of training is the use of a standard type of "trainer" aircraft for the different phases of the pupil pilot's instruction.

Pilots destined for twin-engine bomber and fighter squadrons learn the elements of two-motor technique on the Airspeed Oxford—a fast, low-wing monoplane specially designed for the job. In general appearance it is not unlike the Envoy, a medium-sized civil type of aircraft produced by the same constructors.

The Two Motors

The two motors fitted to the Oxford, Armstrong-Siddeley Cheetahs, each of 375 h.p., give a maximum speed of about 190 m.p.h. They are air-cooled radials, a type of engine commonly fitted to the twin-engine operational aircraft of the R.A.F.

A retractable undercarriage, oxygen apparatus for high-altitude work, Handley-Page slotted ailerons, and other features of modern operational aircraft are incorporated. Its wing span of 53 ft. is a little less than the famous Anson, whilst its range of some 900 miles affords plenty of scope for long-distance training flights. Evidence of its speed and endurance is seen in a record flight of one of the Oxfords in service with the Royal New Zealand Air Force. Fitted with an automatic pilot and carrying survey instruments, it covered the 680 miles between Hobsonville and Christchurch in 3 hours and 40 minutes.

The Crew

Normally a crew of three is carried. But as the Oxford is used for training other members of an air crew besides the pilot, six different stations are provided. In the nose is the pilot's seat, and beside him is the second pilot or navigator. The controls are dual and one set is removable to make space for the prone position for the bomb-aimer. Other positions are those for the wireless operator, rear gunner, and photographer. In this way the Oxford caters for all the different functions of a bomber's crew, which in a big ship may number as many as seven or eight.

In the R.A.F. the Oxford is used mainly during the intermediate stage of the young pilot's training. This takes place at the Service flying training schools, after leaving the elementary training schools from which all embryo pilots graduate. It is also employed at the special schools where twin-engine fighter pilots are trained. Not until they have thoroughly mastered the Oxford do the fully-fledged pilots go on to the "real thing"—the powerful bombers and two-motor fighters of the R.A.F.

Adding "Tone" To The Piano

LAURENS HAMMOND, an American, has invented a musical device which he calls the Solovox. It is a musical supplement to the piano and is operated entirely by electricity. The Solovox is a three-octave keyboard which is attached to the piano so that the fingers of one hand can easily span the two keyboards. Twelve control tablets give the Solovox a six-octave range as well as an indefinite variety of tone colours. Because it is smoother and capable of "swell," these tone colours make an effective contrast to the percussive effects of the piano. A knee lever controls the volume and a slim tone cabinet containing the electrical equipment is set alongside a vertical piano or underneath a grand piano.

Laurens Hammond aided by one of his mechanical experts as he tests his newest invention which he calls the Solovox.

New Automatic Rifle

THE United States Marine Corps are testing out a new type of semi-automatic rifle. General Holcomb stated, after a preliminary test of the gun that it may be the complete answer to what they need. The Marines at present use the U.S. Army's Garand rifle, capable of firing 24 shots a minute, which army ordnance experts have said is the finest rifle of its kind in the world, but the Marine Corps claims that it is not rugged enough for field service.

Producer-Gas Motor Fuel

The Operation Of Producer-Gas Units And The Possibilities As A Fuel For Internal-Combustion Engines

By FRANK PRESTON

Producer-gas vehicles attached to various types of vehicle

SINCE petrol-rationing commenced a considerable amount of attention has been directed toward the use of alternative fuels for motor-car and commercial-vehicle engines. At first it seemed that paraffin and vaporising oil would provide the best solution to the problem of obtaining fuel, but it became illegal for the vehicle operator to obtain these in ordinary circumstances for use in modified engines.

Coal gas also came into prominence at the same time, and is being fairly widely used at the present time—as it was during the last war. This provides an efficient fuel, but there are several drawbacks which prove serious in certain circumstances. In the first place, if gas is stored in a low-pressure bag mounted on the roof of the vehicle only a very small mileage can be covered with one filling of the bag. Thus, this method of storage can be considered suitable only for vehicles used mainly for short-journey routes in town or near a convenient gas-supply point. It is, of course, possible to increase the "mileage per fill" very considerably by carrying the gas under very high pressure in steel cylinders. Here there are other difficulties : the cylinders are very heavy and are not easy to obtain at present; they are expensive; special plant is required to fill them under the necessary high pressure; re-filling cannot be carried out easily at the average garage, as it can when low-pressure bags are employed.

Overcoming Difficulties

As an alternative to the above systems further attention was directed toward the use of producer-gas. This method was by no means unknown or untried, but there had been many practical difficulties in pre-war days. As a result of further research, however, three or four firms were able to produce successful producer-gas plants which were free from nearly all of the objections which had previously been inherent.

The idea of the producer-gas installation is that the gas is produced in an installation which is carried on the car or mounted on a trailer which can be towed by the vehicle. The gas differs from coal gas, and consists very largely of carbon monoxide. It does, however, contain hydrogen, methane and nitrogen, as well as a certain amount (kept as small as possible) of carbon dioxide.

How the Gas is Made

Many readers will be familiar with the method of producing carbon monoxide by burning coke, coal, anthracite, or similar fuel in air. As the glowing carbon-containing fuel comes in contact with the oxygen of the air, carbon monoxide is formed.

In practice there is often an intermediate formation of carbon dioxide, but this gas is not of value as a fuel. Consequently, the aim of the designer of producer gas plants is the create a "local hot spot" so that the intermediate stage is almost completely eliminated.

In practice, producer-gas is formed by drawing air through broken coke, anthracite, etc., which has been raised to incandescence. Instead of air it is possible to use steam, but this is less convenient in the case of a plant of the type under discussion. On some types of producer-gas plant a fine spray of water is passed through the incandescent fuel along with the air, so that the effect is similar to that which would be produced when using steam. On the other hand, some makers of these plants have been able to secure high efficiency without the use of the water spray.

At this point it may be asked how and why it is possible to replace the liquid petrol normally used for an internal-combustion engine by a gas. It should be remembered that petrol is what is known as hydro-carbon—that is, it consists of hydrogen and carbon in combination. Before it can be used to drive the so-called petrol engine, the petrol must be divided into very small particles in the form of a spray. This is done by the carburetter, which also causes a certain proportion of air to be mixed with the spray. By this time the fuel can be considered as being almost in the form of gas, so it would appear more reasonable to use a gaseous than a liquid fuel.

Notwithstanding this, petrol is the most efficient and convenient form of fuel at present known. Producer-gas causes the engine to develop between about 60 and 75 per cent. of the power developed by the same engine when fed from petrol. The efficiency can be increased, however, by increasing the compression ratio of the engine and by providing a full manual control of ignition timing.

Built-in and Trailer Types

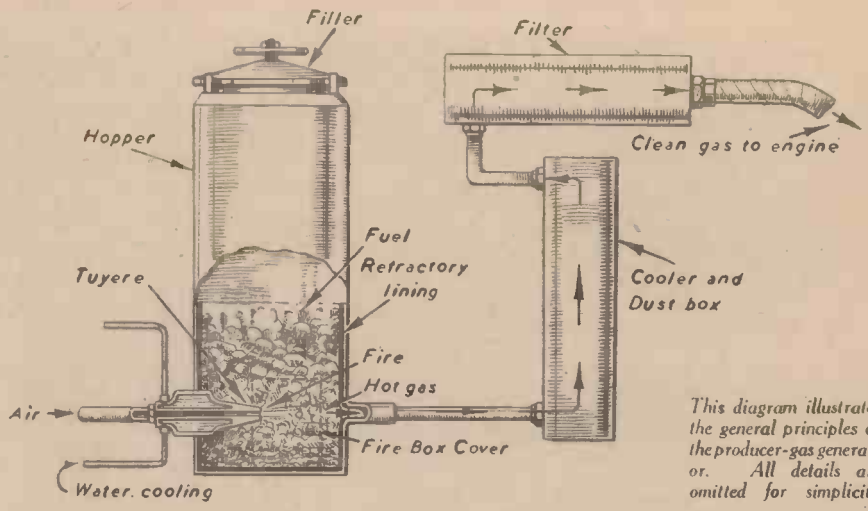
Producer-gas plants are of two main types : for building into the bodywork of the vehicle and as trailers for towing behind the vehicle. The former is in many respects more pleasing, but the latter is better in that additional weight is not thrown on to the vehicle chassis and that body space is not taken up by it. In connection with the trailer, however, it must be remembered that the legal speed limit of the vehicle is then restricted to 30 m.p.h. on both built-up and " derestricted " roads.

The total cost of a producer-gas plant naturally depends to a certain extent upon its size, but an average figure is in the region of £100. Without fuel, a trailer unit can be expected to weigh about 10 cwt., but there are variations according to make and output capacity.

Practical Details

A diagrammatic arrangement of a producer plant is shown in an accompanying illustration. It will be seen that there is a large cylinder which acts as a fuel hopper and fireplace, and that there is an opening for the air near the base. This cylinder generally measures about 20 in. in diameter by 4-5 ft. in length. Air is admitted through a tuyere or pipe, which is often surrounded by a jacket through which water from the cooling system of the car can be passed. This tuyere projects right into the heart of the fire, where the fuel reaches a temperature of between 1,000 and 1,500 deg. C. Opposite this there is an outlet through which the gas is drawn by engine suction. It should be noted at this point that there is no danger of gas pressure being built up within the cylinder, since the production of gas is dependent almost entirely upon a good draught of air being provided by engine suction.

When the producer-gas leaves the fire it is naturally very hot and is thus expanded to such an extent that it is " weak " or of low density. It is therefore passed through a cooler, which may take the form of an exposed cylinder. Next it must be cleaned, since it contains various impurities and also small particles of coke and clinker which would very soon score the cylinders of the engine. A cleaner is therefore provided, this being built according to one of many designs. In some cases finely-broken cork is used as a filtering medium; in other cases use is made of sisal and oil-soaked coke. So-called dust boxes are also included in some designs, these being arranged so that particles of dust and dirt can " settle " from the gas before it is passed through the final filter. After filtration, the gas is passed to a gas carburetter or reducing valve where extra air is admitted to provide the correct mixture strength.



This diagram illustrates the general principles of the producer-gas generator. All details are omitted for simplicity

Operation

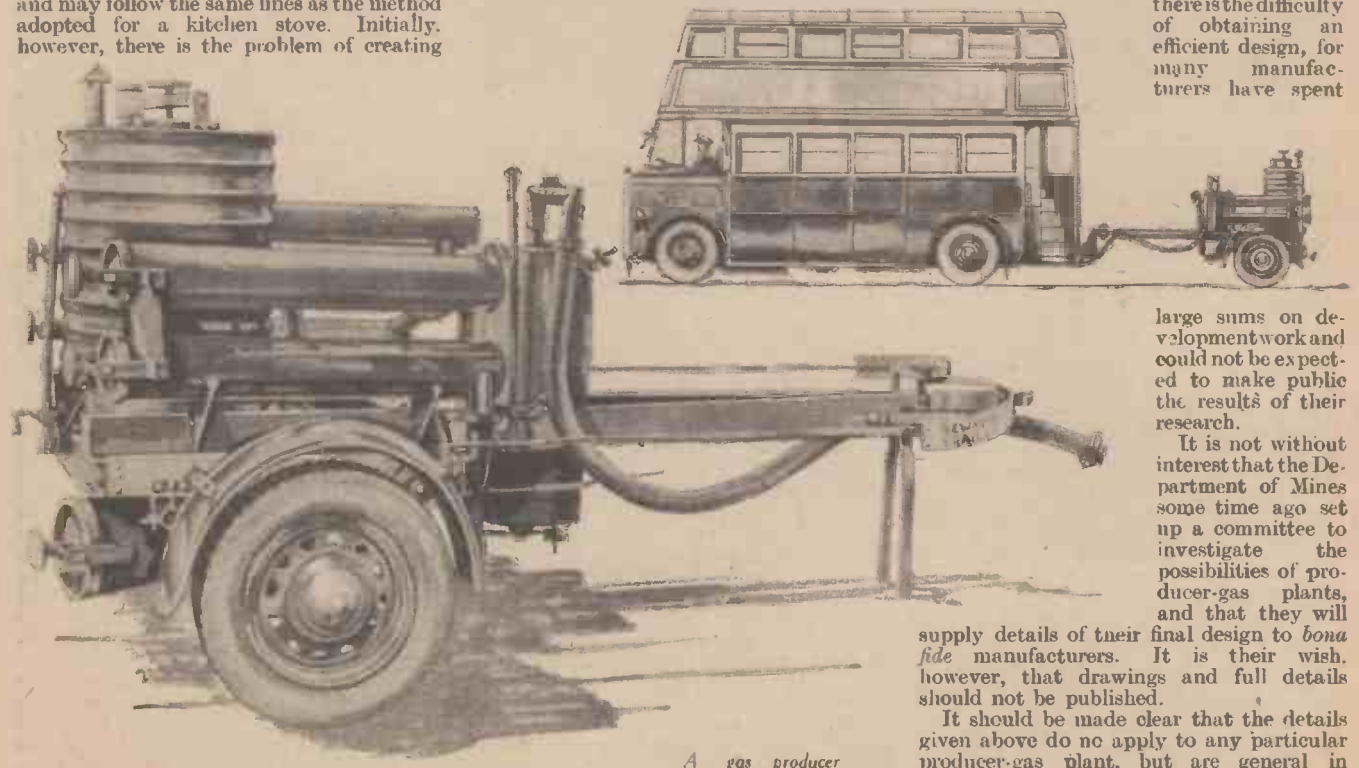
Starting up of the fire is a simple matter and may follow the same lines as the method adopted for a kitchen stove. Initially, however, there is the problem of creating the necessary draught, and this is sometimes overcome by fitting a simple electrically-operated fan, fed from the vehicle battery. Another method is to start up on petrol—fed through an ordinary petrol carburetter—and then to change over to producer-gas after the engine has been running for a few minutes. By gradually changing over to the gas it is possible to keep the vehicle running. When this method is followed, or when there is an electric fan, lighting of the fire is simplified, for it is possible to apply a paraffin torch or burning shavings to the air inlet; the flame is drawn into the fire and soon sets the fuel alight. Some designs have a built-in lighter box containing a wick which is sprayed with paraffin and then set alight.

When the engine is stopped the fire will continue to burn slowly for a short time (generally up to about 20 minutes) and the engine can be restarted without the necessity for applying a flame. After longer periods of stoppage, up to about an hour, it is necessary to start the engine on petrol and then to change over after sufficient draught has been created to raise the temperature of the fuel.

Maintenance of these producer-gas plants is very simple with most of the present designs. Coke and clinker must be removed from the fire grate about once a day, and the filtering medium must be replaced at, say, weekly intervals. Most of the producers will give upward of 200 miles of running per charge of fuel, and the cost of fuel for a given mileage can be expected to be about one-quarter that of petrol for the same engine.

Construction

Because of the apparently simple nature of the producer-gas installation there are many vehicle owners who have considered the possibility of making their own plants. It can be stated, however, that this is not a feasible proposition unless there are ample engineering-workshop facilities and the worker is a skilled man. Even then, there is the difficulty of obtaining an efficient design, for many manufacturers have spent large sums on development work and could not be expected to make public the results of their research.



A gas producer unit and how it is coupled to a vehicle

It is not without interest that the Department of Mines some time ago set up a committee to investigate the possibilities of producer-gas plants, and that they will supply details of their final design to *bona fide* manufacturers. It is their wish, however, that drawings and full details should not be published.

It should be made clear that the details given above do no apply to any particular producer-gas plant, but are general in character and intended only to clear up some of the misunderstandings which exist.

Learning the Morse Code

How to Acquire Speed in Reading and Sending Morse Signals

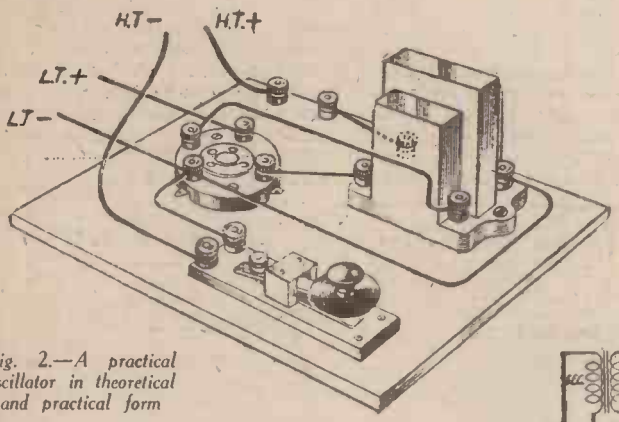
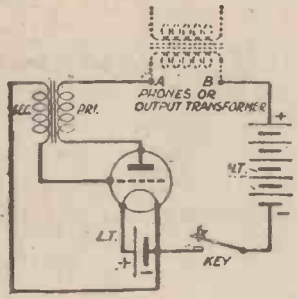


Fig. 2.—A practical oscillator in theoretical and practical form



THE first step in mastering Morse, is, of course, to acquire a knowledge of the code, and for those who have not yet done so we give here the alphabet, and also the grouping of the letters in "opposites" and by learning the latter, it is not such a difficult matter to remember the symbols. It is necessary to learn the symbols by the "tune" of the letter, and not merely to remember, for instance, that "J" is dit, dah, dah, dah. As an aid to memory in this connection you may make use of the following phrases for certain letters. For the letter "F" memorise the

ALPHABET		FIGURES	
A	·—	1	·—————
B	—···	2	··———
C	—·—·	3	···——
D	—··	4	····—
E	·	5	·····
F	··—·	6	—····
G	——·	7	——···
H	····	8	———··
I	··	9	————·
J	·———	0	—————
K	—·—		
L	·—··		
M	——		
N	—·		
O	———		
P	·——·		
Q	——·—		
R	·—·		
S	···		
T	—		
U	··—		
V	···—		
W	·——		
X	—··—		
Y	—·——		
Z	——··		

OPPOSITES	
A	·—
N	—·
B	—···
V	···—
D	—··
U	··—
F	··—·
L	·—··
G	——·
W	·——
Q	——·—
Y	—·——

Fig. 1.—The morse alphabet with opposites shown for memorising

phrase, "Did it 'urt yer"; for the letter "L" (the opposite of "F"), remember, "Of course it did." For "Q" memorise "God Save the Queen." As an opposite to "Q" the letter "Y", remember the opposite of the "Q" phrase—"Queen, the God save."

Figures

The figures are quite easy to remember, the numbers 1 to 5 being dots in that order, and 6 to 0 being dashes in that order, each number totalling five dots or dashes. Thus, 1 is 1 dot followed by 4 dashes. 2 is 2 dots followed by 3 dashes and so on. Having memorised the symbols it is now necessary to acquire practice in reading and recognising them and in this connection there are two simple schemes. In the first you can obtain gramophone records; and in the second you can send the symbols by means of a key and oscillator—listening to your sending over a loudspeaker or in a pair of headphones. For the oscillator you need a valve of the General-Purpose type, an L.F. transformer—any ratio will do—and the necessary H.T. and L.T. supplies. These are wired as in Fig. 2 and the key inserted in the H.T. negative lead. The H.T. voltage is critical, and if too low or too high, an audible note will not be obtained when the key is depressed. Adjust the H.T. until a suitable note is obtained, and thus an H.T. battery tapped at frequent intervals should be used. The records are obtainable from Columbia (Nos. 3262/4), and from F. L. Masters. The former consists of a set commencing with the code and figures and passing on to commercial messages all sent at a nominal speed of about 20 w.p.m. A book is supplied with the records, giving the translation, but unless you have a clockwork gramophone motor capable of being slowed down considerably you may find these records are a little too fast for a start. The majority of electric turntables cannot be slowed down to bring these records slow enough for a beginner. We might also mention there are one or two mistakes in the published translation—so don't follow the code symbols in the book too rigidly if you intend to use the printed matter for practice purposes.

The Masters record is at a nice slow speed and may be speeded up with a clockwork motor to 20 w.p.m., but again, the small speed control afforded with most electric motors will probably only enable the speed to be controlled between approximately 6 w.p.m. and 12 w.p.m. There is also a slip in this disc, the omission of the letter "r" in Northern in the message on the second side.

Acquiring Speed

These records are mainly for reading practice, but both may be used for sending practice and at the same time will enable you to increase your reading practice or powers of concentration by adopting the following procedure. An amplifier with an input mixing circuit is needed so that the output from the pick-up and the output from an oscillator such as has already been mentioned may be mixed. If you do not possess an amplifier you can use your ordinary radio receiver, provided that it is provided with pick-up sockets or terminals. Two separate volume controls are needed, one across the pick-up and one across the output from the oscillator. These are leads being joined to the pick-up terminals or sockets. Using, for instance, the first Columbia record in the set mentioned, adjust the volume control until the note from the record is approximately the same level as that delivered from the small oscillator when the key is depressed. With the copy of the message before you, start the pick-up and take hold of the key. The moment the message on the record commences, start to send and endeavour to read from the copy both the letter and the symbol as printed, at the same time sending the appropriate dot and dashes, keeping the note from the oscillator in step with the pick-up note. At first you will probably

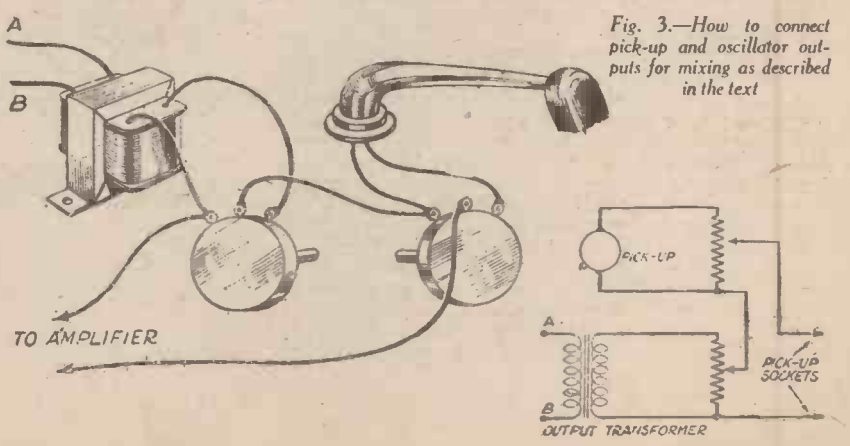


Fig. 3.—How to connect pick-up and oscillator outputs for mixing as described in the text

find it difficult to obtain one note from the speaker, but as your oscillator will undoubtedly be of a different pitch from the record note you will quickly see whether you are lagging behind or sending too fast. This practice will not only enable you to concentrate better, but will control your sending speed and ensure spacing and at the same time familiarise you thoroughly with the symbols for each letter.

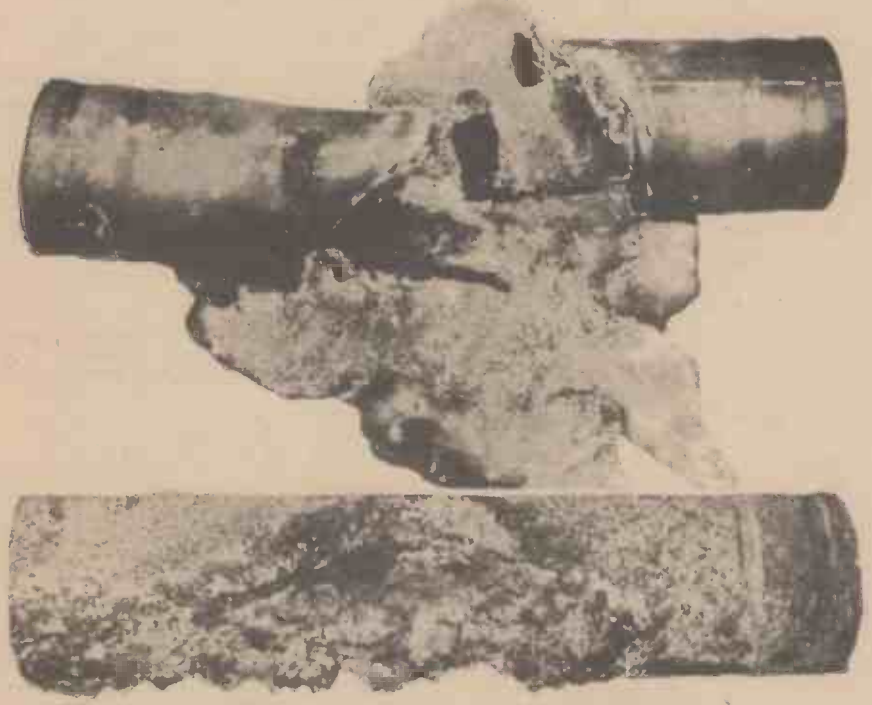
Speed Aids

The drawback normally with a record is that you will become familiar with the message, but this method of sending with the record will give you ideal practice in sending, and by speeding up the record you can acquire perfect practice at sending up to 20 or 25 w.p.m. with correct spacing. If you can devote one hour a day to this type of practice you will soon be able to identify the symbols without having to "translate" each one and will soon acquire the necesssary speed.

When endeavouring to increase speed it is desirable to obtain a message at a speed greater than you can normally manage. It will be found that you have to work two or three letters behind, but when a symbol comes which you cannot immediately identify, don't wait and try to sort it out but forget it and go on to the next letter. In this way you will keep up with the speed and gradually the "faulty" letters will drop into line until every symbol is immediately recognised. Do not keep trying to read at speeds which you can do comfortably. Always try and work beyond your capabilities so that you force yourself into speed. Thus with the records, set them so that they are going just too fast, and when picking up code stations select one which you find just a little beyond you.

Protection Against Incendiary Bombs

An Important New Development in Fire Fighting



Typical incendiary bombs extinguished almost in a few seconds by the "Nuswift" bomb snuffer

PROTECTION of engineering works, garages, repair depots, and other industrial establishments against incendiary bombs can now be given, on most effective lines, as the result of an important new development in fire fighting.

The incendiary bomb is of small size, weighing about 2-6 lbs. and has a casing or body of electron metal (magnesium alloy) which contains a charge of "thermite" (a mixture of powdered iron oxide and granulated aluminium). Ignition of the thermite takes place by an impact detonator of the needle and percussion cap type, and a tremendous heat develops, about 4,582° F. (2,500° C.) which ignites the electron metal casing, the latter then burning in the air, developing a temperature of about 2,372° F. (1,300° C.). To extinguish such a bomb is extremely difficult, since the oxygen for the combustion of the thermite, which lasts about 40-50 seconds, is obtained direct from the iron oxide and not from the atmosphere.

Inorganic Salts

The effective new method, however, the invention of The Nuswift Engineering Co., Ltd., of Elland (Yorkshire), consists essentially in the use of a mixture of inorganic salts which are brought into contact with the incandescent bomb and become molten, extinguishing the main burning of the electron metal bomb casing by choking the crevices and preventing air admission and also by reducing the temperature by cooling to below the ignition point. In this way an incendiary bomb can be extinguished easily and safely in about 20-25 seconds, although it is necessary to wear coloured glasses, such as the standard Government type, as a protection against the glare. Two general methods of application are used, the first of which is called a "bomb-snuffer," consisting of a metal cover, like a large candle snuffer, containing a charge of powder in a paper carton with a celluloid seal, which is placed bodily over the top of the bomb. This is particularly suitable when the bomb is on a flat floor or roof, or otherwise easily accessible. Even more important is the second method, which is to use the firm's standard "R.S.Q." hand extinguisher.

Application

For normal application the latter contains water and a small sealed seamless copper canister of compressed carbon dioxide (CO_2) gas under pressure. All that is necessary when operating the extinguisher is to press down a knob, when an internal sharp point pierces a thin copper seal cover of the canister and releases the CO_2 into the water, giving at once a high-pressure jet of water, containing CO_2 in solution partly mixed with CO_2 gas, which will extinguish most types of fire in effective fashion. In addition the jet is completely harmless under any circumstances, and has the further advantage of being intensely cold because of the liquefied gas, whilst it is a non-conductor of electricity, and safe up to at least 25,000 volts.

Dissolving Mixed Salts

For incendiary bombs it is merely necessary to dissolve the mixed salts in the water used for filling the extinguishers, forming a concentrated solution. When this is directed on the incandescent bomb the water evaporates and leaves the solid salts which, on the same lines as the dry powder method, melt and extinguish the combustion by sealing the crevices and local cooling. It will be remembered also that in the firm's "C.T.C." extinguishers for petrol, benzol, and oil, and for motor vehicles in general, the same compressed CO_2 method is used to propel carbon tetrachloride without the use of a pump.

BOOK RECEIVED

(*See also pages* 25 *and* 31)

"What Engineers Do." By Walter D. Binger. Published by The Scientific Book Club. 304 pages. Price 2s. 6d. to members.

IN this book is told, in simple language, the story of civil engineering and construction. It is an outline of what has been accomplished in this great field from the time of the early Egyptians to the present. The methods by which great difficulties were overcome are clearly described with the aid of numerous illustrations. In the wide field covered by this book are included such subjects as The Steel Age; Concrete; Working Under Water; Surveying; Aerial Photography; Bridges; The Modern Building; The Railroad; Hydro-electric Development; Strength of Materials; and Keeping the Waters Pure. The book is divided into twenty-two chapters, all of which make interesting reading.

Our Busy Inventors

By "Dynamo"

A Sound Hat

THAT fickle jade, Dame Fashion, is never more capricious than when she designs the head-dress of the fair. Sometimes she fancies a hat which spreads itself like a green bay tree. Anon she contracts this to the minimum of head covering, which rides at a rakish angle on her permanent waves. Admittedly, one of the most intriguing styles is known as the Pixie Hood. It is the kind of cap that surmounts the fairy sprites who gamble in the court of Queen Titania. This hood may be made of oilskin, wool, cloth, or fur. There are extensions or tapes which tie under the chin.

Principally intended for rainy days and the wintry season, the hood keeps the ears warm and dry. Some of these caps are formed with openings for the ears and shields to protect those shell-like receivers. But, while they guard the ears against the assault of raindrops and the sharp teeth of Jack Frost, they also exclude sounds, so that sweet nothings are denied admission.

This brings me to an improved style of Pixie Hood which is the subject of an application to the British Patent Office. It is differentiated from its predecessors by apertures at the sides which admit sounds, but are provided with inverted pocket-like covers to exclude rain and icy winds.

By the way, the Pixie Hood is an excellent head covering for ladies in an air-raid shelter which is occasionally raided by cold air that assaults the ears of the sheltering ones.

Premature Burial

THERE is on record the account of a man who suffered with the delusion that he was dead. To humour this queer belief, his friends made a pretence of burying him. It may be asserted that some inert folks are afflicted with the hallucination that they are alive, whereas, if not quite deceased, they are, like one of Thomas Hood's characters, rather dead.

Some nervous people are afraid that they will be buried alive. To prevent such an unpleasant experience, an inventor has applied to patent in this country means for ensuring against premature burial. He states that many medical tests have been provided to prove that the alleged deceased is really a fit subject for a funeral. Such tests, he declares, are not always reliable, even when performed by a skilful medical man. He mentions the fact that it has been proposed to place in the coffin a sort of alarm clock which would be operated by some movement on the part of the reviving body.

His idea is to make quite sure that the occupant of the coffin is really a corpse by an arrangement whereby there is generated within the coffin a gas which will prevent any return to consciousness. This appears to be a merciful method, but I recall the fact that the author of the famous romance, "Manon Lescaut," which has been made the subject of an opera, was killed by his post mortem.

Portable Searchlight

THE searchlight is, in the present day—or rather night, the cynosure of all eyes; in fact, its fierce glare provides its own publicity. Considerably smaller than this Gargantuan bull's-eye, but larger than the humble electric torch, there has emanated from the brain of an inventor a portable searchlight. The batteries are fitted in a flat bundle designed to be carried on the back. An 85,000 candle-power bulb will project a brilliant beam a quarter of a mile, and the spotlight is fired by a trigger. Intended for the police, firemen, sportsmen, and others, the lamp can be supplied with coloured lenses which snap over the ordinary lens for signalling or warning.

Roof-Pools

THE present may be dubbed the Pool Age, the exception being the football pool which has undoubtedly ebbed. Pools are now being provided on the roofs of houses. This would not have been practicable in the Victorian era, when roofs sloped like the shoulders of the ladies. One object of this design was to accelerate the speed of the rain en route to the gutter.

Modern architects favour a flat roof, and this makes possible the construction of a roof capable of holding water for the purpose of insulation. It has been found that a roof-pool reduces the temperature in upper storeys in Summer, as much as 10 degrees. I learn that in the case of air-conditioned buildings, a roof-pool renders it unnecessary to dispose of the water when it has circulated through the system. It can be pumped to the roof, freed from its absorbed heat, and used over and over again.

A pool on the roof can perform more than one role. In addition to acting as a refrigerator, it can furnish an opportunity for bathing or at least paddling. And it would certainly cool the hot temper of an incendiary bomb.

Who's There?

IN the bad old times, in some prison—perchance the Bastille—a guard was required without ceasing literally to keep an eye upon a certain prisoner. Through a small hole pierced in the wall of his cell, the prisoner saw the eye of the sentry perpetually fixed on him. A somewhat similar aperture is part of a newly-devised door-knocker, intended, however, only for occasional glances. It is an inconspicuous Lilliputian window of one-way glass. The person behind the door can see out, but the one outside cannot see in. This tiny quizzing glass will permit the occupant of a house to inspect a caller before opening the door. And his—or more probably her—regard will not be apparent to an unwelcome visitor.

"Milk-O!"

FIBRE milk bottles fitted with a sanitary non-spill spout and an airtight seal are now being produced by a New York firm at the rate of fifty per minute. A sprightly machine shapes a spruce or pine blank into a round container, with spouted top, sterilizes it with hot paraffin, chills it, fills it with milk, seals the cap, stamps the date and dispatches the bottle to the cold storage room, all in one continuous series of operations. The housewife lifts a clip, presses the edges and the spout opens. Truly a very convenient milky way.

Shield on Wheels

THE evolution of the shield is an interesting study. It is stated that the shield was developed from the parrying stick. The gradual widening of the stick or club in the centre eventually expanded into the broad shield formed to cover the body from the thrusts and missiles of an assailant.

The warlike progenitors of Signor Mussolini—the Roman legions—when besieging a city, advanced with shields held above their heads and so locked as to make a continuous cover. This conglomerate shield was known as Testudo, which is Latin for a tortoise—a creature who invariably carries a horizontal shield.

There has just been patented in America a mobile shield. This has a curbed front and top portion and there are parallel sides. In the front there is an opening through which the protected one can warily inspect his opponent. The contraption runs upon wheels.

Easing The Burden

PARCEL-CARRYING is something of an art. Equally distributed weight makes the load less burdensome. A new load-bearing apparatus has made its advent. This consists of a stout but not heavy metal frame to attach to the back. It leaves complete freedom to the chest, sides and waist. A load-supporting arrangement is secured to the frame by means of belts and buckles.

This device should make the heavy load, if not light, seem not so weighty. The donkey with well-balanced panniers finds his work not so arduous as when he carries a lopsided pack.

Balls v. Bombs

UNLESS the present conflict happily proves to be a war that ends war, disputes between nations will continue to be settled by the arbitrament of the bomb. As a consequence, an air-raid shelter will be as necessary to a house as a bathroom. Owing to the ingenuity of our inventors, this sanctum of security will advance towards perfection.

An interesting development of the air-raid shelter is the subject of an application accepted by the British Patent Office. According to this invention, upon two or more thicknesses of concrete beams, there are placed a series of concrete balls. The idea of using balls in this way is not new. It has already been proposed to use metal balls of small diameter. But the characteristic of the improved invention is that they are free to be moved.

The balls are arranged in layers and, as the heap rises, the number in each layer is decreased until the top ball surmounts four balls. Thus a pyramid is formed.

If the shelter be struck, and any ball is hit centrally and smashed, the other balls will roll away. The force of the impact will be spread on all the balls beneath it, so that its action will be dissipated.

Three stages in the development of the bridge

The Development of the Bridge

World Famous Bridges and How they were Built

THE first man who ever fell off a log into a swiftly moving stream must have been struck with the notion that there were better methods of effecting a crossing. But he knew of none. As he scrambled out of the water and shook himself his immediate problem presented itself again—how to get to the opposite bank, apart from swimming. Instinctively he looked around for another fallen log, one that would serve him better this time as a ferry-boat. The savage had yet to develop a log as a bridge.

When at last it occurred to him that his problem would be solved if he could span the stream with a tree-trunk, he was on the way to taking the first practical step that has lead, through many centuries of bold experiment, of heart-breaking failures and superb triumphs, to bridge-building as we know it to-day. That savage who took the toss prevailed upon his family and neighbours to worry a tree from its insecure root-hold in the muddy bank and "throw" it so that it crashed its topmost branches on the opposite bank. Thus-wise did he get his bridge. The next development came when, to get the affair well clear of the water, they raised the ends on heaped stones or soil—and chopped away the branches and flattened the top side.

A Bridge From Trees

Then they tried to span the stream at a wider part, and found their fallen trees too short. We don't know how long it took them to puzzle that one out, but the upshot of their deliberations and experiments was a fine achievement. They felled two trees that chanced to face each other with the stream between, so that the topmost branches intermingled, forming an uncomfortable and highly precarious runway from bank to bank. It served, but they acknowledged how much room they had left themselves for improvement. In due course they manhandled a third tree so that this rested among the end branches of numbers one and two. Came the day when tools and ingenuity had both improved, and they fixed a length of tree-trunk in each bank and

THE WORLD'S LARGEST AND LONGEST BRIDGES

LONGEST: The Storstrom Bridge, Denmark—2 miles long

LARGEST: Sydney Harbour Bridge, Australia

inclined to the centre of the stream. They rested one long trunk on the two inclined tops—and that was the beginning of the cantilever system of bridge-building.

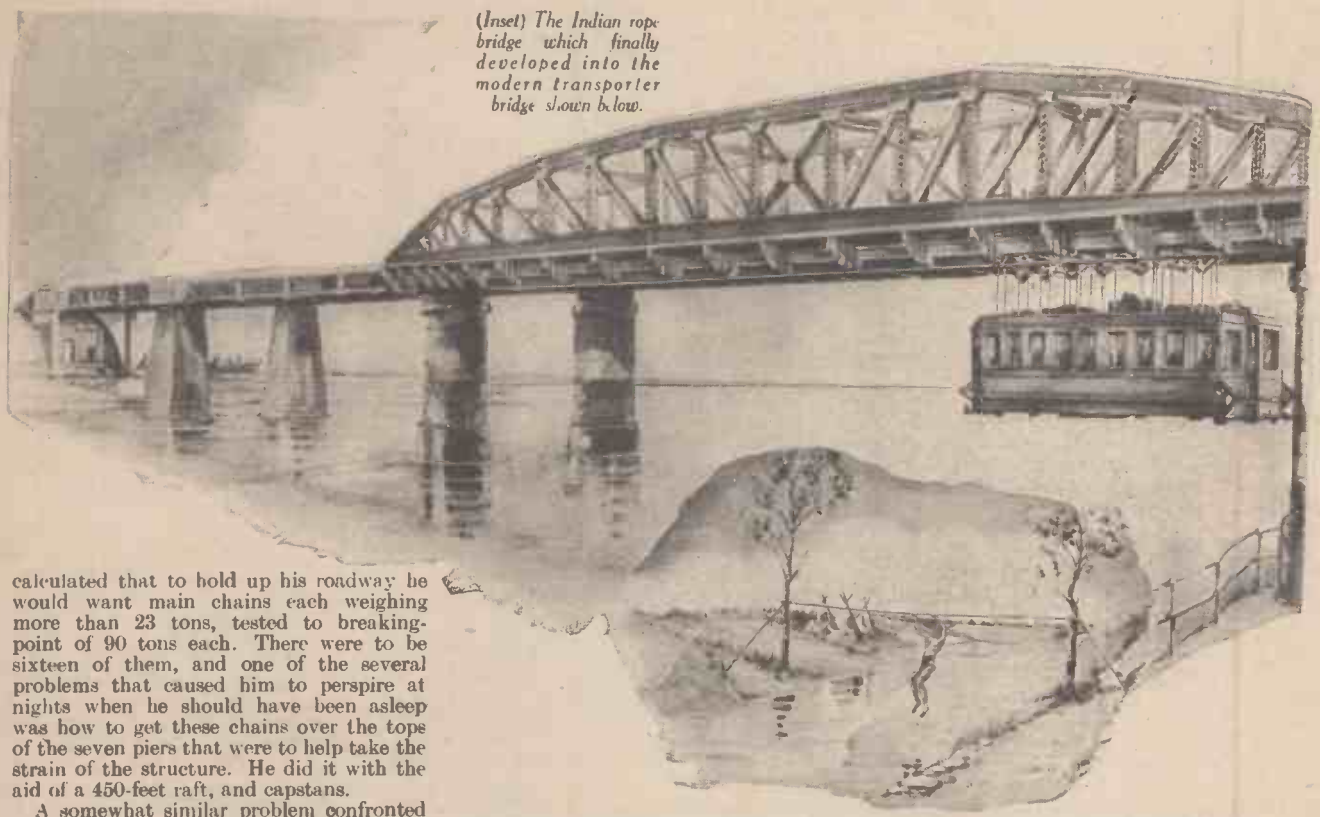
The Forth Bridge, at Queensferry, Scotland, is an example of cantilever construction. Here a number of "brackets" project out over the water and support the main stretch of level bridge. Its total length is 8,295 feet, of which 5,349 feet are covered by the cantilever structures. The two largest spans measure 1,700 feet. The centre space, for the convenience of shipping, is 150 feet above high-water level and its summit 361 feet—only five feet less than the extreme height of St. Paul's Cathedral. There are 51,000 tons of steel in the superstructure, 6,500,000 rivets were used, and at one time 3,500 men were at work on the construction. They tested the bridge finally by running two trains to and fro over it, each 1,000 feet long and weighing 1,800 tons. It was constructed by Sir William Arrol & Co., of Glasgow, and cost £3,000,000.

Rope Bridges

The rope bridge, of native India and elsewhere, has its ends tied around rocks or trees on opposite banks. At first the native worked his way along, hand over hand, his body dangling perilously over the water. Then there was devised an arrangement of pulleys whereby he was pulled across seated on a piece of planking suspended from the main rope. Improvement came when a car or spacious platform took the place of the plank seat. The modern transporter bridge probably grew out of that; the first was in use about 47 years ago, in the vicinity of Bilbao. A British example is the Newport Transporter Bridge, whose travelling platform carries 100 passengers and six vehicles and is 40 feet long and 30 feet wide. It crosses the River Usk in about three minutes, a driver operating the starting and stopping mechanism. The platform is suspended at the ends of 20 iron ropes attached to a trolley which runs under electric power on a rail track overhead. Construction costs of this bridge amounted to £100,000.

Suspension Bridge

A natural sequence of the crude rope bridge was the suspension type bridge. Telford led the way with these. Building his suspension bridge over the Menai Strait (it was opened for traffic in 1825) he had no data to work upon, but he had full reliance upon his own skill as an engineer. He



(Inset) The Indian rope bridge which finally developed into the modern transporter bridge shown below.

calculated that to hold up his roadway he would want main chains each weighing more than 23 tons, tested to breaking-point of 90 tons each. There were to be sixteen of them, and one of the several problems that caused him to perspire at nights when he should have been asleep was how to get these chains over the tops of the seven piers that were to help take the strain of the structure. He did it with the aid of a 450-feet raft, and capstans.

A somewhat similar problem confronted the builders of the Victoria Falls Bridge, over the River Zambesi, South Africa. Somehow they had to get a cable across that wide and deep gorge, and they did it by firing a rocket across. Attached to the rocket's tail was a cord, and to the end of that was secured a wire which was linked with the cable. When the fired rocket landed on the other side men hauled the cord, wire and cable in—and the first big obstacle was overcome. But theirs was not a suspension bridge, it was built on the cantilever principle.

Conway Suspension Bridge

Telford achieved another triumph with the Conway Suspension Bridge, and thereafter there came a succession of big jumps in dimensions. A bold experiment was embarked on in America with the building of the Brooklyn Suspension Bridge over the East River, to connect Brooklyn with New York. Because of the unknown factors, its construction occupied thirteen years. The weaving of the suspension cables alone took years, and in manipulating the continuous strands of wire they learned a very great deal about the effects resulting from changes of temperature. That part of the bridge which actually crosses the river is 1,600 feet long; from the cable-anchorages on either shore is 3,572 feet. The stone towers, 350 feet high, were topped with steel saddles mounted on rollers to allow of movement in the cables which rested on them, this movement being due to temperature changes, sudden unequal distributions of traffic weight, and so on.

Each of the four Brooklyn cables, 15¾ inches thick and with a breaking strain of 12,000 tons, was composed of 5,296 separate steel wires; total length of wire used was 14,000 miles. In modern practice, suspension cable wires are laid side by side, with steel bands to compress them at regular intervals. A coating of red lead is then applied, after which the cable is bound with galvanised wire and the whole waterproofed by painting. Because of the tremendous weight the cables must be built up, wire by wire, in place—a dizzy undertaking, necessitating the slinging of steel safety-nets below the construction.

Sydney Harbour Bridge which is the largest bridge in the world

American Bridges

Farther along the East River are the Manhattan and Williamsburg Suspension Bridges. The Manhatten comprises eight railway tracks, two footpaths, and a roadway for vehicles. The river span is 1,470 feet, and the towers over which the 21¼-inch thick cables pass are founded on masonry 92 feet below high-water level; from extreme top to extreme bottom their height is 424 feet. Each cable contains 9,472 wires and each cable-anchorage weighs 233,000 tons. The main span of the Williamsburg is 1,600 feet. The tops of the towers are 335 feet above high-water mark, and the anchorages for the cables are of masonry 150 feet long and wide and extending upwards 100 feet above ground. Total weight of the four cables is 5,000 tons and they consist of 19,000 miles of wire.

A suspension bridge to cross San Francisco Bay—eight miles—was visualised, and the sum of £17,000,000 for the construction was not considered excessive. Goat Island, a midway rock, somewhat simplified the design, but the enterprise was nevertheless staggering in its immensity. Largest span in this bridge is 1,400 feet, with others of 500 feet. Cables 29 inches thick were employed, accounting for 70,000 miles of wire. Eighteen thousand tons is the weight of the two

main cables, with 68,000 cubic yards of concrete as end anchorages. It was calculated that the 500-foot steel towers would be deflected at the summit by as much as three feet under the combined influence of the sun, weight of bridge-load, wind, etc., and this extreme movement was accordingly allowed for in the fixing of various bridge-members. The Golden Gate Bridge is another suspension masterpiece. Taking six lines of traffic, the roadway is suspended from cables three feet in diameter, each consisting of 27,500 separate wires; the breaking strain exceeds 100,000 tons. The towers soar 746 feet high. Total length of the bridge is 6,450 feet, and the longest span is 2,400 feet.

Lattice Bridges

We got our idea of the lattice bridge from the Britannia Bridge over the Menai Strait. This was built of straight, lengthy tubes of wrought iron supported on three stone towers—a big departure from the use of cast-iron. The first cast-iron bridge was built in 1779, but this material proved to be unsuitable for long spans. Iron side-girders, resembling lattice-work, followed as an improvement on the method of construction of the Britannia Bridge.

Pile bridges figure quite early in engineering history. This system of laying down a roadway on a foundation of stakes, or piles, driven into the river-bed may have given rise to the trestle bridge idea, wherein the roadway or "deck" is raised high on stilts. Once of all-wood construction, and therefore readily open to destruction by fire, trestle bridges are now constructed of steel. A notable example spans Van Staadens Gorge, in Cape Province, South Africa; it is 642 feet long, and 254 feet high at the centre trestle. A Canadian example is the Lethbridge Viaduct, over the Belly River; 33 steel towers support the roadway which is 314 feet above the water.

Swinging Bridges

Bridges which swing sideways, or which allow of part of their length being turned on a pivot, to allow of larger traffic passing up and down river, are of particular interest on account of the constructional problems involved. The Kincardine-on-Forth Bridge, opened four years ago, with a total span of half a mile, has a central swing span. When this is open—the swing span's extremities, pointing up and down river—there is a passage of 150 feet on either side of it. The total length of this steel swing span is 364 feet and it weighs 1,600 tons. It rotates on 60 steel rollers each 20 inches in diameter and disposed in the form of a circular track 36 feet 9 inches in diameter laid down on a 42-feet diameter pier forming a central pivot. This pier stands on six concrete cylinders bedded in solid rock and each 14 feet 6 inches in diameter. The swing span is operated by two sets of turning machinery each powered by a 50 h.p. motor.

A movable bridge of the vertical lift type is designed to give increased "clearance" for vessels of a larger size than normally use those particular waters, a section of the roadway being lifted vertically. One spans the Leeds and Liverpool Canal. In this instance a 20-foot section of the roadway can be raised and lowered, the portion which actually moves weighing 90 tons. Movement of a different kind is evident in the bascule bridges, of which type the Tower Bridge, spanning the Thames at London, is world-famous. Here the roadway, 49 feet wide, is divided across its centre, allowing the two halves of the bascules or "leaves"—weighing 1,200 tons each—to be raised on their outer ends, by hydraulic power.

The arched bridge has come down to us from the Romans. Their arches were half-circular, whereas bridges constructed on this principle in the Middle Ages had pointed arches. There are obvious disadvantages here, the road of necessity having a very steep rise and an equally steep fall. John Rennie swept away the drawbacks when he demonstrated that a bridge need only be gently arched and still stand up to every reasonable test. He was responsible for Waterloo, Southwark and London Bridges.

The Storstrom Bridge

And here are the longest, and largest, examples. Europe's longest bridge is in Denmark—the Storstrom Bridge. It is two miles long, contains 30,000 tons of steel manufactured and fabricated at the Middlesbrough works of Dorman Long & Co., and the superstructure weighs 20,700 tons. Opened officially by King Christian of Denmark in 1937, it cost £1,250,000. The largest steel arch span in the world holds up the deck of Sydney Harbour Bridge. That arch span is 1,650 feet long and its summit is 440 feet above sea-level. The roadway which it supports is 160 feet wide and 170 feet above the water. With its five steel approach spans, and concrete towers and pylons flanking the main bridge on either side, it is 2¾ miles in length. It contains 50,300 tons of steel, of which 37,000 tons are in the colossal main span, and it cost £10,000,000.

Curved Oil Wells

Tapping Oil Fields Under the Bed of the Ocean

AS is generally known, an oil well is made by steadily oscillating a heavy drill, which allows it to penetrate further and further into the earth. A great difficulty has always been to drill a well straight, and a straight well is classed as one within 3 degrees of perpendicular. Actually, such a deviation in a six thousand feet well means that the bottom can be anywhere within an area of seven acres and may actually penetrate some other lease or miss the underground oil supply entirely.

A young American of the name of John Eastman devoted considerable time and ingenuity to developing an instrument which would drill a hole perpendicularly. He then had the brilliant idea not to be content with orthodox drilling, but to deliberately curve his oil wells. The apparatus with which he does this is extremely ingenious. It consists of a long thin metal cylinder, batteries, compass, and miniature camera.

These are let down into the bore hole of a well, and photograph at regular intervals the face of the compass and the angle of the wall of the well. The boring bit is the second special part of his device. This can be dropped down the well and fixed into position at the angle desired to drill. The angle can be changed according to the photographs taken by the underground camera.

Reaching New Fields

The main advantage of this system is the huge oil fields which at present lie under the sea. Firstly, the mineral rights to the three-mile limit are controlled by the State; and secondly, owing to the depth of water they have hitherto been inaccessible.

Eastman sank an oil well about 200 yards from the shore. He drilled in a curve which went four miles under the water and thus beyond the territorial limits. His first hole brought five thousand barrels of oil a day, and incidentally, fourteen law suits, in fact, lawyers are still trying to determine whether he is infringing the mineral rights of the state. Recently a still more important aspect of his invention has come to light.

Quenching Wild Gushers

In Texas a well had blown up from a gas explosion, forming a crater two hundred feet across, boiling with oil, and throwing off fumes as dangerous as dynamite. All the adjacent wells started to fail whilst this well was wasting nine thousand barrels a day, and which past experience had shown would continue until either the well was exhausted or had burst into flame. Eastman offered to stop this. He erected an oil derrick four hundred feet from the crater and began to aim at the bottom of the boiling well a mile underground. He drilled straight down for 1,500 feet and then carefully calculated a slant until he estimated he was within six hundred feet of the bottom of the well. Water at eighteen hundred pounds pressure was then pumped into the newly-drilled hole and the dangerous oil well was sealed within a few hours.

New Lease of Life

For a world that in war or peace cannot live without oil, the discovery of the curved oil well might well mean a new lease of life to the power machines so dependent upon it.

Reproduced from "The Brook Magazine."

Counting Stars

COUNTING stars must be a very tedious job, yet astrologers consider it a very important astronomical activity. To count the stars in the Milky Way would seem a hopeless task, but a group of astronomers endeavoured to count them down to stars of the fifteenth magnitude. They have now found a simple way to do this stupendous task, by substituting an electric eye for the human eye. The surface of a sky photograph is scanned by a spot of light, and an electric current is released every time a star is "discovered." Dials similar to those of a mileage speedometer record the results.

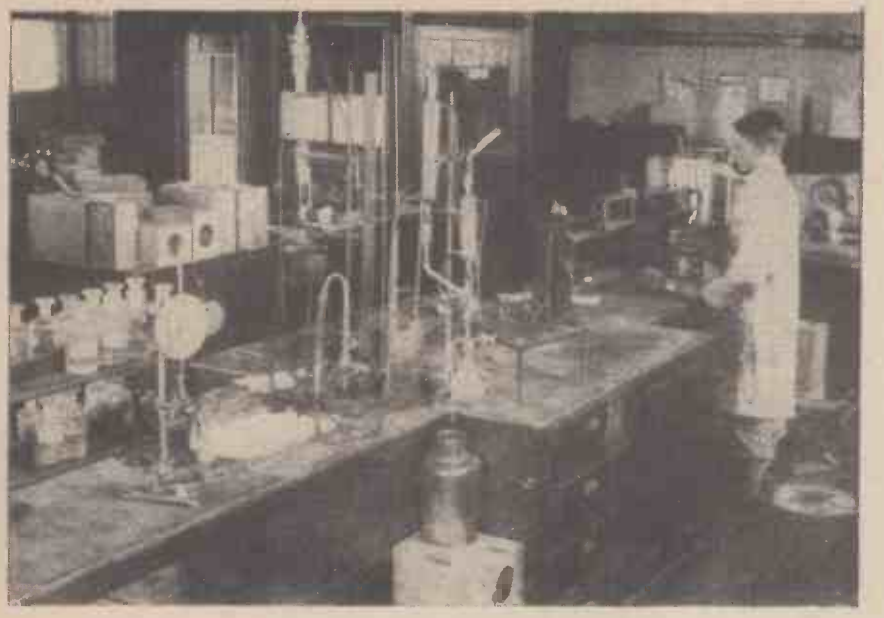
A Road That Vanishes

MR. W. CURRAN, a Chelsea engineer, has thought of an ingenious scheme for making a road "disappear." The inventor has constructed a small scale model in his back garden and by simply pressing a button, a yawning chasm will take the place of the road and the hole will automatically fill with water. With his idea a section of the road can be put out of action in less than a minute. A section of the road is made hydraulically, and when a button is depressed, drops down into 8 feet of water and the road is flooded. Mr. Curran has already been congratulated by the Admiralty for his ideas for supplying fresh air to sunken submarines. In his own words he says: "I can make roads and country lanes completely useless to the enemy, if they ever got here, and although the cost would be tremendous, I fully believe it would be worth it." He is approaching the Ministry of Home Security with his idea.

A NEW SERIES

The Story of Chemical Discovery

No. 3—The Decay of Alchemy



A typical chemical laboratory of the present day.

THE nonsense-doctrine of Alchemy, with its high-sounding farrago of meaningless and fantastic terms, contained within itself the germs of its own decay. For no alchemist, if he happened to be a man of honour and of worth, could profess to remain intellectually satisfied with the endless quest after the utterly mythical "Philosophers' Stone" and the "Elixir of Life," which two entities, when found, were promised to provide the means of turning all substances (particularly metals) into gold and of enabling life to be continued indefinitely.

The trouble, of course, was, that there was money in alchemy. In those medieval days of wealthy and all-powerful Princes, the desire for gain was commonly uppermost in the minds of many rulers. Hence a powerful nobleman would often retain the standing services of a professional alchemist in order that the latter might conceivably hit upon the much-talked-of "Philosophers' Stone" and so magnificently enrich him for life.

The idea, quaintly enough, is pretty much the same in our present generation when a manufacturing firm engages the services of a professional research chemist, although it goes without saying that in such an instance the underlying motive is a far more satisfying and a perfectly legitimate one.

"Paracelsus"

One of the first rebels against the methods, practices and beliefs of the professional alchemists was a Swiss physician who came to be known as "Paracelsus." Although Paracelsus invariably confessed himself to be a practising alchemist as well as a physician, he was an alchemist with his own ideas. Indeed, he was a sort of alchemical Hitler in his way, for he was born with the dictator's temperament and natural intolerance of other people's ideas, so much so that throughout his somewhat short life he played the role of stormy petrel wherever he went.

Paracelsus occupies such a prominent position in the annals of alchemy that our series of articles would be incomplete without some description of his activities being jotted down here.

By birth, Philip Hochener, the son of a doctor practising in the Swiss town of Einsiedeln, in which locality he was born in 1493, Paracelsus changed his name on commencing his professional career to "Phillipus Aureolus Theophrastus von Hohenheim." To its owner, the name sounded excellent, no doubt, but even in those days, life was apparently considered to be a little too short for "Phillipus Aureolus Theophrastus von Hohenheim," and probably on account of that fact it was that an old Abbot of Spannheim who had originally presided over his early studies, dubbed him "Paracelsus," the name being supposed to signify a "dweller in a lofty place."

Thus did the witty Abbot feed the pride of his erstwhile pupil and, incidentally, confer upon him a name which has passed down the centuries.

"Lived Like a Pig"

Of the personality of Paracelsus there seems to be little doubt. One old writer says of him: "He lived like a pig, looked like a drover, and through his glorious life he was generally drunk." Whilst this assertion is rather too much exaggerated, there is no doubt that Paracelsus possessed the Teutonic propensities of arrogance, bombast and intolerance. He generally managed to stir up hatred wherever he went, and at one time he had the entire medical profession of Europe against him.

According to Paracelsus, alchemy was far too serious a study to be dissipated in endless searching after non-existent phantasms such as Philosophers' Stones and the like. All alchemists, therefore, were entirely on the wrong track. So, too, held Paracelsus, were the doctors. With their vegetable potions, decoctions and extractions they were doing more harm than good, needlessly allowing their patients to die, when, by the application of a little intelligence and method many such lives could be saved.

Paracelsus seems to have begun his professional career by being elected to the post of Professor of Physic (Medicine) at Basle University. Here he at once made himself unpopular by publicly burning all the works of the older physicians such as Avicenna and Galen. In place of their system of doubtful remedies, Paracelsus offered various chemical salts which he had discovered and prepared in his laboratory. He used compounds of mercury as purgatives, iron salts as tonics, and preparations of lead for certain other bodily ailments. The use of opium as a pain-killer was introduced by Paracelsus. Medicine, he asserted, was but a brand of chemistry, and he believed that the restoration of a man to health was nothing more than a restoration of the normal chemical equilibrium of his body which, of course, is a perfectly true fact.

Discovery of Hydrogen

Paracelsus discovered hydrogen, having made this gas by acting upon iron filings with spirit of vitriol (sulphuric acid). He knew that the gas was inflammable, but it seemed to be of no practical importance to him and for this reason the real nature of hydrogen lay undiscovered until its elucidation by the English chemist, Henry Cavendish, in 1766.

Despite the unpopularity of Paracelsus's practices in medicine, his name readily gathered a certain amount of renown. A rich ecclesiastic, it is said, fell ill and offered a hundred florins to any physician who would cure him. Several tried, but all failed. At last, Paracelsus came along, gave the ecclesiastic a course of chemical pills and eventually restored him to health. whereupon, the ecclesiastic at once repudiated his offer of a hundred florins for the alleviation of his complaint. Paracelsus took the matter to law, but the verdict he received was that the ecclesiastic should pay him only his customary fee and not the hundred florins which was promised.

Due to this unfair judgment, Paracelsus gave up his post as Professor of Medicine in Basle and went to Strasburg. Here he settled for a time. Then he went to Hungary and finally wandered all over Europe in restless discontent, preaching to all physicians and alchemists his revolutionary chemical doctrines until, eventually, he proceeded to Salzburg, where he died, more or less in poverty, in 1541, and at the comparatively early age of forty-eight years.

Weird Notions

The importance of Paracelsus in chemical or rather, in alchemical affairs, does not centre around his strange and curiously

romantic personality. It derives from the fact that Paracelsus rebelled successfully against many of the weird and nonsensical notions of the alchemists of his day.

Paracelsus had his own idea of the constitution of matter. All things, he said, were made out of three components—salt, mercury, and sulphur. By combining these things in various proportions and by devious ways you ought to be able to produce any material thing of the Universe.

But this fanciful explanation of the constitution of material things did not please Paracelsus for very long. Soon, we find him asserting that by the term "salt" he really means the "principle of saltness," and so on. Thus the "three elements" of Paracelsus ultimately became three principles. And here, he gave up his conjectures in the realm of material constitution. The subject was too deep. even for his own powerful imagination.

The most famous alchemist in the period immediately preceding the demise of this sadly-distorted system of knowledge was a physician of Brussels, John Baptist van Helmont, by name, who was born in that city in 1577. Of a rich family, he was intended for a Court career, but he preferred the seclusion of laboratory work to the glamours of palatial apartments. Accordingly, he devoted the whole of his time to studies in alchemy and medicine, and eventually he became an enthusiastic and devoted disciple of Paracelsian doctrines.

"Last of the Alchemists"

van Helmont is called "The Last of the Alchemists." It is a true title for the man. since it was he who first seriously began to record certain chemical facts which he had learned by dint of actual experiment.

van Helmont shines as the discoverer of carbon dioxide or carbonic acid gas. Naturally, he did not give it that name. He called it *gas sylvestre* and referred to it as being a "wild, untamable thing, which exists in out-of-the-way places."

Here van Helmont introduces a very important conception into dawning chemical science, to wit that of a material thing which cannot be seen—a gas, in fact. Indeed. van Helmont's name goes down in the annals of chemical discovery as the man who first applied the term "gas" which he got from the German *geist*; "ghost" or "spirit," to a material substance or vapour which cannot ordinarily be condensed to a liquid. van Helmont found his *gas sylvestre* at the bottom of deep caves. He mentions, also, that it can be prepared by the action of acids on marble and he seems to have recognised it to be identical with the gas given off by fermenting liquids.

Perhaps van Helmont's epithet of "wild, untamable," was not given to his carbonic acid gas without reason, for he appears to have made attempts to generate the gas by the action of acids on marble in closed bottles. In such instances, of course, the containers were invariably rent asunder by the inward pressure of the generated gas, much, it would seem, to the worthy experimenter's astonishment and perplexity.

van Helmont also mentions a gas—*gas pinque*—which was evolved from dung and garden refuse and which was inflammable. Probably this was an impure form of hydrogen mixed with ammonia.

Phenomenon of Flame

Another scientific fact which this Brussels alchemist brought to light was that if a metal, such as lead or copper, is dissolved in an acid, it is possible to recover the metal from the solution of its salt by appropriate means. van Helmont offered no explanation of this. Had he attempted such he might have been led to the elucidation of that great mystery, the phenomenon of flame and combustion, which so greatly occupied the attentions of the early science workers after his time.

There is no doubt that van Helmont

Paracelsus, the great alchemical reformer.

went wrong through overdoing the *gas sylvestre* business. So fascinated was he by the "wild, untamable" properties of carbon dioxide that he tended to call every gas which he hit upon, "gas sylvestre." Thus it was that confusion arose in his mind about the properties of different gases, which confusion greatly affected his writings.

van Helmont reduced the "three elements" of Paracelsus to two elements—air and water. All things, he was inclined to say, originated from air and water. To prove his contention in one actual case and to demonstrate that water was a primary constituent of all forms of matter, he put a 5-lb. willow sapling into an earthenware pot containing 200 lb. of dried earth. He watered the pot assiduously for five years. During this time the willow gradually effected its normal growth and at the end of five years it was found to weigh a little more than 169 lb., whilst the earth had lost but 2 oz. in weight.

Where, therefore, had the new willow material come from? Obviously, asserted van Helmont, it had come from the water, which, in the willow substance, had changed from a liquid to a solid.

Plant Respiration

Had van Helmont been familiar with the mechanism of plant respiration, he would have known that his "proof" was entirely fallacious, since the willow had increased its substance by absorbing into itself carbon dioxide gas from the atmosphere and building this up, in conjunction with water extracted from its soil, into fresh plant, stem and leaf material.

Towards the end of his days, van Helmont, ever quiet and placid, appears to have taken to deep religious meditation. He retired entirely from his former pursuits and we hear little further about him until his death, which occurred in 1644.

With the passing of van Helmont the alchemical spell which had persisted so tenaciously throughout the centuries seems to have worked itself almost entirely out. Men were rising up in Britain who were perceiving the first truths concerning the interactions of material things. They were patiently evolving systems of experiment and equally patiently recording and interpreting the results of their experiments.

When "The Last of the Alchemists" died in the person of John Baptist van Helmont the famous Robert Boyle, of England, "Chemistry's First Pioneer," was rising into maturity. The black night of Alchemy had departed and the first glimmerings of Chemistry's dawn were already clearly discernible.

THE TELEPRINTER KEEPS WAR SECRETS

A Method of Secret Communication

VITAL messages pass daily and nightly between Headquarters and stations of the R.A.F. by means of the teleprinter. The great advantage of the teleprinter in this work of protecting Britain against air attack is its speed and secrecy.

In appearance the teleprinter keyboard is like the ordinary three-bank typewriter, but there are important differences between the two machines.

Automatic Signals

Teleprinter messages. or signals as they are called in the Royal Air Force, are automatically typed by the receiving set. Stations hundreds of miles apart are connected by cables and when a signal is transmitted the depression of the key sets up a number of electrical impulses which cause the character required to be printed simultaneously on the paper of both the transmitting and receiving machines. By this means speedy transmission of news is ensured. All that is needed is for an operator to detach the copy from the receiving set.

Unlike a typewriter, a teleprinter has no back-spacing key. Another difference is that the result of the key depression does not appear until another key is depressed. For instance, in the word "the" the letter "t" is not actually printed until the key for the letter "h" is depressed.

Secret Communication

The teleprinter is of great value as it provides the Royal Air Force with a means of secret communication. It is impossible for the enemy to intercept signals because of the manner in which the connecting lines are laid, and even if it were possible for the lines to be tapped, decoding of the electrical impulses would be extremely difficult. No other means of communication is so rigidly water-tight.

When the R.A.F. first introduced the teleprinter system into its signalling organisation the normal procedure was for the machine to be operated by wireless operators, but as time went on this was found to be impracticable. They could not always be spared for teleprinting and now teleprinter operators have to undergo special training. Articles entitled "The Teleprinter—How It Works" appeared in the June and July issues of "Practical Mechanics."

THE MONTH IN SCIENCE AND INVENTION

Harold F. Pitcairn, president of the Pitcairn Autogiro Corporation with his new PA-36 autogiro. Mr. Pitcairn is shown pointing out the location of the new type motor used in the 'giro. It is located in the middle of the fuselage. This gives greater visibility over the front cowling. The autogiro is capable of rising vertically, making it independent of ground obstacles or conditions of terrain. Army and navy officials inspected the craft, but have kept their findings a secret.

Britain's Secret Weapon

THE terrific losses that Britain is inflicting on the German air force is causing considerable comment in America, and mention is made of a "new and terrifying British weapon." One American newspaper says: "England's secret weapon, a spiderweb of steel cables fired from guns, has been tried out in Nazi air raids on the South-East Coast.

"Cables were shot from what are called 'rattling guns.' The guns belched forth great balls of cable, which opened out over the sea into steel screens dangling from miniature parachutes. Through the steel nets Germans were seen descending by parachutes, trying to avoid the whipping tentacles of the cable curtain."

Improving Stainless Steel

SCIENTISTS at Massachusetts Institute of Technology have discovered that by adding tiny traces of silver to the composition of stainless steel, the latter can withstand the corrosive action of salt water. Only an infinitesimal amount of silver is required.

A Mysterious Device

MR. R. BACKHOUSE, of Wombwell, a 35-year-old motor engineer, has invented a gadget for immobilising motor vehicles which, he claims, will baffle the Nazis. Moreover, he declares that when his device has been applied no motor expert in the country can start a car in less than half an hour, or even find what the "trouble" is. The ignition key is not removed and the rotor arm remains in position. Mr. Backhouse states that his device costs less than half a crown and can be applied in a few seconds, and so easily that a doctor could use it without soiling his hands.

Long-Range Tanks

TANKS with oil-burning diesel engines, giving them double the range in which to strike without refuelling, are being experimented with in the United States Army.

More Power for the Wellingtons

BRITISH "Wellingtons"—the famous long-range bombers of the R.A.F., have now been given an even finer performance with new-type engines. Two liquid-cooled Rolls-Royce "Merlins"—the type fitted in the famous Hurricane and Spitfire fighters—replace the radial air-cooled types previously fitted. Whilst the improved performance figures are secret the several hundred extra horsepower may be assumed to add considerably to the former speed of around 260 m.p.h.

Seventy-ton Tanks

THE United States Army have decided to embark on the construction of monster tanks, weighing 70 tons and mounting 3-in. guns.

Whale-back Ships

"WHALE-BACK" ships for defeating air bombers are being considered by American naval architects. The ships will have curved armour-covered decks and pill-box gun batteries. The whale-back deck would completely cover all parts of the ship now exposed to fire, including the bridge and communications system.

A "Parachute" Cabin

LONG before Hitler thought of using parachute troops in modern warfare, Robert M. Thomson, a 41-year-old Miami inventor, perfected an armoured cabin to lower fighting men from an aeroplane. Invented in 1928, and patented in 1933, Thomson has been trying to get the United States to adopt his idea. The bullet-proof cabin fits inside the belly of a large plane, is released by the pilot, and floats to the ground by parachute, while the 20 men inside fight off ground snipers with machine guns, rifles, and hand grenades. Although Thomson thought of the idea 12 years ago, recent war developments have brought his parachute invention to the fore. The American War Department is considering the merits of the invention.

One of the famous long-range bombers of the R.A.F., the Vickers "Wellington" which has now been fitted with Rolls Royce Merlin engines.

IN THE WORLD OF INVENTION

A Robot Torpedo

MR. J. R. FISH, a 45-year-old American research engineer, has perfected a sound-directed robot torpedo. The torpedo is directed to the ship by sound coming from the ship to be hit. Fish is also working on a robot rocket for bringing down planes which will operate on the same principle.

From Top to Toe

ACCORDING to an Italian newspaper, the women of Germany are now being invited to give up their hair so that it can be used to make socks and clothes for the troops. In the Thuringia district, it is stated, women provided 400 tons of hair.

Steam Planes

ACCORDING to a report from Washington, successful experiments are being carried out with a new type of aeroplane engine which is steam-powered. It is claimed that both engines and aeroplanes can be built much more rapidly than any of the types now in use. So fast is production possible, that 60,000 planes a year would be quite easy. The inventor claims for his new unit that weight has been cut substantially. The wings of the plane are made to act as water condensers, and the bugbear of ice formation is turned to good account. Experiments with the new engine are now to be made at great altitudes, and if they prove successful, the Government will take over the designs and arrange for production.

Silk-twisting Machine

MR. G. R. LEWIS, of Cheshire, has invented a machine which, for a long time the Germans have been trying to produce. This invention, in one continuous operation, produces the silk-twisted cord used in house furnishing, women's garments and girdles from a single thread to the finished article, measured and wrapped in a container.

Expanding Rings

NEARLY everyone is familiar with the expanding watch bracelet, and now ring shanks have been produced on the same principle. It is like a miniature watch bracelet and, unlike any ordinary ring, stays neatly in position on the finger and does not slip sideways. It can be fitted to any existing gem-set head.

Launching Gear for Rafts

AMONG the devices to help in the rescue of shipwrecked men, which were recently exhibited at the Ministry of Shipping, was a model of the T.D. stowing and launching gear for life-rafts, invented by Mr. R. S. Chipchase, managing director of the Tyne Dock Engineering Company. The special cradle in which the raft is housed can be fitted to the rigging and provides for very quick release by means of a kick. If there has not been time to free the raft before the vessel sinks, the upward pressure of the water would then release it.

The merchant navy is also to be supplied with small lighting buoys designed for carrying on a raft, and with battery lights for fastening on their clothing, as part of its compulsory equipment.

Tiny Robot Planes

MR. EDWARD F. CHANDLER, a well-known American marine engineer, has developed a tiny robot plane of a new type for defence against bombers which he calls "the flying bumblebee." The planes have been so designed that they steer automatically by the sound of the attacking bombers. They then race along overhead, dropping bombs on their victims. Mr. Chandler is a recognised expert in automatic steering controls for torpedoes, aircraft, and marine vessels. In the last war he distinguished himself as the inventor of a gyroscopic control system for accurately aiming submarine torpedoes. He also assisted in developing the Swedish Navy's sound-controlled torpedo. Mr. Chandler plans a set of four sound controls which should lead his bumblebee to wheel into line above a bomber and slightly ahead of it. The controls would also tend to keep the little plane at a predetermined distance above the bomber it is attacking. When in position it would drop its bombs.

New Aeroplane Engine

MR. CHARLES A. TOCE, mechanical engineer, of Houston, Texas, U.S.A., has offered the United States Government a new aircraft engine which, he asserts develops twice the horse-power for the same displacement and with less weight than the normal engine, which costs twice as much as his to build. Toce says that the engine is the result of nine years of development and now has reached the point of perfection.

Flashless Electric Machine Gun

VIRGIL RIGSBY of Hull, Texas, has invented a flashless electric machine gun which may shortly be made available to the United States Army. A Pittsburgh manufacturing company have offered to supply the weapon and attempt to perfect it. The gun, although only in the experimental stage, has a muzzle velocity of 400 ft. a second.

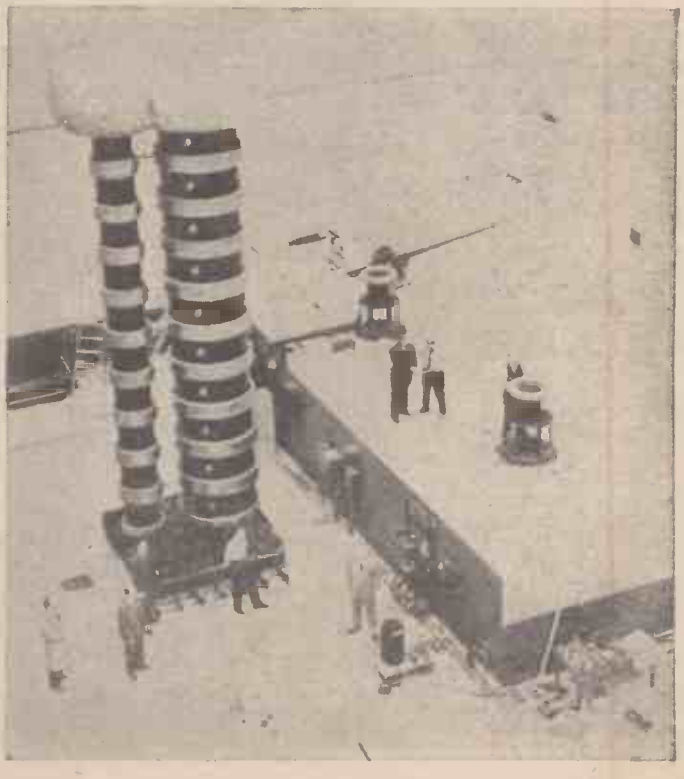
Mr. B. D. Atwell, engineer of the Pittsburgh firm's plant, said that the principle of the gun is sound, but "it will take a much higher muzzle velocity to make a war weapon of the gun." The bullets are jerked through the gun by means of magnetic coils, which may be operated from batteries or from a power line. The big advantage with this type of gun is that concealed troops could silently operate against the enemy, who would find it difficult to spot the machine gunners.

Planes Produced by Photography

PHOTOGRAPHY plays an important part in the mass production of planes at the Glenn L. Martin plant at Baltimore, Maryland. A huge camera is used which is capable of reproducing engineering drawings on any kind of surface. Time and money in redrafting is saved by this method, and, it is also claimed, speeds up production.

Pithead Winding Gear

COLLIERY managers and engineers were recently present at a demonstration of a new type of mobile pithead winding gear. The machine is considered one of the most remarkable of recent inventions, and is for use at any pit in the Cannock Chase, Warwickshire, or Shropshire area in the event of the ordinary gear being damaged by air raids or other enemy action. It weighs 24 tons, is 12 ft. high, and costs some thousands of pounds. The machine is mounted on six huge pneumatic tyres, and it can travel along roads drawn by its special lorry, or the road wheels can be taken off to enable it to be placed on a railway line. Fitted with every safety device attached to the most modern winding gear, it is primarily for use following damage from air attacks, but it can also be used in any emergency.



A view of the installation of the world's mightiest X-ray machine in the new high-voltage laboratory of the U.S. Bureau of Standards in Washington. The General Electric Company is constructing the 1,400,000-volt machine that will supply X-radiation equivalent to that of $150,000,000 worth of radium. The 32-foot columns in centre form the generating unit of the machine

Testing Magnetic Materials

Fig. 1.—Apparatus for testing magnetic materials.

THE basic characteristics of magnetic materials may be determined for the most part from the various relationships between the flux density and the magnetising force. These relationships are represented graphically by a magnetisation curve, and a series of hysteresis loops. The magnetisation curve represents the relationship between flux density, B, and magnetising force, H, as the latter is increased from zero up to such a value that further increase produces no appreciable increase in flux. The hysteresis loops represent a complete cycle of flux change as the magnetising force is decreased from some value HI to zero, then reversed to a value HI, and then increased to the original positive value. The areas of these loops represent the magnetic losses in the material over such a cycle when the change in magnetising force is made slowly.

Measuring Flux

A large part of the magnetic materials testing consists in determining these curves for the various materials used in the Bell System, but since these materials vary widely not only in magnetic characteristics, but in the form or shape in which they are obtained, no single procedure can be applied to all of them. In general the flux is measured by placing a winding on a sample of the material and measuring the quantity of electricity caused to flow through this coil when a change is made in the magnetising force. The determination of magnetising force, however, is not always so easy. When the material can be formed into a ring of uniform cross-section, it is determined by placing a winding of a known number of turns on the ring and passing a measured current through it. This gives the magnetomotive force in ampere turns, which may be converted to the magnetising force by dividing by the length of the magnetic path. This is the simplest and most satisfactory method, and is always used when possible. Where large numbers of similar size samples are to be measured, special jigs are employed to avoid the necessity of placing separate windings over each. This method is particularly suitable for measurements on toroidal cores, such as are commonly used for loading coils and for certain forms of transformers or repeating coils.

Fig. 2.—Clamping a specimen in a Fahy Simplex permeameter.

Type of Specimen

In other cases, this type of specimen can be approximated in one of several ways. Where the material is a straight rod of such physical characteristics that it can be bent, it may be formed into a ring and then welded by one of several methods that are known not to have a harmful effect on the material. Where this bending is not desirable, the equivalent of a ring may be formed by milling a narrow slot lengthwise down the rod and then spreading the sides to form a link. Coils may then be placed around the two sides of the link. Both of these methods give the magnetic properties in the direction of drawing. At right angles to this direction, however, the magnetic properties are occasionally different, and to determine them the rod may be drilled out to form a bushing, which may then be tested as a simple ring. Typical specimens of this type are shown in Fig. 3.

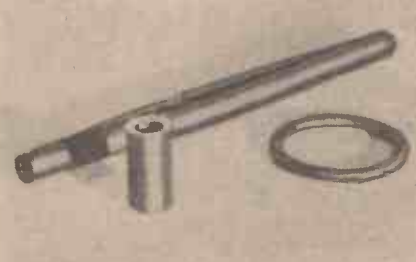


Fig. 3.—Typical specimens of magnetic materials made from bars.

Electro Mechanical Apparatus

Thin Sheets

Magnetic material frequently comes in the form of thin sheets, and these may be formed into the equivalent of rings in several ways. Such sheets also occasionally have different characteristics in different directions. Where the characteristics are to be determined in one direction, the material may be cut into a narrow strip and then wound into a coil consisting of a number of layers, over which a winding is placed. Where the material is very thin, the tape is often wound on a spool of refractory material, which serves as a support during heat treatment and test. With material of such a nature that the pressure of a winding might change the magnetic characteristics, the wound tape is placed in a toroidal box which serves as a support and protection for the coil. Sometimes the sheet, due to its crystalline structure, has two directions in which the magnetic characteristics are the same, but different from those in other directions. Under these conditions hollow parallelograms are cut from the material to form a core. Specimens of sheet materials in various forms are shown in Fig. 4.

Some materials, such as the steels used for permanent magnets, are too hard mechanic-

ally to be treated in any of these manners, and must be tested in their rod or bar form. Several types of d-c permeameters are available for such tests. They consist primarily of yokes of high permeability and large cross-section to complete the magnetic circuit of the bar specimen, and coils for creating the magnetising force. Although there is a closed magnetic circuit carrying the same flux throughout, as when a ring specimen is used, the determination of the magnetising force in the specimen is not so simply obtained because of the difference between the magnetic material of the yoke and of the specimen.

Magneto-Motive Force

The magneto-motive force divides itself across the various sections of a magnetic circuit in direct proportion to their length and in inverse proportion to their cross-section and permeability. Since both permeability and magnetising force vary over different sections of the magnetic circuit, the correct values for any one section cannot be determined with sufficient accuracy from the total magneto-motive force and total flux. The magnetising force must be found, therefore, by other means, and is determined differently with the two types of permeameters described below.

With the Fahy Simplex permeameter, shown in the foreground, Fig. 2, the yoke is U-shaped and the entire magneto-motive force is supplied by a winding on the base of the yoke. With this arrangement the magneto-motive force acting on the specimen is determined from the flux through an air-core coil bridged across two high-permeability posts in contact with the ends of the specimen.

Babbitt Permeameter

With the Babbitt permeameter, shown in the photograph at the head of this article, the magneto-motive force is supplied by two windings connected in parallel electrically. One is on the U-shaped yoke and the other across the sides of the U, and the specimen is

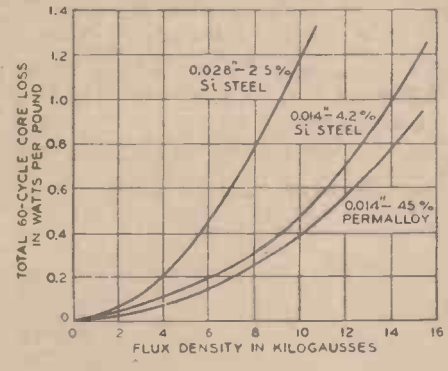


Fig. 5. — Core losses in typical materials determined with an Epstein testing set.

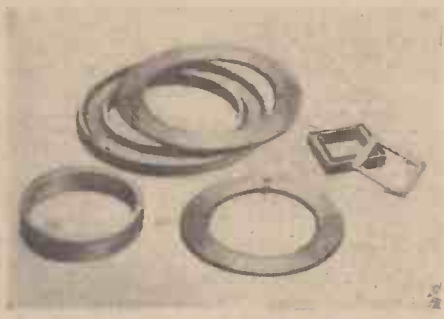


Fig. 4.— Typical specimens made from sheet material.

placed inside this latter coil. These two windings are proportioned so that the one on the yoke produces just sufficient magneto-motive force to maintain the flux through the yoke while that around the specimen maintains sufficient magneto-motive force to maintain the same flux. With this arrangement the magneto-motive force in the specimen can be calculated from the current flowing in its exciting winding, and the flux is determined from an auxiliary winding placed over the specimen. The ratio between the two exciting windings should theoretically be varied for each change of specimen, but since these permeameters are used only for low-permeability materials, while the yoke is of very high permeability, the magneto-motive force applied to the yoke is only a small part of that applied to the specimen, and small changes in it are negligible.

A.C. and D.C. Fields

The properties of magnetic materials under the influence of A.C. fields differ from the D.C. characteristics, and for low magnetisng forces are determined for the most part by bridge measurements of the inductance and resistance of a winding placed on them, as already described. For sheet material used in power transformers, however, the sixty-cycle loss at high flux densities is of particular importance, and is measured with an Epstein testing set shown in Fig. 6. Strips of the specimen sheet are placed inside four coils forming a hollow square, and the coils—connected in series—are supplied from an A.C. source through a wattmeter. The reading of a voltmeter connected across a secondary winding with the same number of turns as the primary is a measure of the flux, and the loss is obtained from the wattmeter reading. The losses of typical materials are shown in Fig. 5.

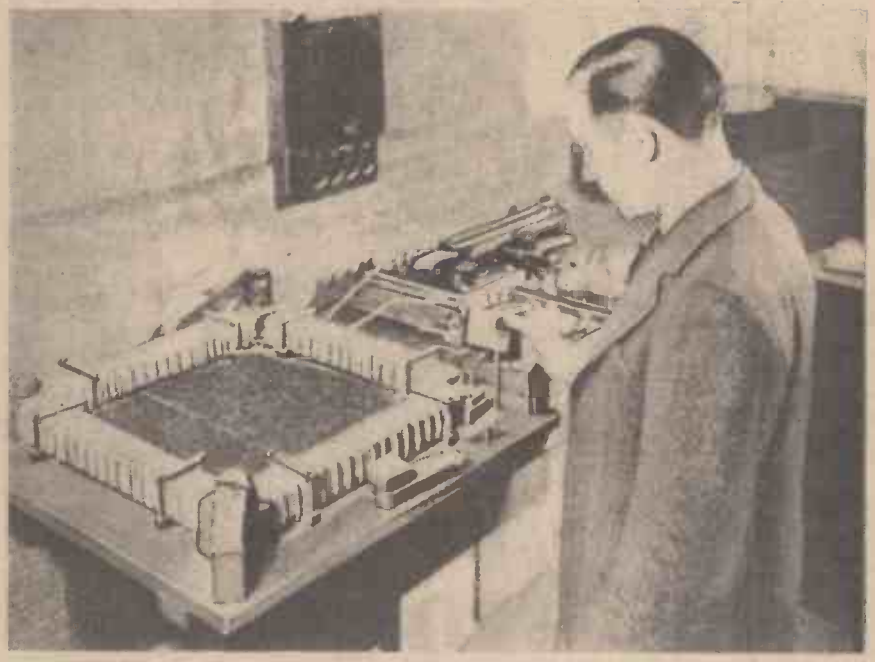


Fig. 6.—An Epstein testing set employs primary and secondary windings on a rectangular core made up of specimen strips.

Because of the very extensive use of magnetic materials in the telephone plant, almost every known magnetic property is utilised. Not only must a very great variety of materials and shapes be tested, but a wide variety of types of tests is also required. Those described above, of course, are only a few, but they are representative and give an indication of the types of tests that must be made. (*Reproduced from Bell Laboratories Record.*)

BOOKS RECEIVED

See also pages 14 and 31

"Everyday Science," by A. W. Haslett. Published by The Scientific Book Club. 266 pages. Price 2s. 6d. to members.

NOWADAYS it is evident that science is no longer confined to the laboratory, and its varied uses in the world outside need to be explained. In this book it has been the author's intention to explain in an interesting manner the many ways in which the application of science affects our lives from day to day. Commencing in the home, there are the problems of refrigeration; questions of diet and cooking; and heating and lighting problems. Building, crime detection, transport and agriculture are also dealt with. in addition to the fight against disease and insects. Further, in the realm of the engineer there is the important problem of waste, and our inability to use nature's riches to the full. The book is written in non-technical language, and makes an informative tour of everyday topics which are of interest to everyone.

Stamps of the World

WE have just received a copy of the standard catalogue of Postage Stamps of the world (1941 edition), published by Whitfield King & Co., Ipswich. Although the number of copies printed has had to be considerably reduced, the size of the volume and number of illustrations are increased as compared with last year, and there are now nearly 1,000 pages and more than 7,800 illustrations. There has been no alteration in quality or curtailment of the usual features.

This catalogue lists and describes every issue of the world's postage stamps since 1840, known at the time of going to press, and the information as to prices, geographical data, etc., is based on the latest available information. It costs 6s. 6d.

An Ingenious Multi-Purpose Tool

Metal Working and Model-Making at Small Cost

Fig. 1.—Showing how six separate tools are incorporated in the Juneero Tool.

MODEL making is always a fascinating hobby, and provided one has suitable tools the task is considerably simplified. But when tools and materials are not available, models are apt to take so long to produce and to cost so much that many would-be model makers are forced to give up their hobby. A tool is now on the market, however, known as the Juneero Multi-Purpose Tool which is sold complete with model-making materials. With the tool it is possible to construct and finish an almost endless variety of articles, from complete working models to a host of practical and useful things for the home, garden, garage, and workshop. Juneero is sold in two sets—No. 1 costing 15s., and No. 2, 30s. There is also the workshop set at 60s. The Juneero tool is the same in both sets, but No. 2 is more comprehensive and includes a scroll tool and shears, as well as more materials, enabling advanced work to be undertaken. It also contains metal strips and rods and a cutting die for cutting threads on the rods. Ruled metal sheets which simplify cutting are also included as well as corrugated metal, metal discs of various sizes, glass substitute, spanners, nuts and bolts, and a penknife which incorporates a rule and screwdriver.

Fig. 4.—Cutting strip.

The Juneero Tool

A glance at the illustration of the Juneero tool shows that six separate tools are incorporated, most of them operated by the single lever or handle. There are shears for cutting strips and at the back there are shears for cutting the rods. Below the shears is a punch for perforating the strips with perfectly round, clean-cut holes for the bolts. At the back of the tool is the forming die in which the strips can be bent to any desired angle and below the hole in which round bars are held to bend them. The tool is also provided with a gripping vice for holding the rod when cutting screw threads on it. A wing nut locks the gauge bar in position. With the aid of the gauge bar parts can be mass-produced with factory precision—each exactly like its fellow.

Fig. 3.—Setting the gauge bar.

Punching Holes and Slots

The punch for the holes, which is situated in front of the tool, is operated by pulling the handle down gently in the manner indicated in Fig. 2. Particularly in model engineering work, slots are occasionally required. These can be cut by punching one hole and then moving the work along in steps of $\frac{1}{16}$ in., punching successive overlapping half-holes. With a little practice perfectly formed slots can be cut. To space the holes correctly they can be marked out with dividers or the gauge bar may be employed. Where a number of equally-spaced holes are being cut an alternative method suggests itself : bend one end of a length of round bar up about $\frac{5}{8}$ in. Clamp the bar in the vice with its upset end set to indicate the space desired between successive holes. Oil the punch occasionally to preserve its cutting edge.

Cutting Strip

To cut metal strip, place the strip as far as it will go into the jaws of the tool and, by pressing the handle down, the shears will cut the strip. To ensure cutting the ends off dead square, you will find it best to stand behind the tool and sight the strip along the gauge bar. Fig. 4 shows how the tool is used for cutting strip. The hole in which the rod is inserted for shearing is to be found at the top of the back of the tool.

For some decorative work it is sometimes desirable to cut the ends of the strip into a spear point. To do this place the strip in the jaws from the front of the tool, holding it at the required angle in relation to the operating handle. Oil the cutting edges occasionally to preserve their cutting edge.

Fig. 2.—Punching strip.

The Gauge Bar

Mention has been made of the gauge bar, and this can be moved endways to any gauge. It can also be rotated in its holder to bring its end opposite the punch or either of the shearing or bending positions. After the gauge bar has been moved into position it is locked by tightening the wing-nut that projects in the front. By the use of this bar the necessity for marking out each part is avoided and it is possible to produce as many parts as are required, all exactly the same as each other.

If it is desired to perform a number of operations on parts which must all be exactly alike, the first part of the series to be made should be marked off and placed into position in the tool. The gauge bar is then moved to come into contact with its end and locked in position as shown in Fig. 3. After the operation has been completed, each succeeding part is inserted in the tool, in such a manner that its end comes into contact with the gauge bar, obviating the necessity for further marking off and ensuring absolute uniformity.

A further article describing other applications of the Juneero Tool will be given next month ; in the meantime readers may obtain any information regarding the tool from Juneero Ltd., 25, White Street, Moorfields, London, E.C.2.

THE SPARK CHRONOGRAPH

Keeping a Continuous Check on the Relative Rates of Crystal Clocks

Fig. 1.—Inspecting the chronograph chart.

TO keep a continuous check on the relative rates of the crystal clocks in America which comprise the Bell Laboratories' frequency standard, and also of their absolute rates in terms of radio time signals, a spark chronograph is used. It permits a continuous intercomparison of the timekeepers by automatically recording on a slowly moving chart a curve for each clock. These curves indicate at any point the difference in time between the clocks.

The record is made on waxed recording paper which is drawn slowly by a sprocket over a long knife-edged electrode mounted with small clearance below a rotating drum. The drum has raised above its surface a metal spiral which just clears the paper and forms with the electrode a short spark gap which traverses the width of the chart once for each revolution of the drum. Sparks perforate the paper at positions which depend on the angular position of the rotating drum and leave very small but readily visible marks where the wax melts around the hole. The visibility of these marks can be varied by controlling the intensity of spark.

Successive Sparks

When successive sparks occur at intervals which correspond exactly to any whole number of revolutions of the spiral, the perforations lie on a straight line parallel to the direction of motion of the recording paper. If the sparks come earlier or later by amounts proportional to the elapsed time, the corresponding indications lie on a straight line inclined to the direction of motion. The slope of this line is an accurate measure of the rate of the clock mechanism which produces the sparks, relative to the rate of the chronograph drum. Thus, any mechanism that produces electrical impulses at intervals simply related to the period of the rotating cylinder may be compared with it as a timekeeper.

Any accurate source of alternating current may be used to drive the chronograph, and this source then becomes the reference standard. When a crystal oscillator or other high-frequency source is used to control the speed of the drum, a submultiple of the high frequency is used to drive it.

"Gaining" or "Losing"

The chronograph shown in the photograph operates from a 100,000 cycle crystal oscillator through a frequency converter which gives a 100-cycle output, and is designed so that the spiral makes two revolutions every second. The time interval corresponding to the entire chart width is therefore one-half second and the smallest divisions represent hundredths of a second. If the record changes its position by five small divisions per day, the clock which made it is gaining or losing five hundredths of a second per day, relative to the rate of the drum. Whether a given slope means "gaining" or "losing" depends on the direction of rotation of the spiral. The instrument described here has a left-hand spiral and a clockwise rotation when viewed from the left, so that a slope upward to the left corresponds to a gaining rate relative to the chronograph. The chart is moved at the rate of three inches per day by gearing from the main motor and the record of the entire past week is kept continuously in view before it is wound automatically on the take-up reel.

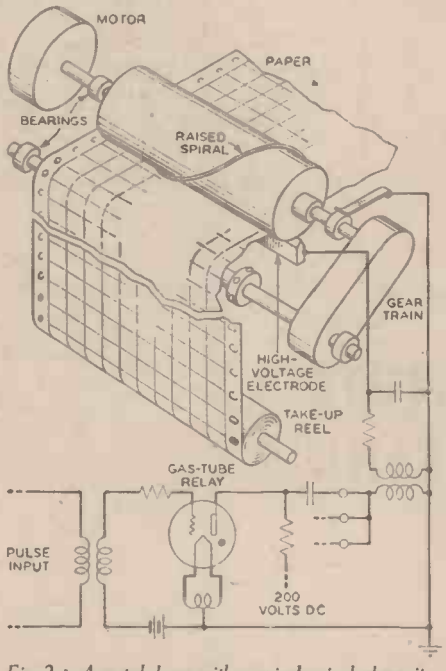


Fig. 2.—A metal drum with a spiral raised above its surface rotates above a moving sheet of recording paper, which passes over a long knife-edged electrode. Sparks from the knife edge to the spiral perforate the paper at points which depend on the angular position of the rotating drum.

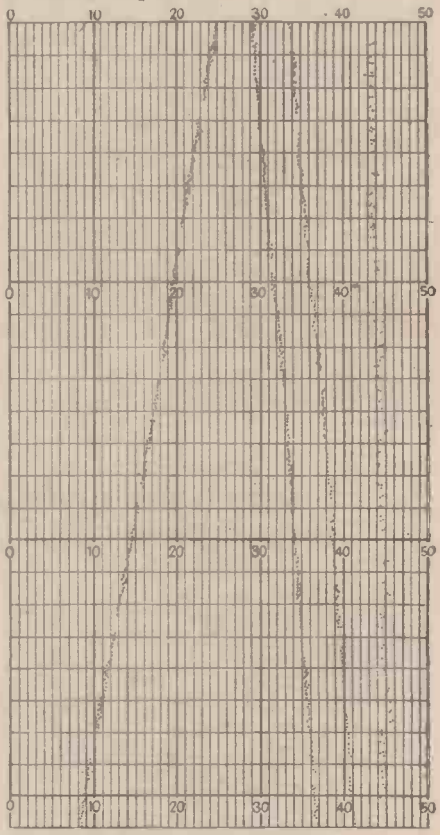


Fig. 3.—Chronograph chart. The three records at the left were made by three crystal clocks. The other trace is a record of time signals received hourly by radio.

The Electrical Circuit

The electrical circuit used with the spark chronograph permits making several clock records on the same chart without mutual interference. The rate of any clock mechanism which produces regular electrical pulses at intervals of a half-second, or multiples thereof, can be measured by allowing the pulses to operate a gas-tube relay. The condenser in the plate circuit of the relay tube is charged slowly to about 200 volts through a high resistance, and discharged very abruptly through the primary of an induction coil when the operating pulse arrives. This creates a high potential in the secondary winding which breaks down the gap between the knife-edged electrode and the grounded rotating spiral. The passage of the spark through the paper makes a permanent record on the chart and

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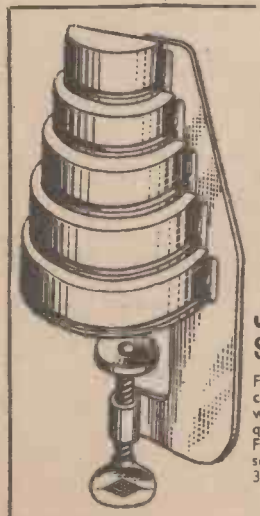

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indicates the instant of occurrence by chronograph time. As the chart moves, and more sparks occur in succession, the traces form a line which is straight when the rates are constant.

Scattering

The points on the record scatter somewhat because a spark does not always choose the most direct path. This accounts for most of the normal scattering which amounts to about one and a half milliseconds either side of the mean. Mean observations can be made with an accuracy of better than one millisecond by measuring to a line drawn through the centre of the line that is traced.

Several gas-tube relays can be used with one induction coil so that many records can be made on the same chart without mutual interference. Fig. 3 shows a chart with four records, of which the three at the left are comparisons of three crystal clocks against a fourth which controls the chronograph. The fourth trace is a record of time signals received hourly by radio. The somewhat greater scattering in this record is largely due to irregularities in radio reception, such as those caused by fading and static. The radio signal is allowed to record for one minute during each transmission. There is no observable movement of the chart during a single transmission and the record appears as groups of points spaced hourly along the chart.

The three similar records are identified by the use of a simple timing device which deletes a small portion of each trace every twelve hours in a pre-arranged sequence. This method can be used to label any number of records and does not impair the value of the long-time comparisons.

Precision of Measurement

The section of chart shown includes records for somewhat over three days and indicates relative rates accurately to somewhat better than one part in thirty million between the crystal clocks. Thus the precision of measurement with the spark chronograph can be very great although it involves apparatus and methods of great simplicity and reliability. The only moving parts, aside from the recording paper, execute simple rotation at slow speeds. In four years of continuous use, no operating trouble has developed. The only maintenance involved, apart from infrequent oiling and changing of the chart roll, is to remove a thin layer of wax from the cylinder about once a year. This wax, which is vaporised from the paper by the spark, condenses on the cylinder and increases somewhat the scattering of the record.

By increasing the speed of rotation of the cylinder or by enlarging the physical dimensions of the recording parts, the resolution and hence the accuracy of time comparisons can be increased considerably. The dimensions and speed of operation of the Labcratories' chronograph were chosen to give the best practical compromise for accuracy, convenience of mounting, and long life. The result is an instrument which has served very satisfactorily as the chief visual means of checking continuously the performance of the frequency standard. *Reproduced from Bell Laboratories Record.*

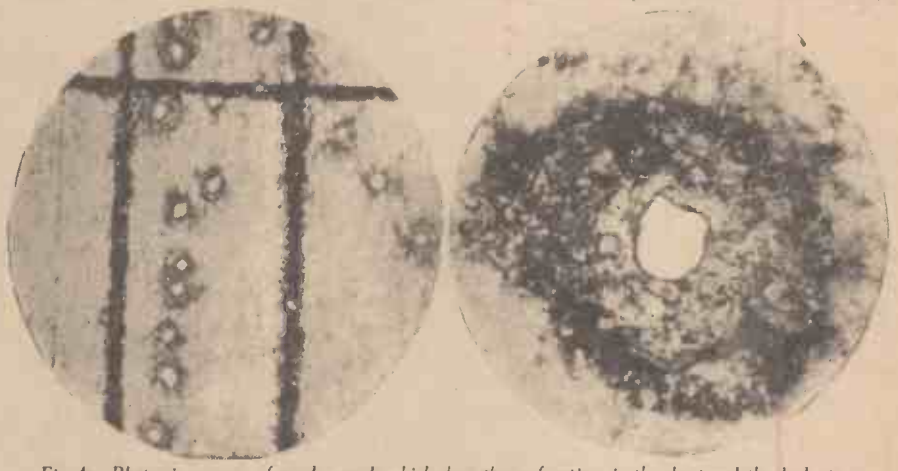


Fig. 4.—Photomicrographs of spark records which show the perforations in the chart and the dark rings where the wax was melted by the spark. The divisions on the chart represent hundredths of a second.

"Electrified Dirt"

Aluminium—the Aircraft Metal

Aluminium, sometimes described as electrified dirt, has suddenly become almost a precious metal. This may seem surprising, since roughly one twelfth of the entire earth's crust consists of the element aluminium. In fact, the world holds near twice the amount of aluminium as of iron, the next most abundant metal.

The trouble about aluminium is that it is never found in its metallic state. Such is its affinity for oxygen that it occurs principally as a hydrated oxide, known as alumina. Richest of the alumina ores is the claylike substance bauxite. There are others, such as gibbsite, felspar and china clay which contain the elusive metal. Occasionally, too, it turns up more spectacularly as a precious stone. Turquoise, topaz, and garnet are but phosphates and silicates of aluminium.

Bauxite

Bauxite is generously distributed throughout the world, more especially in subtropical and tropical areas. India, central and west Africa, Australia, British and Dutch Guinea, have vast deposits. And so have Greece, Jugo-Slavia, Roumania and the U.S.A. Not all of it is workable, or contains a sufficiently high proportion of alumina to make its mining an economic business. Some of the best mines are in the region of Baux, in southern France. Other good producers lie along the Adriatic. Since the fall of France, the actual—but not potential—world production of bauxite has swung over in favour of the Axis powers.

Making Aluminium

But bauxite is not the only thing that goes to make aluminium. Besides the four or so tons of clay needed to produce a single ton of metal, a ton of soda and other chemicals and half a ton of carbon electrodes are consumed. A vast amount of electrical energy, too, is used in the process of electrolysing the alumina—the current passing through the electrical furnace being somewhere around 10,000 to 20,000 amps. For this reason aluminium plants are best sited near rivers or falls, where cheap power is available from hydro-electric sources. Norway, Italy and Austria are all well placed in this respect. North America is also blessed with abundant power, hence both U.S.A. and Canada are large producers.

Lightest of Metals

One of the lightest of metals—it has only half the weight of iron, little more than a third that of copper—aluminium was destined, from its first effective production in 1907, to play a vital part in aircraft construction. In 1918, when aircraft were still largely made of wood, about 90,000 tons of aluminium—or half the world's output—were used in the aircraft of the Allies. The advent of the all-metal 'plane, and modern developments in aluminium alloys and the technique of hardening and welding, have greatly increased the possibilities for the use of the flying metal.

"Calvert's Mechanics' Year Book"

THE issue of "Calvert's Mechanics' Year Book for 1940" contains much useful technical and industrial information for the mechanical, constructional, electrical, and gas engineering industries, including a number of handy tables such as metrical equivalents of inches, weight per lineal foot of seamless drawn copper tubes, comparative table of different wire gauges in use, and many others. The year book is published by Sherratt and Hughes, Park Road, Timperley, Altrincham, and costs sixpence.

An Amplifier and Mixer Unit

Combined Pre-Amplifier and Mixer Unit Constructional Details of a Compact Unit for Home Broadcast Use

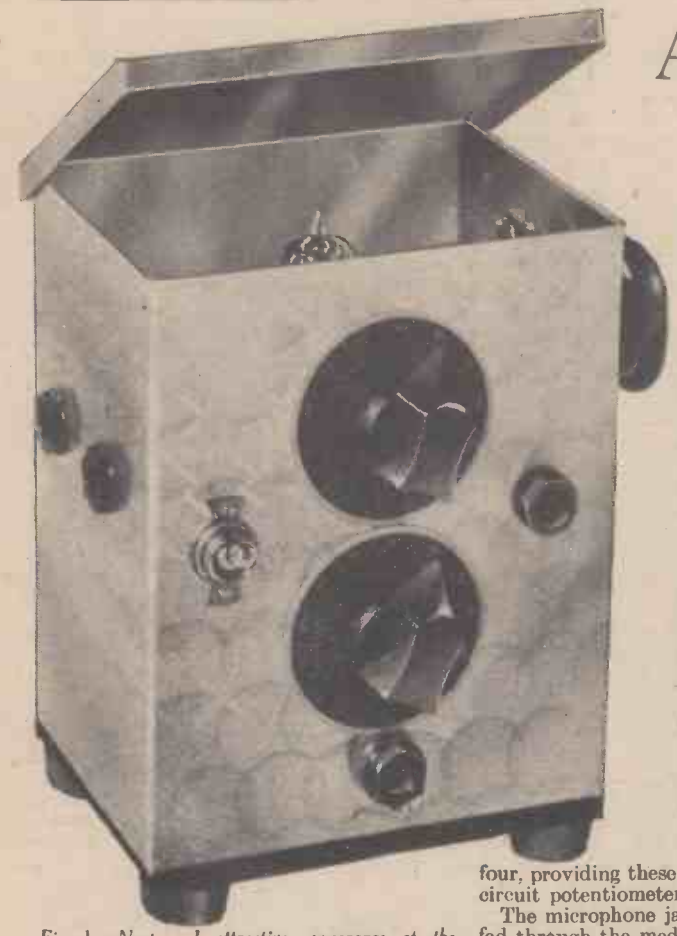


Fig. 1.—Neat and attractive appearance of the finished unit.

ONE form of radio entertainment which is becoming increasingly popular, is that of "Home Broadcasting," this being largely attributable to the more frequent gatherings now, round the fireside.

The majority of receivers making provision for gramophone reproduction, afford at least two stages of L.F. amplification, and this is normally quite suitable, assuming the circuit conditions to be up to standard, for the average domestic requirements in the direction of home broadcasting.

The merits of a microphone reproduction, however, depend very considerably on the ability of the "home producer" to equalise the sound distribution of the performers in the broadcast, with the instruments or effects, good mixing being essentially the factor which ultimately determines the feasibility of say, a thriller play, or a musical item.

This consideration then brings one immediately to the question of microphone to performer distance, the word performer, of course, being literally applicable to the effects side. For good dramatisation where the actions and positions of the performers are to be unrestricted, and even with the best microphones obtainable, it is practically essential for an "easy running" reproduction to provide some degree of pre-amplification where not more than two stages of receiver amplification is in evidence.

It is along these lines that we have carried out some interesting but quite simple experiments to ascertain the better way of meeting the requirements just mentioned, and with no mean view to the question of expense. The serviceableness of a pre-amplifier called for the combined advantage of a mixer control and pilot point to keep a check on the reproduction.

Circuit Details

Fig. 4 shows the scheme adopted, and a preliminary study of this circuit, in conjunction with the other illustrations, will more clearly define the reasons governing the layout. The mixer circuit makes provision for two microphones, but there is no reason why this should not be increased to three or four, providing these are kept to the same circuit potentiometer sequence.

The microphone jacks MJ1 and MJ2 are fed through the medium of these potentiometers to the grid of a Hivac midget pentode of the type X.Y, the "earthy" end of this mixer circuit being directly connected to the negative line and frame.

It will be apparent, therefore, that a somewhat higher anode current will flow than would be the case if grid bias were introduced, but, as the lesser of two evils, namely that of either increasing the size of the unit to accommodate a dry cell, or providing a separate battery, as against a low H T. (since excessive gain is not desired which could soon introduce microphone distortion through overload), the latter consideration is preferable.

The transformer chosen is from the Bulgin range, and is of the filter feed type; but in view of the necessary primary load restriction to a safe maximum current of 1 to 1.5mA, the screened-grid circuit depicted was decided upon, and, by so doing, the anode circuit could readily be commissioned for the pilot phone tapping.

The simple volume control in parallel with the pilot phone jack PJ only effects a slight change in screen current by .1mA at the maximum H.T. setting of 48 volts, this variation falling, of course, proportionally with any decrease in H.T. This point, however, is important in so far as the resistance of the pilot phones is concerned, and is based on 2,000-ohm earpieces, with the potentiometer at maximum.

It must be remembered, therefore, that on no account should the headphone jack be removed unless either the pilot volume control is mid-scale to zero setting, or preferably when the unit is switched off, as a surge of anode and screen current will take place; the normal maximum screen current with phones in circuit should read .71mA at 48 volts.

For any increase in L.F. gain above that provided on 48 volts, a slightly modified circuit will be necessary introducing grid bias, but the operating conditions of the circuit here will meet the majority of requirements admirably, whilst the fact that exceedingly good results are obtainable even down to 36 and 24 volts, examples another advantage in the design, namely ease of portability. A well balanced component layout, with rigidity as an important feature, combine to make the unit a true facility and a pleasure to handle.

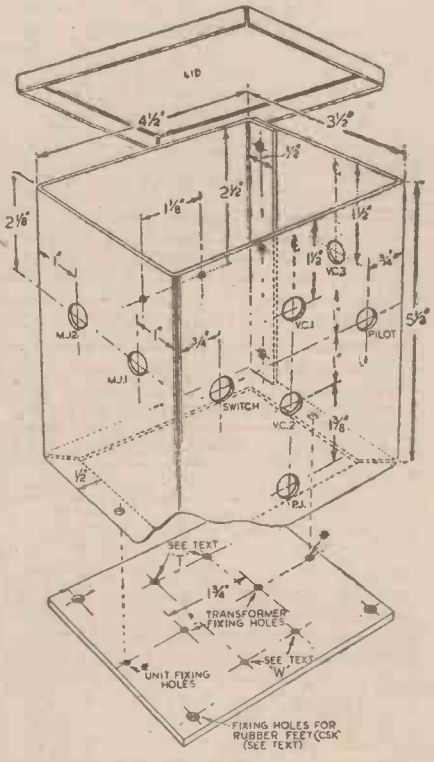


Fig. 2.—Constructional details of the casing.

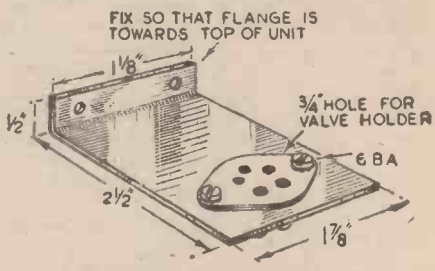


Fig 3.—Details of valveholder bracket.

Construction

No. 18 gauge aluminium is employed for the unit box, a $\frac{3}{16}$ in. ebonite base being used for neatly mounting the transformer. Fig. 2 gives full constructional details for the unit box and base.

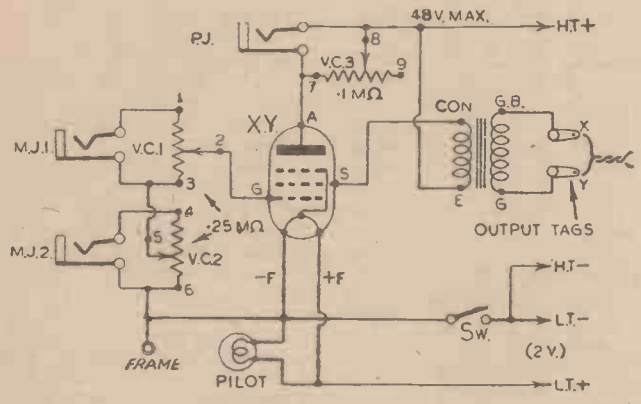
All large drillings for the components, excepting the on-off switch drilling, should be $\frac{3}{8}$ in. clear, the jack drillings requiring a slightly larger (but less than $\frac{1}{2}$ in.) diameter. All other holes, including those in the ebonite, are carried out with $\frac{1}{8}$ in. bit, the four holes for the rubber feet being countersunk as depicted, whilst for neatness, it is preferable that the transformer fixing screws which are 6B.A, should be of the countersunk type, let in through the underside of the base, and secured with nuts on the transformer. For this reason, then, the holes should be countersunk on the underside.

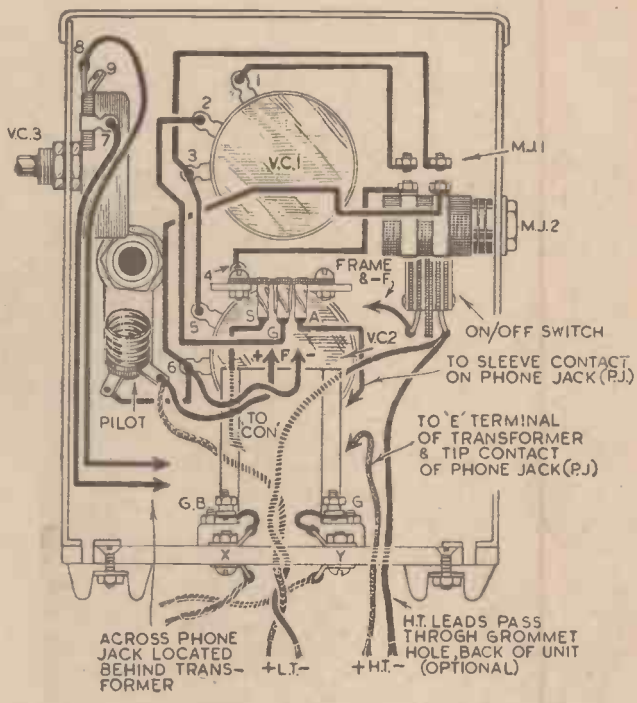
It will be seen in the diagram, that four other holes are required either side of the transformer fixing holes, two of these (marked "W") are for passing through the L.T. leads (see the wiring diagram Fig. 4), the other two (marked "T") are for fixing the output tags. The positions of these holes are not critical, and can be determined after temporarily positioning the transformer. Make sure they clear the unit flanges when the base is finally fitted.

The above comment also concerns the unit to base fixing screw holes indicated by the asterisks.

The box construction needs little explanation here, but as the fixing-screw holes are not designated in any way, it would be as well to mention that these are simply equidistant, and can be drilled for 4 or 6B.A bolts, as desired.

Figs. 4 and 5.—(Left) Theoretical circuit diagram of the amplifier and mixer unit. (Right) Layout of the components and wiring diagram.





Components for the Amplifier and Mixer Unit

PILOT BULB FITMENT	
1—type, D19 (red) miniature signal fitting	Bulgin
1—type, B206 Bulb	"
POTENTIOMETERS	
1—100,000 ohms (without switch)	Erie
2—250,000 ohms (without switch)	"
VALVEHOLDERS	
1—type, X114 midget (with soldering terminals)	Clix (B.M.P.)
JACKS AND PLUGS	
3—open circuit type (midget)	Igranic
3—type, P38. Plugs	Bulgin
SWITCH	
1—type, S80T	Bulgin
VALVE	
1—type, X.Y.2	Hivac
SPADES, PLUGS	
2—type, MP1a plugs (red, black)	Clix (B.M.P.)
2—type, R415 spade terminals (red, black)	Clix (B.M.P.)
TRANSFORMER	
1—type, L.F.12	Bulgin
KNOBS	
2—type, K58	Bulgin
1—black wheel type knob	Webb's Radio
DIALS	
2—type, IP7	Bulgin
UNIT	
Aluminium box	Peto-Scott
Ebonite base	"
MISCELLANEOUS	
6BA nuts and bolts	Bulgin
Shakeproof washers for 6BA bolts	"
Push-back wire	"
Rubber feet and washers	"
Solder tags	"
H.T. Battery (see text re L.F. gain and bias adjustment)	Drydex
L.T. 2v. accumulator	Exide
PHONES	
Ericsson	

Wiring and Assembly

With regard to the wiring and assembly, after mounting the box components, the transformer and base fitments should be assembled in readiness for wiring after dealing with the rest of the unit. The valve holder, which is mounted on a separate bracket (see Fig. 3), should not be mounted in the unit until the other connections have been made.

The potentiometer wiring, and that of the jacks MJ1 and MJ2, should be arranged so that it will not foul the valve when this is finally fitted. The valve base wiring can be carried out with suitably determined lengths of wire, since the bracket will still be "floating" for convenience in handling. Similarly, the transformer connections may be made, then neatly adjusting all leads, the valve holder and base can be fitted, two screws or small terminals and shakeproof washers serving to clamp the base.

There is one point concerning the jacks—it will be necessary for these to be turned when fitting, so that the switch and transformer are not fouled, and in the case of P.J it will be necessary to use the spacer washers on the front of the box, and not behind the jack as is normally the case.

All wiring which might prove confusing, due to the perspective of the diagram (the view taken in the wiring diagram Fig. 5, is that which would be apparent if the back of the unit were removed) is correspondingly lettered in the circuit Fig. 1.

The X.Y tags are connected (preferably by screened leads) to the pick-up terminals of the radio set, a separate earth being made at the unit if desired, by connecting to L.T. negative.

In conclusion, we would like to recommend quite strongly the economical use of cone speakers as very able makeshift microphones, the opening comments in this article being fully complied with by this means, as proved after extensive experiments under normal "home broadcast" conditions.

New Pom-Pom Gun

ONE of the chief dangers to convoys is the dive-bomber, and it is now believed that Britain has found an answer to this method of attack. It consists of anti-aircraft guns of a new type, together with a balloon barrage. The balloons keep the bombers high enough to prevent accurate bombing, and if they come low enough to shoot at the balloons they can be fired on by the new guns. The gun is of the many-barrelled pom-pom type, firing shells of 1 in. or more calibre, so delicately made that they explode on the slightest contact.

Man-made Lake

LAKE MEAD, a section of the Boulder Dam, Colorado, is claimed to be the largest man-made lake in the world, according to a report submitted to Mr. Harold Ickes, Secretary of the Interior. Its storage capacity is estimated at 32,359,274 acre-feet, nearly 2,000,000 more than the original estimate. The lake is filled by the winter snowfall, and will solve the serious drought problem which has confronted many farmers in Western America.

"MOTILUS" PEEPS INTO THE

Pilots being taught how to recognise different types of warships by means of wooden models at the R.A.F. School of Air Navigation.

The Use of Models in Wartime

The Foire de Paris

THE Foire de Paris was held as usual this year, but scarcely had it closed its doors when the Germans entered Paris and, therefore, unfortunately, the business that was being transacted as a result is now in a state of suspense and will be so for the duration. Messrs. Bassett-Lowke, Ltd., had a small but attractive exhibit at the office of the Federation of British Industries, which included a gauge "O" model of the L.M.S. Royal Scot, a ship's motor lifeboat, and a waterline model of the crack French liner *Normandie*, together with a selection of boiler, ships and railway fittings. It is hoped that this propaganda for export trade will bring better results in the future.

An Armoured Train

ON page 35 is illustrated a relic of the last Great War, 1914-1918—a toy armoured train produced in America by the Lionel Corporation and is gauge "O" electrically propelled. Looking at it in the light of 20 years' progress, it seems rather a crude affair. To-day scale models are produced in mass that are really something like their prototypes, but this does not alter the fact that this armoured train was literally "sold in thousands" during the last war. It was attractively finished in battleship grey.

Miniature Warships

APART from the use of models in connection with inventions for winning the war, miniatures of the fighting fleets of the world are utilised in many ways. Pilots of the R.A.F. and the Fleet Air Arm are taught to recognise the different types and nationalties of shipping with the aid of scale waterline models. The fine achievements of the Fleet Air Arm in naval engagements recently, in dive bombing, fire "spotting," and in general reconnaissance had their modest beginning in the study by pilots of these actual models of enemy warships.

(The Fleet Air Arm, originally under the control of the Air Ministry, has, since May 24th, 1939, been controlled entirely by the Admiralty and for this reason officers of the F.A.A. wear naval uniform, though at present many F.A.A. pilots are R.A.F. officers who have been seconded to the Navy, but they are being replaced by naval personnel as these become available.)

Model Locomotives

AMONG 2½-in. gauge model locomotive owners and builders, Mr. C. Courtice is certainly to the forefront as an admirer of all types of amateur work, and is at the same time a competent builder who has introduced on his models many interesting gadgets. Illustrated is his 2½-in. gauge G.E.R. 1,500 class, built from Bassett-Lowke castings by the owner. The feature of this locomotive (and also his L.N.W.R. Jumbo of the same gauge) is that they are controlled by an electro-pneumatic system of his own design. In a horsebox or similar vehicle is housed a permanent magnet electro-motor coupled to an oscillating cylinder which creates either a pressure or vacuum according to the direction the electro-motor is turning. From the oscillating cylinder a pipe is led which terminates on the vehicle in the form of the ordinary Westinghouse or vacuum brake coupling hose. Electric current is fed to the motor by the usual third rail connected by a shoe fitted to the vehicle. According to the polarity of the current applied to the third rail, a vacuum or pressure is created in the hose connection. On the locomotive is fitted a simple cylinder ⅜-in. bore by ½-in. stroke, the piston of which is connected by rod and bell cranks to the throttle lever, thus operating it in either direction. The said cylinder being of diminutive size, is concealed under the footplate and there connected to a similar hose pipe on the tender buffer beam. It is only necessary to couple a loco to the "controller" vehicle and connect the "brake hose pipe," when the train can be completely controlled in speed, starting, and stopping by merely applying current to the third rail, using any standard controller switch employed in electrically driven railways. In the owner's words, "The main appeal of this system is its extreme simplicity. I have demonstrated its working to a number of people, who agree that, except that the locomotive cannot be reversed on this system, the controlling effect is equal to an electrically driven railway, but with the added attraction that the locomotives were steam driven."

A 2½ in. gauge G.E.R. 1,500 class model locomotive built by its owner, Mr. C. Courtice, of Stanford-le-Hope, Essex, from Bassett-Lowke model castings.

MODEL WORLD

The "Heather Glen"

ON this page is shown a picture of the *Heather Glen*, deemed by her maker to be the world's fastest model yacht. In July, 1939, she won the British championship cup after one week's racing, and the following week she gained the International Championship cup. But here is her history. Towards the end of the "gay nineties," there was built in a famous yacht-building yard on the Clyde a 23-metre racing yacht called the *White Heather*. Among the skilled operatives on this super craft was a young boat builder who bore the famous surname *Alexander*! Being Scottish, he was "canny" and capable and quickly made progress towards the top rung on the ladder of sailing craftsmanship. He became first man, then manager in sailing yachts, he then superintended the construction of flying boats, and some fifteen years later he founded a business for building of miniature racing sailing yachts. These boats are now well known throughout the British Isles—the *White Heather*, or shall we say the *Alexander* boats. *Heather Glen* was an A class racing model designed and built by Alexander and sailed by the brothers James (skipper) and Bill (mate) Alexander, she defeated in six days' sailing at Fleetwood 30 British opponents thus obtaining the British trophy. In a further three days' sailing, the champion yachts of Norway, France, Germany, and Sweden were met and well beaten by *Heather Glen*. In those memorable days at Fleetwood—July, 1939—she took the lead in the first day's sailing and never lost it, and, to cap the lot, not content with the beautiful silver trophies—British and International—she carried off the *Carpenter* trophy (known as the "Wing to Wing" Cup) for the fastest run down win in the International series. This run was also a record for the Fleetwood lake.

For the benefit of beginners in the noble sport of yacht racing, Mr. Alexander says, let your motto be "Try, try, and try again." For 10 years the *Heathers* have been competing for the blue riband of model yachting. Twice they have been runners-up, once fourth, and once fifth. These *White Heather* models are not toys, but are designed very scientifically and constructed very carefully and should be sailed very skilfully. Indeed, since these models have to be sailed without a steersman, they are probably more carefully designed than their larger sister craft. In *Heather Glen*, for instance, the length on the water line, and on the quarter beam, the square root of the sail area, and the cube root of the displacement (weight) have to be most carefully calculated in the design, to meet the requirements of the rules under which these miniature craft compete.

The "Heather Glen" at Fleetwood.

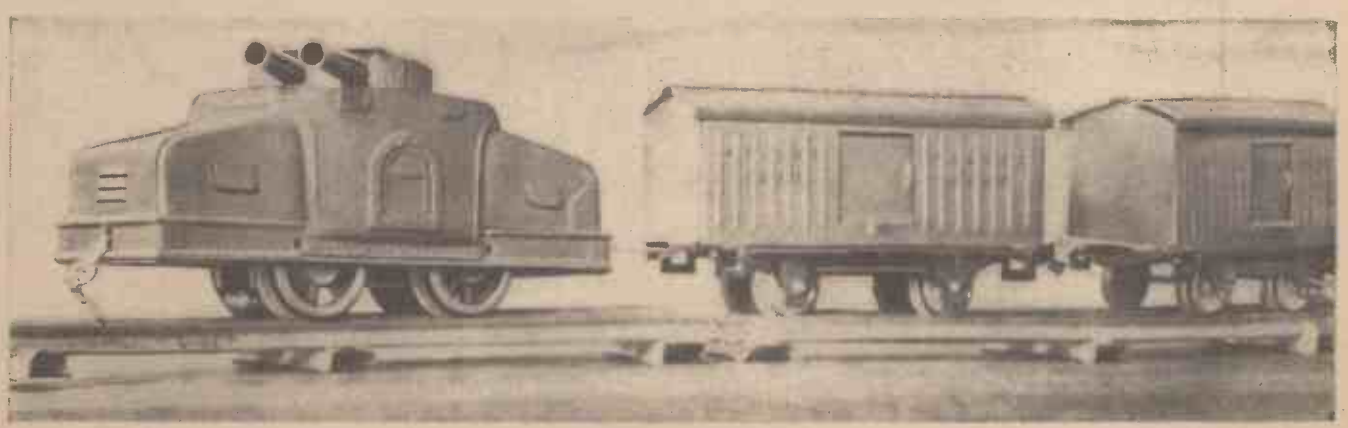
A model exhibited at the Foire de Paris—this summer.

Models to Build

FOLLOWING on the success of the set of finished parts for making an L.M.S. 2-6-0 Mogul in gauge "0" steam—a set which was prepared for the model enthusiast owning few workshop tools—Messrs. Bassett-Lowke, Ltd., have introduced a steam model for the advanced model builder.

This is a ½-inch scale, 2½-inch gauge L.N.E.R. "Flying Scotsman," of which a full set of castings and finished parts are available, together with full-sized working drawings. The making of this model is described and illustrated in a booklet reprinted from "Practical Mechanics," edited by Mr. F. J. Camm, and this can be obtained post free for 8d. or, if purchased at a Bassett-Lowke establishment in London or Manchester or Northampton, at 6d.

This is the first time that the building of a high-pressure scale model has been so comprehensively handled, and it should find a big response from all keen model locomotive builders. The drawings provide for either a watertube or solid fuel boiler.



A toy armoured train manufactured by the Lionel Corporation of America in the last war.

Facts About Metals

(*Continued from page 540 of September issue*)

P

Palladium.—Metallic element. Chemical symbol, Pd; At. No. 46; At. Wt. 106; M.P. 1549° C.; B.P. 2820° C.; Sp. Grav. 11.9; Sp. Ht. .0582; Coef. Exp. .00001176.

Like all the platinum metals, of which group it is a member, palladium is found in the metallic state alloyed with platinum and its allied metals. Discovered by W. H. Wollaston in 1803-4, and named by him after the minor planet *Pallas*, which had been discovered about the same time.

Palladium is a greyish-white metal which is fairly ductile and malleable. It is softer than platinum and has a lower melting point than the latter. Although scarcer than platinum, it is commercially cheaper, because it is not in such great demand. Palladium is the only one of the platinum metals which will dissolve in a single acid, it being soluble in hot concentrated nitric acid. Palladium possesses the remarkable property of being able to absorb or occlude a large quantity of hydrogen gas, 1 part of metallic palladium at red heat being able to absorb about 900 parts of hydrogen. Several applications have been made of this interesting property.

Alloyed with gold, palladium whitens the metal, several of the "white golds" being gold-palladium alloys.

Palladium also alloys with lead, tin, nickel, copper, antimony, and bismuth. Salts of palladium have been used in photography in the production of "palladiotype" permanent prints.

Palladium Bearing Metal.—An extremely hard alloy, sometimes used in watches instead of jewelled bearings. Composition: palladium, 24 parts; gold, 72 parts; silver, 44 parts; copper, 92 parts.

Palladium Leaf.—Very thin palladium foil, which is sometimes used for "silvering" purposes. Palladium leaf can be produced in thicknesses of as little as 1/200,000 of an inch.

Partinium.—An alloy introduced in France some years ago for bicycle and motor-car fittings. It is light and strong. Average composition: aluminium, 88.5% copper, 7.4%; zinc, 1.7%; silicon, 1.1%; iron, 1.3%.

Pearlite.—The "pearly constituent of steel." It is a mixture of cementite (an iron carbide) and pure iron, and, under the microscope, it has an appearance resembling mother of pearl. Annealed steels contain a large proportion of pearlite.

Pencil Alloy.—A metallic composition which leaves a heavy mark when drawn across paper and can therefore be used as a pencil core. Since it contains mercury, it is an amalgam. Composition: lead, 70 parts; bismuth, 90 parts; mercury, 8 parts.

Permalloy.—Name given to a class of nickel-iron alloys originally developed in 1921 by the Western Electric Company, of America. The original "Permalloy" contained 78.5% nickel and 21.5% iron, all impurities being kept down to a minimum. After suitable heat-treatment, such alloys develop a remarkable magnetic permeability, and much use has been made of them in radio and electrical work on this account.

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

Pewter.—Name given to a number of lead-tin alloys which have been put to extensive uses since the Middle Ages. Some pewters contain small amounts of copper and/or antimony. The so-called 'lead-less pewters" made nowadays are usually unalloyed tin.

Pholin's Alloy.—A silver-like alloy containing a trace of mercury. Composition: bismuth, 19.26%; tin, 76.9%; copper, 3.84%, plus mercury, a trace.

Phosphor-Bronze.—A copper-tin alloy containing a small percentage (about .10) of phosphorous. It is a hard, fine-grained yellow-coloured metal having great toughness and a high tensile strength.

"Low Tin Bronzes" contain from 3.5% to 5% of tin, whilst "High Tin Bronzes" contain from 4.5% to 7% tin. For special purposes, phosphor-bronze containing up to 9% of tin is available.

Phosphor Tin.—This is really a tin phosphide, containing about 21% of phosphorous. Although it is silvery-white in colour, it is not metallic. Made by heating tin with phosphorous out of contact with air.

Pig Iron.—This is a crude form of iron which, after smelting from its ore, has been allowed to run off into channels and moulds and to solidify in the form of ingots or "pigs." of about 3 ft. long and 3-4 in. thick. It is of varied composition, a typical grade of pig iron containing, in addition to iron, about 4% of carbon and 2% of silicon together with smaller amounts of sulphur, manganese and phosphorous. Some of this carbon is combined with the iron, some of it is merely dissolved in the iron. If much of the carbon is combined, the metal has a light appearance and is known as White Pig Iron. If the majority of the carbon is merely dissolved or "free," the metal appears grey and is known as "Grey Pig Iron." Intermediate types are known as "Mottled Pig Iron."

Pig iron is not malleable or ductile. It cannot be worked or welded. It can only be used for the production of castings. Hence its well-known name—"Cast Iron."

Pig or cast iron forms the starting point for the manufacture of wrought iron and the various steels. It has a relatively low melting point (1,200°C.).

Platinite.—A nickel-iron alloy containing from 42% to 50% of nickel. Its coefficient of expansion is similar to that of glass, on account of which it is used in the form of wire for embedding in or passing through glass, thus providing an absolutely gas-tight glass-metal joint in electric lamps, radio valves, etc. It replaces the much more costly platinum which was formerly used for this purpose. Is often employed in the copper-coated state, which provides a still more secure bond between glass and metal.

Platinized Asbestos.—Platinum powder deposited on asbestos, and employed in such form on account of its chemical activity. Prepared by soaking good quality asbestos fibre in a solution of platinum chloride and then strongly heating it.

Platinum.—Metallic element. Chemical symbol, Pt.; At. No. 78; At. Wt. 195, M.P. 1,755°C.; B.P. 2,650°C.; Sp. Grav., 21.45; Sp. Ht., .03243; Coef. Exp. .00000886.

The best-known and most useful member of a famous family of "noble" metals. Occurs always in the metallic state alloyed with palladium, iridium and allied metals. Its costliness is occasioned not only by its natural scarcity, but, also, by the operations of a "ring" of producers.

The metal was first recognised as an individual one by R. Watson in 1750. Previously, it had been known to South American Spaniards under the name of "platina," this term being the diminutive of the Spanish, *plata*, meaning "silver." "Platina," therefore, was the "little silver." It was considered as a dross in silver, and at one time was actually thrown away by order of the Spanish Government in order to prevent its being used for adulterating gold. The scientific use of platinum dates from comparatively recent times. It is a whitish metal, with a greyish tinge. It is malleable and ductile and will take a very high polish. On account of its coefficient of expansion being about the same as that of glass, platinum wires were long used for sealing in the glass of electrical devices. Substitute wires are now used for this purpose.

Platinum is used in the jewellery, electrical and scientific-instrument trades on account of its well-known permanent qualities. It is one of the most useful of metals. Its salts are used in photography in the "platinotype" process. Platinum salts are highly poisonous. Platinum itself alloys with a large number of metals.

Platinum Alloy.—A thickly-fluid lead-grey metallic mass. It is made by grinding spongy platinum with hot mercury.

Platinum Black.—A velvety black powder consisting of finely-divided metallic platinum which is highly chemically active, particularly when freshly made. Prepared by adding a reducing agent, such as formalin, to a solution of platinum chloride.

Platinum Black will absorb as much as 100 times its volume of oxygen or hydrogen.

Platinum-Bronze.—Name given to a group of alloys containing from .5% to 10% of platinum. They polish well and retain their lustre for a long time, whilst they are relatively inexpensive. A typical platinum-bronze composition is: platinum, 0.9%; nickel, 90%; tin, 9%.

Platinum Metals.—A family of six metals, having similar properties and appearances to platinum. These are: ruthenium, rhodium, palladium, osmium, iridium, platinum. The first three are sometimes termed the "Light Platinum Metals," and the latter three the "Heavy Platinum Metals" on account of their differences in specific gravity.

QUERIES and ENQUIRIES

A stamped addressed envelope, three penny stamps, and the query coupon from the current issue, which appears on page iii of cover, must be enclosed with every letter containing a query. Every query and drawing which is sent must bear the name and address of the reader. Send your queries to the Editor, PRACTICAL MECHANICS, Geo. Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2.

Preparing Chlorophyll

CAN chlorophyll be extracted from leaves by heating them with methylated spirit? Is it possible to prepare pure chlorophyll?—S. C. (Glamorgan).

IT is not a difficult matter to prepare a pure chlorophyll extract. Simply warm chopped fresh green leaves with methylated spirits (or, preferably, rectified spirits) for several hours. Then filter the green solution and evaporate it. The pure plant chlorophyll will then be obtained as a green amorphous or non-crystalline mass. Its composition is unknown, but it is noteworthy that it contains magnesium.

Testing for Sugar

IS there a simple test by which the presence of sugar, or other carbo-hydrates (including formaldehyde) may be shown in either chlorophyll or an alcoholic solution of chlorophyll? If so, what is it?—A. B. (Wilts.).

CHLOROPHYLL is a definite chemical compound and, as such, does not contain any sugar or formaldehyde.

Furthermore, there are many different types of sugars, so that we should have to know with which one the chlorophyll extract was contaminated before we could advise you fully on the detection of sugar in chlorophyll mixtures. Assuming, however, that the sugar in question was Fructose or Levulose, fairly small amounts of it could be detected by boiling the extract with an equal bulk of Fehling's Solution, whereby the sugar, if present, would reduce the blue Fehling's solution to red copper oxide.

The "Electron" Microscope

WHAT is the principle of the "Electron Microscope"? Can you tell me the name of a book which explains the instrument and what is its highest magnification?—A. S. (Bristol).

THE precise mode of operation of the Zworykin "Electron Microscope" has not yet been fully disclosed. The Zworykin instrument, however, uses electrons instead of light rays for magnifying purposes and the magnified objects are projected on to a fluorescent screen. In principle, the electrons emitted by the object under microscopical examination are focused by a powerful magnetic field and the focused image, much magnified, is shown on the fluorescent screen after the manner of a television image.

The highest magnification obtained by the Electron Microscope is of the order of 1,000,000 times, but it is reported that the instrument is capable of even greater magnifications.

There is no published book on this subject so far.

Making Carbon Monoxide

HOW is carbon monoxide prepared? Is the preparation of this gas dangerous if carried out in the open air? What chemical could be used to absorb this gas or render it harmless?—A. D. (Manchester).

CARBON monoxide, CO, is best prepared by heating formic acid or a strong solution of sodium formate with concentrated sulphuric acid. In practice, the strong sulphuric acid should be contained in a flask provided with a delivery tube and heated to 100° C. The strong formic acid should then be dropped into the sulphuric acid, and as each drop of the formic acid enters the sulphuric acid, pure carbon monoxide will be given off.

Carbon monoxide is an *excessively powerful poison* and, even when prepared in the open air, the experiment is not without danger. If, therefore, the preparation of this gas is carried out, the experimenter should keep well away from the table or bench.

Carbon monoxide is absorbed by a saturated solution of cuprous chloride in concentrated hydrochloric acid or of cuprous chloride in ammonia. These solutions do not decompose the gas; they merely dissolve it. Some, however, suggest that the carbon monoxide combines with the cuprous chloride, forming the compound —$2CuCl.CO.2H_2O$. Carbon monoxide is not appreciably soluble in water, and thus can be collected over that liquid.

Highest Magnification

WHAT is the highest magnification possible with a modern optical microscope (both monocular and binocular)? —E. R. (Reading).

THE highest practical magnification obtained by means of an ordinary high-class commercial microscope is about 1,500 times. With a binocular microscope, the highest practicable degree of magnification is very much less than this, seldom exceeding 400 times.

A Leaky Radiator

WHAT is the compound used to seal radiator leaks? I believe it contains leather filings. Is this correct? —W. F. (Clapham, S.W.4).

A MIXTURE of lithage (lead oxide) and asbestos powder, or of red lead and putty will seal radiator leaks in a temporary manner, and provided that the sealed parts are not strained in any way, they may, in some instances, last for a considerable time.

Sometimes solutions of iron chloride and carbonate of soda are added to the radiator water, whereby brown iron carbonate is precipitated in the water and, being insoluble, tends to seal up a tiny radiator leak. All such methods, however, are, at the best, purely temporary ones.

Liquid Cement

CAN you give me the recipe for making liquid cement and a wax car-body polish?—C. V. (Watford).

LIQUID jointings vary enormously in composition. A good one consists of a thick solution of orange shellac in methylated spirits which is mixed to a thin paste with red or white lead. Others consist of thick shellac solution and goldsize mixed in about equal proportions.

In order to make a wax car-body polish, melt an ounce of beeswax or carnauba wax (or a mixture of both) in about double its weight of turpentine. This, when cold, will set to a solid, pastey mass.

A liquid polish of the same nature can be made by diluting the above with four or five times its volume of white spirit.

Another liquid polish consists of a solution of ammonia in spirit, but this is expensive and unsafe to use.

Running-In Compound

CAN I make a running-in compound by blending graphite with mineral oils?—W. H. (Woking).

YOU cannot possibly blend graphite with mineral oils in order to produce a running-in compound, for such blending requires the use of a "colloid mill," an extremely expensive apparatus in which the graphite is actually ground into the oil. Even the finest graphite which you could buy would not produce a running-in compound by an ordinary simple stirring into the oils.

Rays

IS there a method of detecting the presence of infra-red and ultra-violet rays?—S. T. (Plymouth).

FOR the detection of infra-red rays, your best plan is to use a camera and an infra-red colour-filter together with an infra-red sensitive plate or film. Such materials may be obtained from Ilford, Ltd., Ilford.

With the infra-red colour-filter in position over the lens, the pieces of glass are photographed against a background illumined by the rays of an electric lamp, an infra-red sensitive plate or film being used for the purpose. If the glass passes infra-red rays, it will appear more or less transparent in the photograph, whilst if it does not pass infra-red rays, the glass will appear dark grey or black in the photograph.

Other methods of testing the presence of infra-red rays depend upon the use of extremely delicate thermocouples or else an instrument known as a "bolometer," but all such methods are far too expensive and delicate for an amateur to apply.

In order to test for the presence of ultra-violet rays, use a solution of quinine sulphate in diluted sulphuric acid. This, in the presence of ultra-violet rays, has a strong, bluish fluorescence.

Frosting A Window

CAN you tell me the simplest method of frosting a window?—N. O. (Middlesbrough).

ONE of the best and simplest methods of frosting a window consists in giving it a thin coat of clear celluloid solution containing in it a small proportion of chalk or talcum powder.

Mix together one part of acetone and ½ part of amyl (or butyl) acetate, which liquids can be obtained from your local chemist and in these mixed liquids dissolve, with vigorous shaking, clear celluloid until a varnish the consistency of paint is obtained. Into this varnish stir a small proportion of talcum powder or some other similar material so as to give the varnish a slightly opaque appearance.

Now paint this varnish on to your window, using a flat brush for the purpose. Give your window about three hours to dry, and afterwards, you will find that you have obtained an excellent frosted effect.

Oxidising Effect

CAN you tell me how sheet steel, which is blue when purchased, and tinplate can be given an oxidised effect? The appearance I desire is similar to that seen on fire-screens, coal boxes, etc.—R. C. (Sussex).

SHEET steel and tinplate can only satisfactorily be given the oxidised finish you desire by:

(a) Varnishing over with a brown lacquer, or

(b) Copper plating and then by immersing the copper-plated article in a very weak solution of sodium or ammonium sulphide.

The articles to which you refer (fire-screens, etc.) are usually surface-coloured by simple lacquering. We think, therefore, that this will be your best plan to adopt. Go to your nearest paint store and procure a quick-drying lacquer of the shade you desire. This may usually be thinned down with white spirit. It is frequently advantageous to apply it to the metal not with a brush but with a fairly large turf of cotton-wool, thus avoiding a hard outline to the lacquered area.

THE Cyclist
Editor : F. J. CAMM

VOL. IX OCTOBER, 1940 No. 224

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

'Phone : Temple Bar 4363.

Telegrams : Newnes, Rand, London.

Comments of the Month

By F. J. C.

Sport and Accidents

THE minor accident to Kitching in the North Road "12," which robbed him of almost certain victory when, at 226¾ miles and 42 minutes to go, he was in collision with an Army lorry, has drawn attention to the immunity from accidents which cycling sport has enjoyed for the past 60 years. There have been very few fatal accidents, and that in which Kitching was involved was fortunately not serious. Cycling sport is, indeed, extremely well organised. Marshals are arranged at all of the danger points on the course. The courses themselves are measured, inspected and approved, and it is only on few occasions that an accident occurs. A few have been caused by the carelessness of riders in keeping heads down. There are penalties for riders who bring the sport into disrepute in this way.

The accident does, however, confirm the wisdom of those clubs who, in cancelling famous fixtures, did so in the belief that the presence of Army lorries, identity-card inspections, and other military causes of delay, might give rise to the very incident which happened in the North Road "12."

As usual, this "12" was well organised.

Immobilising Bicycles

THERE seems to be some confusion of thought on the part of the police regarding bicycles left unattended by the roadside. The present regulations apply only to motor-cars and mechanically-propelled vehicles. A cyclist is not compelled to deflate his tyres, to remove the pedals, to chain the wheel, nor in any way to take precautions against it being stolen. In spite of this, some cyclists who have left their machines by the roadside have found that the tyres have been deflated and the valves removed by the police, who have left a notice to say that such can be reclaimed by calling at the police station. The cyclists concerned would have been quite justified in insisting that the police replaced the valves and inflated the tyres.

It is, of course, a wise precaution to leave the bicycle in such a condition that it cannot be stolen; and, indeed, if cyclists could be persuaded to take these precautions in peace, as well as in war, the police would not have on their hands thousands of stolen bicycles which they have recovered, the owners of which cannot be traced. Nor would some tens of thousands of cyclists each year be deprived of their machines by cycle thieves.

We were told that on the Continent the German parachute troops carried, strapped to their backs, folding bicycles, and *if* the Germans contemplate a parachute invasion of this country, it is fair to presume that they would not rely upon the stealing of bicycles or motor-cars to complete their plans.

We were considerably amused to hear, during a talk on bicycles radiated by the B.B.C., the statement that a bicycle was one of the most difficult things to immobilise. We were also somewhat surprised that cycling journalists did not take the opportunity to correct the talker, especially in these days when they have so little to write about. It would be thought that such a peg would have provided material for considerable copy and criticism. May we, therefore, correct the talker by informing him that there is no vehicle more easily immobilised than a bicycle. The removal of the valves, the removal of the pedals, the loosening of the wheel nuts, the removal of the tools, the slackening of the handlebars, the use of a lock and chain, the removal of the saddle—these are but a few of the methods of rendering a bicycle immobile. We presume that someone vets these broadcast talks, and it is hoped that in future they will only permit them when the speaker has something to say.

The Death of Desgranges

THAT hardy old veteran of cycle sport, Monsieur Henri Desgranges, founder of the Tour de France, and the famous French sporting newspaper *L'Auto*, has died at the age of seventy-six. He set up the first one-hour record in 1893, and for more than fifty years had been interested in the promotion of professional sport. The success which attended his efforts is obvious from the fact that the Tour was front-page news each year. There is no cycle event in this country which is considered of sufficient importance by newspaper editors to occupy front page. In this country our newspapers like to concentrate on the negative aspect. If five cyclists are mangled by a lorry, that would be front-page news. If five cyclists escaped from being mangled by a lorry, that would not be news at all—an inversion of Northcliffe's doctrine that dog bites man is not news, but man bites dog is.

The organisation of the Tour remains in the hands of those whom Desgranges trained, and we have no doubt that the post-war period will see a revival of it, as a tribute to the memory of its founder. Another famous cycling character who died recently was Edouard Michelin, manufacturer of the famous French tyres bearing his name. He had a considerable amount to do with the development of the pneumatic tyre, and at one time was a racing motorist. He died at the age of 84.

The Social Season Begins

THE sporting calendar is practically at an end, and the social season of dinners and lunches, prize-givings, and dances begins. Most clubs intend to run their annual dinner as usual, but many have substituted a lunch because of the difficulties imposed by the black-out, and because many restaurants are refusing to provide banqueting arrangements. The dinners, and the lunches, because of rationing, may not be so sumptuous as in previous years. Nearly all clubs have given prize-winners the opportunity of selecting and receiving their prizes soon after the event, and so there is bound to be a smaller number of prize-givings this year. In our view, this is all to the good. There are few things so boring as prize-givings, which are of interest only to the few. The attendances must necessarily be smaller, but the important thing is to keep the enthusiasm alive.

A number of clubs which formerly used the London restaurants for their annual dinner have fixed the venue this year outside London. Others have made it a Sunday date to fit in with the times of those working on munitions. Let us hope that when the next social season arrives we shall be able to drink to the victory of this country.

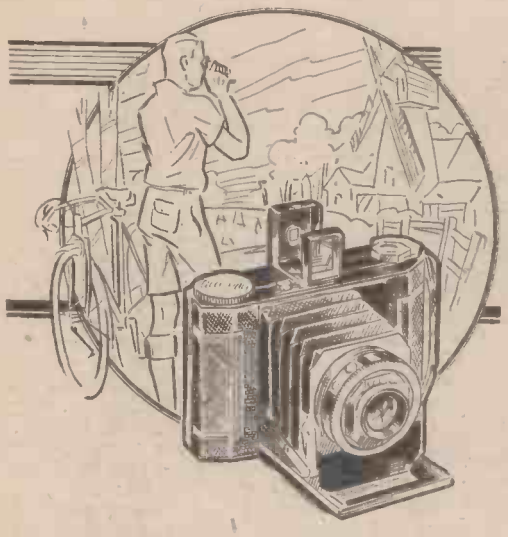
We shall be glad if clubs will send us details of their social fixtures earlier than usual, in view of the fact that we are temporarily appearing monthly. By sending us the details well in advance we shall thus be able to accord them due publicity.

Steel Studs

THE C.T.C. makes a suggestion that the dangerous steel studs used to mark pedestrian crossings should be pulled up and used to swell the metal scrap-heap which help to make munitions. We approve the suggestion. There is no need for steel studs *and* white lines, and as the white lines followed the steel studs it is obvious that the latter failed in the object for which they were introduced. They are dangerous. They have caused numerous accidents and prevented none; they fail to indicate the crossing, especially at night. We hope, therefore, that the authorities will remove the studs together with the Belisha memorials adjacent to them. Let us, in fact, remove every trace of evidence that we once had so incapable a Minister of Transport as Hore-Belisha, the man whose fantastic ideas on the cause of accidents and their prevention resulted in road chaos and the handing out of unwarranted privileges to pedestrians.

Air Raids

IN spite of air raids, road sport goes on. Some events, indeed, have been run during an air raid. Now that air raids, however, have become of longer duration, and extend from the evening until the following morning, it may be more difficult to carry on. Nothing must be done which will cause the authorities to ban sport. Clubs will, therefore, be circumspect in their decisions concerning the running of an event if the all-clear has not been given when the race is due to start.



Paragrams

A.R.P. Messengers

NOTTINGHAM still requires cyclist volunteers for A.R.P. work. They will be needed for messengers and must be over 16 years of age. Interested cyclists should make enquiries at the A.R.P. Headquarters, Goldsmith Street, Nottingham, or from Mr. H. F. Widdowson, 223, Radford Road, Nottingham.

Cycling Inventions

INVENTORS appear to have been very busy of late in their efforts to improve the bicycle. Patents have recently been taken out for a cycle support, a pedal and crank-driving mechanism, change-speed hub gears, saddle supports and frames and electric lamps.

Miss Wilson has Them All

MISS M. Wilson, Claud Butler and Sturmey-Archer professional cyclist, now holds every one of the sixteen records on the books of the Women's Road Record Associations. Her last was collected on August 20th, when she beat the Glasgow-Edinburgh and back record with a new fastest-ever time of 4 hrs. 33 mins. for the 88½ miles.

Miss Wilson started from Gyle Bridge, Edinburgh, at 5.30 a.m. and reached Glasgow at 8.16, four minutes slower than schedule. On the return, she made full use of the fast finishing miles and reached Gyle Bridge at 10.3 a.m. Despite unfavourable conditions, Miss Wilson finished undistressed.

Previous fastest over the route was put up last year by Mrs. Ann Briercliffe, West of Scotland Clarion, 4-47-14, the Scottish record, although the British record was 5-3-12, also put up last year, by Miss T. M. Biggs, of London. Fastest man over the route is J. Dickson, Edinburgh Road Club, with 4-1-17.

Miss Wilson was timed by Mr. G. R. Herd, of Edinburgh, and Charlie Davey, of Sturmey-Archer Gears, was also in the following car.

Photography on Show

THE annual Photographic Exhibition of the Notts. D.A. C.T.C. is to be held on October 19th at the Scout Hall, Shakespeare Street, Nottingham. It will be in four sections: (1) Club-life, contact prints only; (2) Landscape, contact prints only; (3) Landscape, enlargements, and (4) Miscellaneous section. The latest date for accepting entries is October 1st, and forms are obtainable from D. H. Burton, 12, Hood Street, Sherwood, Nottingham.

Bicycle Polo

ARRANGEMENTS have been made for the playing of bicycle polo at Duppas Hill, Old Town, Croydon (the turning opposite the "old" Waddon Station), every Sunday afternoon starting at 1.30 p.m. The charge will be 1s. 6d. per player per match, this fee must be paid before the game. Players who have additional polo shirts are asked to bring them along to loan to players who may be selected to play with them so that the teams can be kept in uniform colours, making it easy for players and referees alike to follow the game. Complete sets of shirts will be available on hire at an additional charge of 3d. per player.

Officials Re-elected

THE previous officials were re-elected at the sixth annual general meeting of the Western R.R.A. People wishing to get into touch with the Association should write to Mr. G. A. Widmann, "Abona," Roman Way, Stoke Bishop, Bristol, 9.

Mrs. Briercliffe Fails

MRS. BRIERCLIFFE who recently made an attempt to regain the British women's 50 miles record, was forced to retire, owing to cramp, after covering nearly two-thirds of the course.

Road Sport Support in Scotland

AFTER some weeks of poor support, road sport in Ayrshire was revived during August. Perhaps the most sensational news from this quarter was the breaking of the Scottish and English competition 30 record by J. McKay, Douglas Water Clarion, in an Ayrshire Clarion event.

This miner-cyclist clocked 1 hr. 12 mins. 45 secs. for the distance, an improvement of 1 min. 14 sec. on the previous Scots record, set up last year by Will Scott, Crawick Wheelers, and of 16 secs. on G. Fleming's English record.

Scott also broke his own 30 record in the trial with a time of 1-13-7, and his club, Crawick Wheelers, set up a new Scottish 30 record with 3-44-38. Other members of the team were Scott's brother, eighteen-year-old David Scott, and J. Tudhope.

The new times are subject to the confirmation of the Scottish Amateur Cycling Association.

The Black Watch are now equipped with bicycles

NOTES OF A HIGHWAYMAN

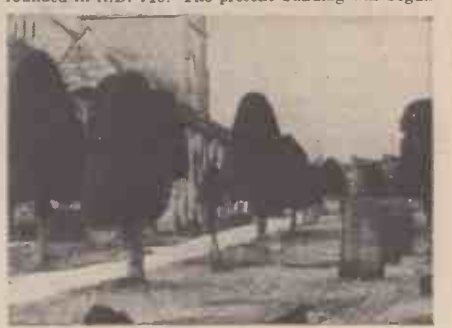
By L. ELLIS

A Western Paradise

GLOUCESTERSHIRE is pre-eminently a touring county. It can lay claim to the possession of at least three recognised touring areas—a large part of the Northern Cotswolds, practically the whole of the Southern Cotswolds and the Forest of Dean. It might rightly claim a large share of the Wye Valley. Indeed, the river Wye acts as its western boundary for many miles and the road that follows the wild convolutions of this lovely river is largely in Gloucestershire. In spite of all these touring areas de-luxe some of the most interesting towns cannot be classed under any of the headings. There are few more interesting towns in the whole of the British Isles than Tewkesbury, no matter from what angle one regards the subject. On the score of history it easily holds its own. For picturesqueness it compares favourably with any. For accessibility it cannot be excelled. So far as history goes Tewkesbury can show that it was occupied by the Romans in A.D. 44. It has figured in many famous wars and more than one decisive battle has been fought in the vicinity. Here it was that Edmund and Canute settled their argument. In 1471 one of the major battles of the Wars of the Roses was fought at Tewkesbury, when Prince Edward was killed. During the Civil War the town suffered great hardships when it constantly changed hands, first to the Cavaliers, then to the Roundheads.

The Glory of Tewkesbury

THE glorious abbey, some say only excelled by Westminster in size and dignity, was originally founded in A.D. 715. The present building was begun after the Norman Conquest and some part was rebuilt after a disastrous fire in 1178. It is often said that the great central tower is the finest Norman tower in existence, a statement that one finds easy to believe. Another notable feature is the west front, consisting practically of one immense Norman arch. In the matter of old houses Tewkesbury is particularly fortunate and both sides of the long, wide street are adorned with excellent examples of ancient domestic architecture. More than one famous author is linked with the town. The old Bell Hotel at the Abbey end of the town bears an inscription reading: "This house is mentioned in 'John Halifax, Gentleman,' as being the residence of Abel Fletcher, the Tanner." The bowling green at the rear also figures in Mrs. Craik's novel. The Royal Hop Pole Hotel is mentioned in Dickens's "Pickwick Papers" as the place where Mr. Pickwick and Mr. Ben Allen were so influenced by the quality of the liquor dispensed that they slept for thirty miles. One of the most beautiful old houses is the "House of the Golden Key," a lovely black and white structure, four storeys high and crowned with twin overhanging gables. This brief catalogue merely touches the fringe of the host of delightful old places waiting to be seen, and others include Warwick House, Ye Olde Hatte Shoppe, Clarence House, several old inns and an old mill. At the other end of the town from the Abbey is King John's Bridge, overlooked by the Olde Black Beare Inn, bearing the date 1308. Quite close to this spot the Warwickshire Avon merges with the Severn, near a bridge erected by Telford in 1826.



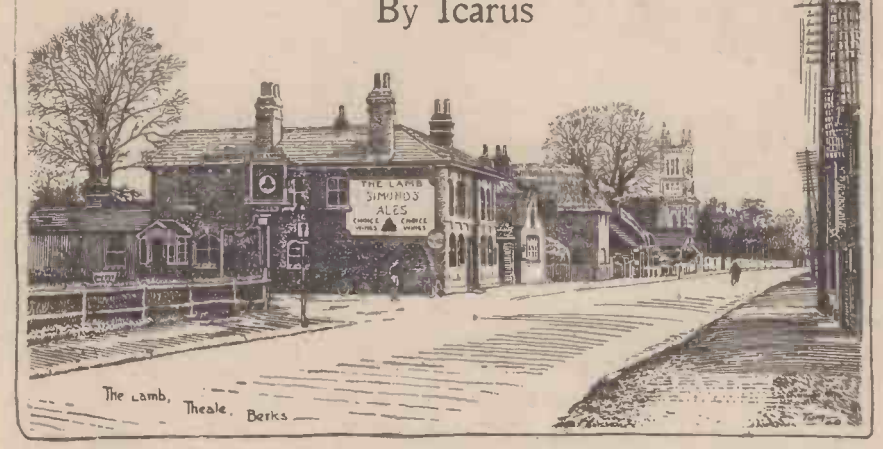
Painswick Church and a few of the Yew trees.

A South Cotswold Legend

FARTHER to the south-east of Gloucestershire lie the Southern Cotswolds, a tract of lovely country but differing widely in character from the North Cotswolds. Here the places tend rather to be towns than sleepy little villages, and there is a greater tendency towards industrialism. The district, however, is well worth exploring and the town of Painswick should not be overlooked. Its aged church is surrounded by a remarkable collection of tombs. Of even greater interest is the magnificient collection of clipped yew trees. It is said that there are ninety-nine and that all efforts to grow the hundredth have failed. For many years the yews have been trimmed on September 8th and the following Sunday is known locally as Clipping Sunday. On that day the parishioners march round the churchyard and then form a ring holding hands.

AROUND THE WHEELWORLD

By Icarus



Another Pneumatic Tyre

I WAS interested to read of an invention to provide cyclists with what virtually amounts to a spare wheel. Whether the invention will ever be marketed I am unable to say, but it has been provisionally protected. It is a tyre and the inner tube has another tube within it. This second tube is made of thinner rubber and of slightly smaller diameter than the main tube. Thus, it lies snugly to the rim when the main tube is inflated, and is itself uninflated. When a puncture occurs in the main tube the flint or nail causing the puncture is removed from the cover, and the inner tube pumped up, leaving the cyclist to repair the main tube when he reaches home. I understand that the tube is on the heavy side and thus it would be of little use for racing purposes.

There have been numerous devices for puncture-proof tyres, but I am yet to learn that one of them has really caught on. In the first place, punctures are far less frequent than they used to be, due to the better road surfaces, and in the second, few cyclists find difficulty in quickly repairing a puncture. The inventor of this new tyre states that he has been testing one of them for over six months, and is encouraged to believe that the device is entirely satisfactory. As the secondary tube lies flat to the rim, it is thus protected by the rim when the main tube becomes punctured, and unless the nail is unusually long, it is unlikely to pierce it.

Another Medal for Monty Southall

FRANK SOUTHALL'S brother Monty has been honoured by the award of the Medal of the Order of the British Empire for services overseas. It will be remembered that Monty was wounded whilst serving in France. He was a Norwood Paragon "crack," and as such accumulated a large number of medals among which his present award will take pride of place.

Road Casualties in London

THE MINISTER OF TRANSPORT has recently published the statement received from the Commissioner of Police for the Metropolis on road accidents in the first half of the present year. From this it appears that road casualties totalled 15,623 which compares with 26,630 in the corresponding part of last year. This shows a drop of more than 40 per-cent. Cases of serious injury numbered 1,327 against 2,464 last year, a drop of 46 per-cent. The slightly injured totalled 13,922 against 23,707, a decrease of 41 per-cent. The decrease in road deaths has not been so marked, for they totalled 374 against 459, a drop of only 18.5 per-cent. We must remember that private motoring, both as to number of vehicles on the road, and the number of miles covered by those which remain, have dwindled to infinitesimal proportions compared with pre-war. The figures, therefore, are not so comforting as one might have expected, especially when we remember the long period of ice snow and fog, when road traffic was practically at a standstill. According to this statement, casualties at night amongst all road users totalled 174 killed, and 4,328 injured. For hours of daylight the figures were 200 killed and 10,921 injured. Included in the 374 fatalities were 260 pedestrians. Only 78 of these pedestrian fatalities occurred in the second quarter of the year, and of the 182 deaths recorded in the first quarter, 132 occurred during the hours of darkness, an increase of 46.7 per-cent. over the corresponding figure for 1939. Over the six months there was an increase of 21.4 per-cent. in pedestrian fatalities during the hours of darkness.

Letters to the Press

THERE is a peculiar section of the public known as writers-of-letters-to-the-press. They love to see their names at the foot of a letter, and they keep up a battery of correspondence with editors, giving solutions to all sorts of national and international problems. I do not suppose that there is one sensible letter in a hundred, and it is difficult to understand why newspaper editors do not exert editorial discretion and hurl the letters into the wastepaper basket. Some of these letter writers duplicate a particular letter, and shoot it off to hundreds of newspapers so that the same letter appears in several newspapers simultaneously. They adopt, in some cases, the familiar *noms des guerre*, such as "Paterfamilias," "Pro bono publico," "Father of seven," or "Old Soldier." I am certain that these people live in smug little jerry-built cottages rejoicing in the name of "Chez Nous," "Dunromin," or "Ourome."

I suppose we must class these people with those who are fond of using a double-barrelled name, or smoking a long pipe, and in this latter class we must, of course, put authors at the top of the list. I remember the efforts of the late Algernon Ashton, whose claim it was that he had more letters published in a greater variety of newspapers and periodicals than anyone else. Pure vanity, as one would expect from a man who, not being able to help being christened with such an unfortunate christian name, yet used it.

Vain People

ONE must expect Algernons to be vain people. Retired military officers are not, I hope, in a similar category, but I would draw your attention to a letter which appears in the *Yorkshire Post* from Lt.-Col. Raleigh Chichester-Constable, if you please. This is what he says : "When are we to have a tax on bicycles? One of 5s. or 7s. 6d. would bring in millions. Why is the user of such in these days when money is so much needed allowed to go free? It is a scandal that such should be allowed to continue." Mr. R. C. Constable as Lt.-Col. has, I assume, been taught arithmetic. If we assume that there are 12,000,000 cyclists and the tax were imposed at 5s., it would yield exactly £3,000,000. Constable's use of the word "millions" might lead readers of the newspaper to suppose that by taxing cyclists we should be able to abolish the income tax. I advise soldiers, retired choleric colonels, majors, captains, and others, to confine their attention to military subjects, and leave cycling matters in the safe hands of national organisations such as the C.T.C. They should also read the occasional but pointed letters to the press published above the signature of G. H. Stancer, the Secretary of that organisation.

Summer-time Extended

SUMMER-TIME extends to November 16, and so for a few more weeks we shall be able to enjoy the evening rides for a few hours—yes, in spite of the sirens, bombs and anti-aircraft fire. There is nothing so conducive to tranquility of mind as a bicycle ride. When William Willett introduced the summer-time principle, he little thought how useful it would be in time of war. We have accepted the principle that we can fix our clock according to our needs. Cyclists appreciate the idea more than most. Ours has been one of the few sports to carry on in spite of the war, increased overtime, seven-day weeks, and lack of training opportunities. There was a full field of 100 riders in the Finsbury C.C. Open "25" which fell to the credit of Pape in 1 hr. 4 mins. 10 secs. The Brentwood Road Club early in September ran four events at the Romford Football Ground Track, in spite of the fact that a warning went during the meeting.

The R.R.A. Handbook

I HAVE received from Leonard Ellis, Secretary of the R.R.A., a four-page leaflet listing the officers elected at the last A.G.M. in January, and who were appointed for the duration of the war. The leaflet includes the list of records as from December 31, 1935. I have a collection of R.R.A. handbooks, and I hope that it will not be more than a year before the war is over and a new handbook is published. There will not be attacks on professional records during the war.

WAYSIDE THOUGHTS

By F. J. URRY

The Essence of Safety

NO bicycle can be considered safe unless it is properly braked, not even the fixed wheel machine. True enough, in the old days we rode brakeless bicycles and relied on our muscular power of back pedalling, but then there were no motor-cars on the roads and the need for a sudden stoppage seldom arose. Now the minimum braking power should be at least one brake on a fixed gear machine and two on a free wheel model.

Brakes are made in three types, those operating on the rims, either by side pressure (caliper brakes) or on the underside of the rim (pull-up brakes); hub brakes, operating an expanding shoe inside a drum fixed on the hub; and coaster brakes (rear wheel only), operated by foot back pressure on the chain, which expands a metal cone inside the rear hub.

When new, all brakes are effective, even the cheapest types, and they would remain effective if care and attention were given to their adjustment. But in 99 cases out of a 100 it isn't. The bicycle has become such a common vehicle that it suffers the neglect of all common things, even though that neglect imposes a certain amount of risk on the rider.

The commonest form of braking is the roller-lever type rim brake, worked by roller levers running parallel with the handlebar operating rods attached to the pull-up stirrups of the brake. To keep the front brake in perfect adjustment is a simple matter, as the pull is a direct one. It is the rear brake that so frequently suffers from neglect or careless adjustment. The angles of the rod-jointing levers must be kept correctly adjusted to the pull if the brake is to retain its power in retardation, and I am sorry to say it, but few folk pay the slightest attention to this important feature of proper working, and not all dealers.

Another point is that this type of brake should have the blocks renewed when they are about half worn down in the shoes, or when the screw adjustment of the rear brake has been fully expanded to take the block wear. There is then no need for the lever angles of the operating rods to be upset, and a new pair of blocks is the cheapest and easiest method of retaining braking power.

Take Your Choice

ON practically all sports models, the caliper brake (the side-pressure type) is the fashion. The mechanism of this form of brake is always actuated by Bowden cable, so joints and angles are eliminated and adjustment is obtained through a screwed sleeve.

In one form of caliper braking, the cantilever, the operating cable is divided and the brake shoes do their work independently and firmly with a gentle hand pressure on the actuating lever. But there are many types of caliper brakes on the market, and undoubtedly one of the most popular is the side-pull caliper, with its scissor-like movement clipping the rim, and its neat attachment with one bolt through the crown fork in the case of the front brake, and the bridge strut on the seat-stay in the case of the rear brake. These bolts should always be kept tightly screwed home, for on them all the braking strain devolves.

Like all machinery, the cable brake needs some trifling attention by way of lubrication and occasional adjustment, and, provided it is given such simple overlooking, it will render you good service.

The hub brake is the latest comer in the way of bicycle retardation, and closely follows the practice of motor-cycle and motor-car braking. It was first used as the retarding power on tandems because the heating of the rims due to brake pressure on tandem wheels when long hills had to be negotiated was so excessive that burst tyres sometimes resulted, and patches on inner tubes were often lifted under the friction heat.

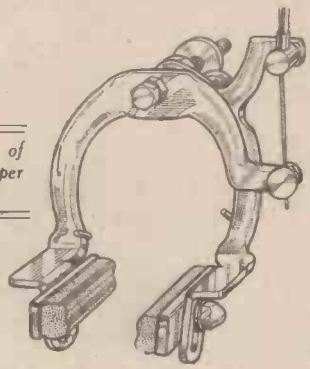
So a well-known firm designed and marketed a hub brake for tandem service, and it immediately became popular with users of the double seater. The mechanism of the hub brake is precisely similar to that employed on the motor-cycle brakes, and actuated by Bowden cable leading from the usual type of handlebar lever.

It is a trouble-free retarder, which only needs occasional adjustment, but care should be exercised in oiling the hubs through the usual lubricator by not over-oiling and thus allowing excess oil to percolate to the brake draws and so seriously reducing braking efficiency.

Evolution

NATURALLY, when the tandem hub brake was so successful, numerous accessory makers turned their attention to the design of a lighter and smaller pattern for service on singles, and the result to-day is we have a selection in hub brakes to meet all requirements. The hub brake is neat and most efficient, but it is heavier than the rim brake and more costly, so is usually found on the better models of roadster bicycles.

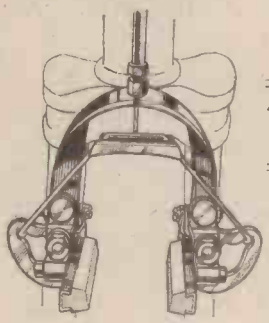
The hub brake can be bought and fitted as a separate unit; it can also be obtained in conjunction with two-speed and three-speed gears.



One form of Bowden Caliper brake

There is now only one type of make left to mention, the coaster hub, once so popular in this country, and still retaining its popularity in U.S.A. and on the Continent. Indeed, most of the Continental bicycles are so equipped, and before the war many of the hubs were supplied by British manufacturers.

As already explained, the coaster is, in its braking effect, a metal-to-metal friction clutch never quite clutching. The expansion of the braking cone is actuated by applying leverage via the chain in the manner of back-pedalling action. The brake comes on smoothly when the necessity of the moment only calls for reduction of speed, but a sudden back-pedalling movement may skid the rear wheel, so for quick stopping a front rim brake should always be used in conjunction with the coaster.



A famous brake The Resilion "Anchor"

Two- and three-speed gears can—or could—be obtained with the coaster brake incorporated in their manufacture. The great virtue of the coaster is the fact that it is practically foolproof and everlasting.

Be Certain and Safe

JUST one last word on the question of braking. It has been said that the man who knowingly uses a car with defective brakes is a potential murderer, and should be treated accordingly. I agree; but I also agree that the cyclist who rides a defectively braked bicycle knowingly is a potential suicide and may be worse. There is no excuse for such conduct, for cycle brakes are simple in construction, easy to adjust, and even if complete replacement is necessary, they are not costly.

My outlook on cycling is to be comfortable and secure. The first I obtain through saddle and gears; the second by the fitment of good brakes and care of them during their working life. The result is a confidence in cycling that adds a considerable measure to its enjoyment—how much it is difficult to estimate, yet the sense of ease and security is always there when the machine is running sweetly and silently and you know you can immediately check its speed by a finger pressure on the brake lever. That condition is worth a trifle of trouble to attain and retain, both easily possible.

I have said a lot about brakes because of their safety importance in the scheme of cycling. Now I want to mention another matter which is far too often a question of pride over-riding good judgment.

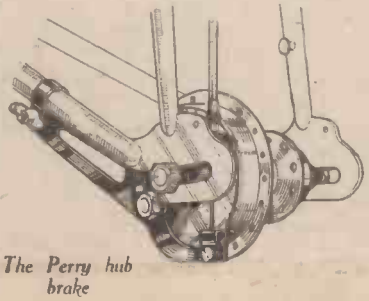
You have seen people struggling up hill, literally struggling, just because they were too pig-headed to get off and walk and by so doing change the exercise and actually obtain a rest. Why do we do it? Mainly because we imagine the onlooker thinks we cannot ride that hill. As a matter of fact, the onlooker, as a general rule, has no interest whatever in our performance, and even if he has, why in heaven's name should we make an uncomfortable effort to mollify or disappoint him?

Believe me, I was once just as determined to ride every activity as the next youth, and probably the violent exercise did me no harm, but now I am riding a bicycle for joy, and when the work of propulsion cancels out the joy, I take the next best method of continuing the journey until the road gradient eases.

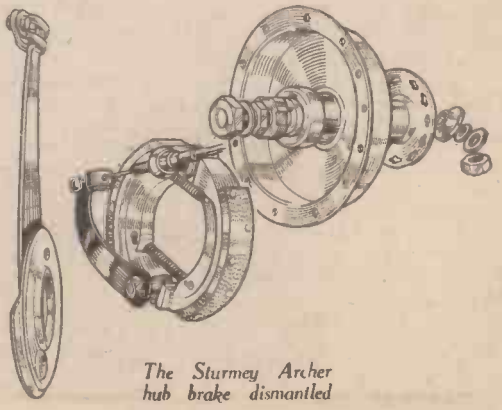
What, you may ask, about the low gear of the four-speed hub? Well, there comes a hill now and then with a gradient that defeats easy pedalling even with a very low gear; or it may happen the wind, or your own mood of idleness or muscular condition, resents the extra pedal pressure needed to sustain equilibrium. Then walk or rest, and you will be a happier cyclist when the summit is reached and you are in the saddle once more.

Remember, a bicycle is not like a pair or roller skates. You haven't got to take it off and carry it, and then fasten it on again; you just quietly push it to the top of the hill, cock your leg over the saddle, and are away again without any trouble.

If you are riding with a companion, then make your speed to fit his comfort, or if the boot is on the other leg, tell him quite frankly such is your comfortable gait and, if he must hurry, then the road is equally his property. Lots of people have been wearied of cycling because the urge of companions has speeded them beyond their comfortable capacity. Do not fall a victim to such thoughtless kindness; you are the captain of your speed, and yours is the engine-room.



The Perry hub brake



The Sturmey Archer hub brake dismantled

My Point of View

By "WAYFARER"

Cycling will Help you to Forget the War

THESE are indeed halcyon days from the cycling standpoint. It is true that a grim shadow hangs over our lovely country, but there is no doubt in my mind that it is going to be dispersed—and dispersed in the only way which will ensure to us, and to those who come after us, a continuance of the abiding freedom and security won for us by our forbears. The genius of our people, who hold in constant remembrance our high traditions, will triumph, and we shall return to our essentially peaceful mode of life.

But, if you want to get right away, momentarily, from that grim shadow, and from all the dread possibilities which "total" war connotes, take your bicycle and go out into the country. Such a country it is too! Seek the seclusion of the lanes. Pedal serenely along, now taking this turn to the right, now this one to the left: here riding through a water-splash, there finding that you have finished up in a farmyard and must retrace your steps; now pausing to absorb a delicate view and anon loitering in a delectable woodland How good—how very good—it all is, to be sure! Indeed, there is nothing like it, and the gifts named, together with a hundred others, are secured at an infinitesimal cost, for the price of running a bicycle is a fraction of one penny a mile.

When appetite reminds you that it is meal-time, look out for a typical cyclist's house of call, and there have a good tuck-in, resuming your journey before the moment comes for the B.B.C. to remind you that "there's a war on." So continue your ride until you have completely forgotten the war—until you are saturated with happiness—until you realise anew how easy it is to get away from the things that worry. And then make your way placidly homewards, with mind soothed and healed, and with a new outlook—a serene and joyous outlook—on life; with your store of optimism and philosophy re-established and with a thankful heart to "whatever gods there be" for the creation of the handiest travel-instrument the world has ever known—the little old bicycle—the despised and condemned bicycle, which, all the same, was one of the really great creations of the Victorian era.

Very, Very Good

YES, they are halcyon days for us who remain loyal to the bicycle, or who, by the necessity of the times, have "returned to the fold." (I have had 50 years of the game, and I seek no other, because, for one thing, I always like to have the best!) The absence of sign-posts and mile-stones adds a new difficulty and a new piquancy to cycling. One realises now what jolly old pals these roadside features were—especially the sign-posts. However familiar the highway, one looked up to the sign-post as it slid by and read for the thousandth time the old accustomed message. Now the sign-post, like the mile-stone, stands in its place stark and dumb; it has no word for us: it has ceased to be on speaking terms with passers-by, and we are ignored. Incidentally, since the sudden panic about "Fifth Columnists" (a euphemism for "traitors") started rampaging, I have come across only one active sign-post, and I thought that its message was extremely significant from the parachutist point of view. It said, "To the Cemetery"! May it be a true word for those, from within or without, who would savage our country.

Then the need for displaying one's identity card to persons with a right to see it sometimes adds a humorous touch to one's cycling. On a recent evening, as I was dragging my reluctant card from its lair, a jocular policeman told me that a card he examined a few minutes earlier contained a ten-shilling note. "Well," I retorted, "if you can find a ten-bob note in *my* card, we'll share it—and I'll have my five shillings at once!" At the same very point, a week later, I found the police on the job again, and I quietly came to a standstill in order to oblige. Then the "special" on duty waved me on, saying, "It's all right, Mr. Urry; I recognise you." Which was rather clever of him, because I happen not to be Mr. Urry, nor am I at all like him. But I was not prepared to have a bother with the "special" on those flimsy grounds, and I went on my way without displaying my card.

The Humorous Side

ON another day, being in some little doubt as to my whereabouts, I made inquiry of a lady who was indulging in the pleasant task (at which I could be very good!) of leaning on the gate to her front garden at a country cottage. She at once gave me the information I wanted, and then she was assailed by a perfectly hideous thought, which she voiced thus: "I suppose that I ought really to ask you to show me your identity card." My reply was in these terms: "If you did, I would say that you had no right to see it, and then you—quite rightly—would refuse to give me any information. So what are you going to do about it?" Then we both laughed, and I resumed my journey.

Back to Tea Places

LET me revert for a moment to the matter of forgetting the war. This process is markedly aided by some of the rest-houses at which I call, the quantity of food supplied, and the price charged, causing you to decide that Hitler is just a bad—a very bad—dream. Believe it or not, it is still possible to obtain shilling teas comprised of first-class food (I have little use for any other), with cakes galore and with overflowing sugar basins, and without any sign of the rationing of butter and tea. Really, you begin to doubt this war business. True, one of my favourite caterers has temporarily thrown in her hand owing (so she says) to the difficulty of obtaining supplies. The Food Office told her bluntly (so she says) that they were going to do their best to prevent cyclists obtaining extra rations by going out for meals. I can hardly believe that this is anything like a literal record of what the Nabobs said to my friend, and my incredulity is supported by the circumstance that at another tea place, a couple of miles away, the tables are groaning under the weight of food. Possibly the approach to the Nabobs of the first caterer mentioned was not quite as tactful as that of the other caterer. You can get so much by going the right way about it!

ITEMS OF NEWS

The well-known cycling enthusiast of Nottingham, Wilson Barratt, has received his papers and is joining the Navy within the next two weeks. He has recently been very active in connection with the N.C.U. Spitfire Fund and has been the means of raising a fairly large sum of money and obtaining much recognition for the Fund in Nottingham and District. We are sure his many friends will wish him a speedy return to peace-time activities.

* * *

N.C.U. Affiliated Clubs in the Surrey Centre should note that until further notice, enquiries of every description should be addressed to The Secretary, National Cyclists Union, 35, Doughty Street, W.C.1, as the immediate acting officials in the Surrey Centre have been called to the colours.

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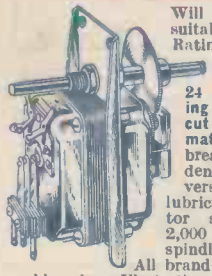

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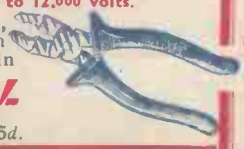


Strongly made, insulated with thick rubber. In two sizes, 6 in. 7 in. 2/6. *Post 5d.*

2/-

SET of POCKET SOCKET SPANNERS

Made in U.S.A.

For Ignition and Household use. Smallest and most comprehensive 8-piece set on market. Comprises 7 sockets and handle. Sizes ¼, 5/16, 11/32, 3/8, and 7/16 hexagon, ⅜ in. roundknurled, and ¼ in. square. Complete in steel rack. ... ... Length 4½ in. *Post 7d.* ... ...

2/3

Heavy Duty Block Type CONDENSERS

1 M.F.D. capacity. Suitable for voltages up to 1,000 A.C. or 2,000 D.C. Tested to 4,000 volts D.C. Dimensions approximately 4¾ in. wide, 9 in. overall height, ¾ in. thick, bakelite case. 200 to be cleared at an enormous reduction. *Post 7d.*

2/6

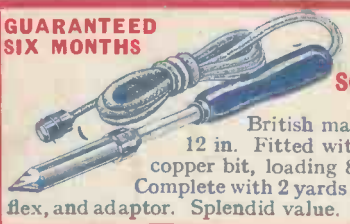
Britain's Biggest Value in Tool Chests

61 SHEFFIELD MADE TOOLS IN CHEST FOR 97/6

Contains an exceptionally comprehensive range of fine quality tools—suitable for practically all woodworking jobs. Chest stained and polished walnut colour. Size : 27 in. by 11 in. by 7½ in. Fitted with fixed compartments for small articles, and movable tray with 24 spring clips to hold chisels, bits, etc. *Full list of contents sent on request.*

Carriage (outside our free delivery area) 3/- extra England and Wales.

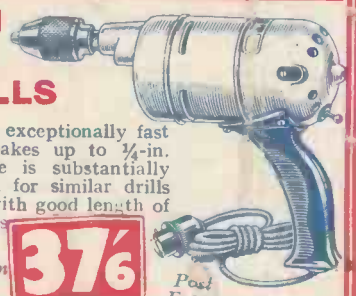
GUARANTEED SIX MONTHS Super Quality ELECTRIC SOLDERING IRONS



British made. Lgth, 12 in. Fitted with a 6-oz. copper bit, loading 80 watts. Complete with 2 yards of power flex, and adaptor. Splendid value.

9/6 *Post 7d.*

High-Speed ELECTRIC HAND-DRILLS



A high-grade tool with exceptionally fast penetrative power. Takes up to ¼-in. drill. Gamages' price is substantially lower than that asked for similar drills elsewhere. Complete with good length of flex. For 200/240 volts A.C. or D.C.

Please state voltage when ordering.

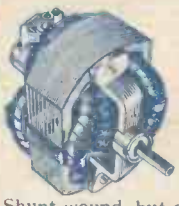
37/6 *Post Free.*

SOCKET SPANNER SETS

PER SET

3/9 *Post 7d.*

Made from special alloy steel, oil hardened and cadmium-plated. Six sockets, complete with double ended ball-loaded crank handle. Sizes : 5/16 in., ¼ in., 5/16 in., ⅜ in., 7/16 in. and ½ in. Whitworth.



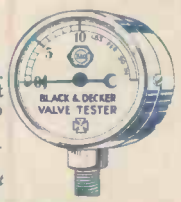
POWERFUL 12 volt A.C./D.C. MOTORS

at a very keen price

Commutator type. Overall measurements (excluding shaft) 2¾ x 2¾ x 2¾ in. Weight 2 lb. Shunt wound, but can easily be altered to series, then machine operates on 30-40 volts. *Post 7d.*

6/6

Bordon Tube Type PRESSURE GAUGES



Calibrated to 10lb. per square inch but can be calibrated to approximately double this pressure. Amazing value. **2/-** *Post 5d.*

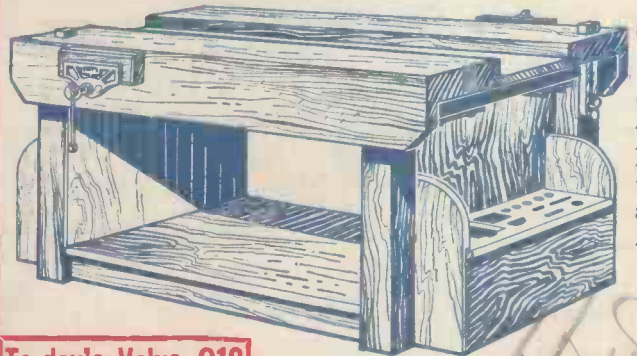
BOXES OF TWELVE ASSORTED FILES

The best and cheapest way to buy Files. British made and excellent quality. Sizes 6-12 in. Also sizes 4 to 8 in., 12 for 3/3. *Post 7d.*

12 for 5/6 *Post 9d.*

SUPER DOUBLE-SIDED WORK BENCHES

at POUNDS below to-day's value



To-day's Value £10

Carriage Forward outside our delivery area.

These are exceptionally strong and very rigid. **Fitted with two "Record" 7 in. vices (one either side)** 2 in. thick, solid English beech top. Smooth clean finish. Extra heavy deal underparts. Fitted two bench stops, two large tool racks (*one at each end*). All parts exceptionally heavy and bolted together. Bolt heads are sunk and pelletted. A bargain not to be missed.

4 ft. 6 ins. long
2 ft. 6 ins. high
2 ft. 3 ins. wide

£6/17/6

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