ESCAPE FROM SUBMARINES

NEWNES

PRACTICAL MECHANICS

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PRACTICAL MECHANICS

Editor: F. J. CAMM

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FAIR COMMENT

WHAT IS AN IDEA?

THE highest form of human intelligence is said to be the ability to invent. I have never subscribed to this doctrine, nor do I place inventors in a class apart. Every human being who overcomes a difficulty is an inventor, and it is merely a question of degree as to where invention begins and ends.

The average professional inventor, however, is indeed a curious individual. He is so intoxicated with what he conceives to be the importance of his invention that intelligence seems to depart, and he is converted into a furtive individual obsessed with the thought that everyone is out to filch his ideas, and rob him of the reward of his work.

I think that patent agents will confirm this point of view, for many inventors will refuse to disclose their ideas even to patent agents. It is time that so-called inventors came down to earth and realised that they are not any different to ordinary mortals. They do not possess any higher degree of intelligence than normal individuals.

There is a particularly obtuse section of professional inventors who claim to have invented everything. It does not matter what new idea or device is suggested, they rush round to their friends, claim to have invented the thing many years before, and accuse the sponsors of having stolen the idea.

Many of them think that by producing some device they can make fortunes out of it without going through the usual procedure of patenting which alone can give them proprietary rights in the idea. There is another group which frequently writes round asking for a list of things to invent.

Patent Advice

WE have retained from our first issue the services of a qualified patent agent, whose job it is to advise on the validity of ideas and to suggest if novel whether it is worth while patenting an idea. Quite often, he states that the idea is novel but not worth patenting, because it does not contain a sufficient degree of invention. There are some ideas which are most ingenious but which would not succeed commercially, for they do in a complicated way what is already being accomplished simply and at little cost. Some inventors, however, are not satisfied with this advice, and have proceeded to act against it. There is not an instance on record where an inventor has succeeded in proving our advice wrong.

There are other inventors who still think it is possible to devise machines for perpetual motion. We do not submit these to a patent agent. We always advise that it is not possible to invent the impossible, and recommend that the reader dismisses fantasies from his mind. In some cases this may lead to a lengthy correspondence before the inventor is able to perceive some elementary law of mechanics.

Many inventors have not the courage of their convictions in that when advised to take out a patent and informed of the amount they require to know whether a firm will take the matter up and pay the entire costs.

Convincing Manufacturers

IT is not possible for us to undertake to put successful inventors in touch with likely buyers of their ideas. We cannot set up as a clearing house for inventions. The inventor with a belief in his idea must energetically attack the somewhat formidable task of breaking down the opposition and the apathy, which all manufacturers have, to a change from existing methods. That attitude is not unreasonable when the cost of scrapping tools, jigs, fixtures, cartons, advertising matter, etc., is taken into account. They need to be convinced before they will incur this expense. Few of them will consider designs on paper. They want a working model of the device, preferably full sized. There are some firms who are prepared to go to a certain amount of experiment to demonstrate the truth or otherwise of the claims made. Others will provide the inventor with facilities for putting his ideas into effect. Yet other firms will buy up an invention with the idea of killing it. Many thousands of inventions become public property after the lapse of 16 years through this cause alone. Where rings of manufacturers exist they will often freeze out an inventor, knowing that in the long run the idea can be obtained for nothing. Some of the most noteworthy inventions have failed to make for their creators the rewards which are their due. That has been made by commercial exploiters. It is often so in other walks of life.

The Successful Inventor

AS I have before remarked, the successful inventor is the man who can combine 99 per cent. of business ability with one degree of invention. Invention for the sheer joy of inventing is a pleasant hobby, which has a stimulating effect upon the mind. The inventor who desires to make a profession of it will in many cases tread the thorny paths of penury if he relies upon the financial return from inventions. There are a few courageous people who invent, manufacture, and market, and it is such as these who reap the fortunes. It is often possible to get financial backing for such ventures when the individual is known to be highly trained and of personal integrity. Too often inventors are cranky people of the lank haired type who are totally ignorant of the first principles of mechanics. Even when their ideas are taken up these are unrecognisable when they eventually emerge as the finished product, for an engineer by that time has been to considerable trouble to rectify the elementary faults.

HOW FAST DO BIRDS FLY?

By E. Hardy, F.Z.S.

This illustration, made in 1/50,000th of a second, reveals in detail the position of the primary and secondary feathers of the wings in a fast downward stroke as the dove sought to gain altitude.

A morning dove in flight.

IT is often extremely difficult to correctly estimate the speed of a bird in flight. Some birds which are notorious for their impression of speed—the swifts and swallows for example—are very deceptive and the graceful lines and narrow tail streamers of the swallow are for rapid turns and evolutions in the air rather than direct speed, for the swallow is probably no faster than the starling.

100 m.p.h.

Speed in the air is a matter of the proportion between the wing surface and the body weight, and in this matter the guillemot and other auks of our coasts are amongst the fastest birds, doing 100 m.p.h. or so when speeding low over the water, their small wings whirring rapidly. The pigeon averages about 80 m.p.h., and here it is possible to estimate speed fairly accurately owing to their homing instincts. The fastest pigeon flight on record, a Liverpool bird's feat, averaged 99.306 m.p.h. from South Wales. Even in racing circles officials with their sealed clocks cannot give us the most accurate result we desire, for the time is from release to entry of the loft, and the bird does not make the same speed when flying round to gain height and direction, and there are the few seconds before it enters the loft : so that we may safely say the homer can exceed 100 m.p.h.

Wing Beats per Second

The rapid whirring of the wings of a flying bird do not always make for speed. It has been calculated that the revolutions of the wings per second with the sparrow are 13, with the wild duck 9, the pigeon 8, the barn-owl 5 and the buzzard 3. The ratio between wing surface and body weight is highest in the falcon, vulture, hoopoe, raven and lapwing, and lowest in the teal, water rail, waxwing, starling and coot. In the case of the wild duck, the total duration of a wing revolution has been calculated at 11⅝ hundredths of sec., 5 on the ascent and 6⅝ on the descent; the pigeon 12½ hundredths of a second, 4 on the ascent and 8½ on the descent, and with the slow flying buzzard the revolution takes 32½ hundredths of a second, 12½ on the ascent and 20 on the descent.

Some birds have a wide range in their powers of flight, the lapwing for instance travelling slowly at 24 m.p.h., migrating at 41 to 50 m.p.h., or with a spurt doing 48 m.p.h., all according to its needs. The swallow ranges from 22 to 27 m.p.h., and migrates at about 34 to 40. The rook ranges from 24 to 45 m.p.h., and the starling 23 to 49 m.p.h., a flock going to roost averaging 41 m.p.h.

There is a great tendency to over estimate the speed of birds, as there is to over estimate the numbers in a bird-flock. It is true that swifts have been reported circling round aeroplanes travelling at more than 100 m.p.h. By the time in which it negotiated certain distances, the golden eagle, in Scotland, has been carefully estimated to have a speed of 120 m.p.h. for 3½ miles with a very slight cross wind from the west. It has left the peregrine far behind in a downwards swoop. Other birds estimated to be able to exceed 100 m.p.h. include the swallow (although its average speed is nearer 30 m.p.h.), possibly the hobby and peregrine on the swoop, and the guillemot.

The Rapid Whirring of the Wings of a Flying Bird do not Always Indicate Speed, in Fact its Speed on the Wing is Often Very Deceptive.

A seagull in flight.

Speed of Birds

The lapwing can reach 80 m.p.h., the golden plover and teal 70 m.p.h. Between 60 and 70 m.p.h. is attained by the blackcock, red grouse and the peregrine. Merlins, wild geese, most wild duck, blue rock-pigeons, wood-pigeons, stock-doves and turtle-doves range between 50 and 60 miles per hour. Between 40 and 50 is the speed of swans, the normal flight of lapwings, partridge, rooks, starlings and kestrels.

We come to much more typical bird flight with a speed averaging between 30 and 40 m.p.h. This is the speed of the mistle-thrush, most of the finches (like sparrows and green finches), although many of these may do only just over twenty m.p.h. (for shorter flights), blackbirds, quail, corncrakes, wheatears, buntings, fieldfares, sand-martins, gulls and pheasants. Between 20 and 30 m.p.h. is the flight of warblers, wagtails, magpies, herons, terns (excepting on migration), owls, cuckoos, and curlews.

Birds with long narrow wings like the terns and swallows are long-distance fliers with slower, steadier wing-beats; those with short, rounded wings like the game birds and finches are usually short-distance fliers with more rapidly whirring wings. Those with long narrow tails like the pheasants, sparrows, etc., can rise quickly and almost vertically, whereas those with short tails like the gulls and plovers, the geese and rooks, need to sweep or run low over the ground, beating their wings for "lift" before they get going. The kestrel, tawny owl and buzzard are good at hovering; the buzzard, eagle, sometimes rooks, ravens and gulls, are good at soaring; the roller, lapwing, and raven at tumbling in the air, even to somersaulting; but no bird can actually fly backwards, although the raven may seem to do so in its spring courtship antics.

The Venterspost gold mine.

THE LURE OF GOLD

By Arthur Ashdown

A Brief Survey of Gold-Mining Methods and Conditions on the World's Largest Reef

THE discovery of buried treasure has, for centuries, been one of the most romantic and enthralling pursuits of mankind. Spanish galleons (some real and some mythical) have lured legions of people into dangerous adventure whilst the ever-green "Pirate's hoard" has set men trekking all over the world for the possible reward of discovering a chestful of golden pieces. It is almost unbelievable, therefore, that a whole tract of gold-impregnated land, stretching in an unbroken line for miles and miles should have been left undiscovered until but a little more than fifty years ago. And when it is remembered that this gold was, in some cases, literally above the surface, it is all the more amazing.

A Famous Gold Reef

It was not until the year 1886 that the famous Witwatersrand gold reef was discovered and although it is difficult to say with any certainty who was the actual discoverer, George Honeyball, James Walker Jan Bantjes and the Strubens are among those claiming the distinction. The actual site of the outcroppings of gold was but a few hundred yards from what are now the main streets of Johannesburg and perhaps the barren nature of the country was the main reason for the late prospecting in this area. With the initial discovery, one of the greatest and most romantic gold rushes in history commenced and almost overnight a mushroom town of tents and tin shanties laid the foundation stone of Johannesburg, the largest city in Africa. The location of this gold reef in the very centre of the Union of South Africa has proved advantageous for the country inasmuch as it has allowed the wealth to be distributed more evenly than it might have been had the location been on the coast.

Problem of Supplies

The geographical position of the reef was, in the early days, a distinct disadvantage, for, with the nearest railway at Kimberley, the problems of bringing supplies and equipment to the goldfields presented an enormous problem and made the working costs extremely high. The bleak and wild nature of the country and the lack of water added to the hardships of the pioneers on the plateau, nearly 6,000 feet above sea level.

After the early days of uncertainty, however, the commercial future of the field was established and the forecasts of the sceptics were confounded. The out-croppings of gold were, of course, soon appropriated and thus shafts were sunk to ever-increasing depths until to-day men are working 8,000 feet underground. The area was soon covered with a network of trial holes and the run of the reef in an East to West direction was soon established.

When the gold-bearing reef is located by the trial holes, the main shaft is sunk, at a cost of anything from £1,000,000 to £2,000,000. At appropriate positions tunnels are driven into the reef and the ground divided into blocks. These underground roads and communicating passages are known as "drives," "raises" and "winzes" and it is from these that the excavations are carried out. The drives and winzes, or "stopes" as they are called when they are being worked, are on an average five feet wide and are supported by "pig-styes" consisting of round timbers built across each other in the form of a square and filled with waste rock. The walls and roof (or "hanging") of the drives are also supported by closely packed stone and in some instances by concrete.

Manual Labour

At the comparatively shallow depths reached in the early days of the workings, the rock was oxidised and capable of being mined by manual labour. As the depth increased, however, the rock became more dense and hard and thus it was found necessary to employ mechanical means for driving the tunnels and also for the mining of the ore itself. The original mechanical drills were of cumbersome design and weighed between 300 and 400 lbs. They had to be mounted on substantial doublejack supporting bars, which in themselves took two natives to erect. In 1908 the Chamber of Mines instituted a competition for improving the design of the drills, but even the winning drill was not put into commercial use. The competition, however, stimulated interest

Drilling underground in a Rand gold mine.

and inventors and designers concentrated on the improvement of the drills. To-day the drill known as the Jackhammer is in most common use and weighs only 50 lbs. It can be used by one person and is capable of drilling on an average 70 to 80 feet per shift.

Deep Level Mining

Deep level mining has certain peculiarities and it is interesting to consider some of the conditions governing it. At great depths, development work is carried on well under and parallel to the ore body, instead of on it. This ensures that the main workings shall not be interfered with by the gradual but inevitable closing up which follows upon the extraction of the ore. One of the main problems associated with deep level mining is that of ventilation and for this purpose gigantic fans (some of the largest in the world) are employed, whilst special ventilating shafts are sometimes sunk. The temperature increase is approximately 1 degree Fahrenheit for every 200 feet of vertical depth. One of the problems which handicaps ventilation is the presence of silicosis-producing dust caused by the drilling of the ore. In order to settle this dust, large quantities of water are used and thus the air, becoming saturated, its cooling properties are much reduced.

Raising the Ore to the Surface

Another problem associated with deep level mining is that of raising the ore to the surface. This is carried out by what is called "stage-hoisting," and for this purpose engines are installed underground and hoist the rock to a level from which it is possible to use the surface hoist. The amazing speeds at which these loads are elevated are capable of being appreciated when it is realised that a load of nine tons can be raised from a depth of 4,500 feet at a speed of 3,700 feet per minute. The hoists are electrically operated and the drums, weighing as much as 350 tons, carry 18 tons of steel rope.

When the rock has reached the surface, the gold-extracting processes are put into operation. The ore is first of all screened and washed and then carried on a conveyor to the crushers which reduce it to two inches in size. The crushing process is now carried a stage further in the stamp mill. Each stamp weighs approximately three-quarters of a ton and drops 100 times per minute. The ore is by now reduced to sandy particles and in the classifier the finer grains are separated from the coarse. The latter are now subjected to further grinding in the tube mills. These are steel cylinders, about 25 feet long and 5 feet 6 inches in diameter, and are half-filled with hard rocks or "pebbles" as they are known. The mills are now rotated and the rocks, falling on the coarse sand, from the stamp mills, reduce it still further. In some of the more modern plants, the stamp mills are eliminated entirely and the ore is crushed to a great degree of fineness in the tube mills.

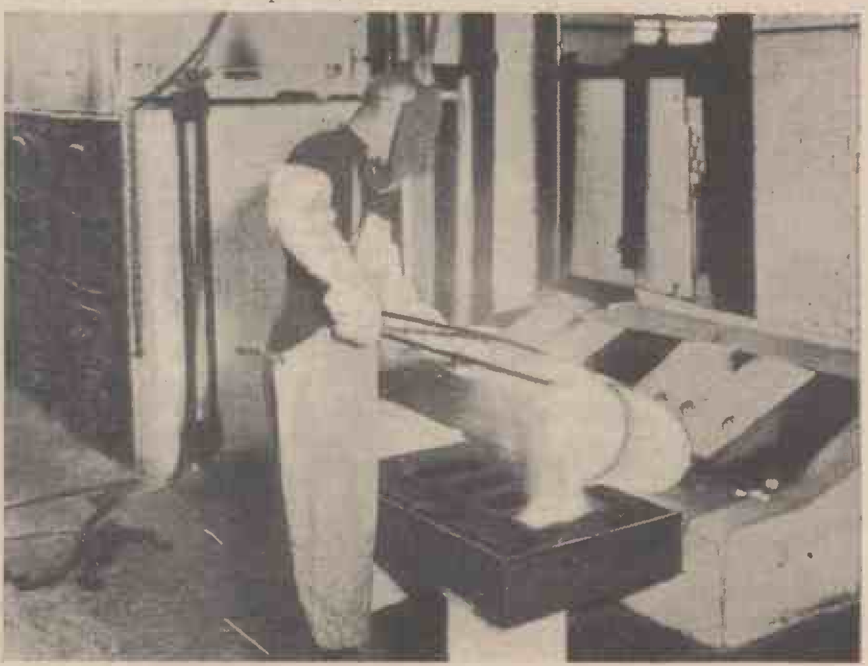
Separating Gold from Sand

The next stage is the separation of the gold from the sand. In one process the gold-bearing sand is passed through a solution of cyanide which dissolves the gold, while in the extractor house the gold slime is recovered from the cyanide solution by means of zinc on to which the gold is precipitated. Another method of concentration is by means of blankets or corduroy. In this process, the gold-bearing sand is washed down slanting tables on which corduroy is stretched. The grooves in the corduroy run horizontally and trap the gold as it passes down. This method, besides being extremely simple, reduces the risk of mercury poisoning and lends itself readily to the recovery of metals of the osmiridium group, of which the mines produce six thousand ounces per annum. The gold recovered by these processes is sent to the smelting house, and, after various impurities have been removed, it is melted down in crucibles and cast into bar moulds ready for the refinery. A central refinery has been established at Germiston and is the largest of its kind in the world, dealing with more than half the world's output.

And so, what was once a barren wilderness has now blossomed into a highly civilised and commercial centre from the gold seed planted by nature countless centuries ago. At the end of 1937, gold to the value of £1,427,000,000 had been extracted from this reef and with the possible exploitation of the Far West Rand, where further supplies have been definitely established, one is overawed by the shape of things to come.

THE GROWTH OF THE RAND'S GOLD INDUSTRY

	1931	1937
Tons milled ...	32,000,000	51,129,650
Yield in ounces ...	10,355,000	11,740,891
Working revenue ...	£43,867,000	£80,177,687
Working profit ...	£12,974,000	£31,699,760
Dividends declared ...	£8,026,000	£17,070,714



Pouring gold at a Rand gold mine.

Our Busy Inventors

By "Dynamo"

Anti-Doze Gadget

SLEEP, "Nature's sweet restorer," is sometimes responsible for very serious consequences. A proportion of the appalling number of motor-car accidents may be caused by napping on the part of drivers.

The prevention of dangerous dozing is the subject of an application to the British Patent Office. The somewhat cumbersome title of the specification is as follows : "An Improved Device to be worn on the Person to Maintain Wakefulness in the Wearer."

The device in question is attached to the eyelid. the dropping of which closes an electric circuit, which causes an alarm to sound. The contrivance consists of a lever maintained on a ball joint, which at its free end is formed as a feeler. The end of the feeler rests on the exterior of the eyelid, above the lashes. It is so light that it exerts no appreciable pressure upon the eyeball. The source of the current may be a battery carried in the waistcoat pocket. There is preferably provided an arrangement to ensure that the alarm does not sound as the result of a mere blink. The alarm may be a bell, but the imparting of a slight electric shock is also suggested as a means of warning the involuntary sleeper. The device may be affixed to the temple piece of a pair of spectacles or incorporated with motor goggles.

This invention is designed for all those jobs in which keeping awake is an absolute necessity. In case of war, it is contended that the device would keep airmen, sentries and others on the *qui vive*.

Safety Razor Plough

NORMALLY, a ploughshare, when dull, is re-sharpened. A new idea has been conceived in relation to the time-honoured furrow-making machine. When the share becomes blunt, the inventor removes and replaces it on the principle of a safety razor blade. It is stated that the extension of this method to the farm would make for considerable economy. In addition, it is claimed that, in average soil, this novel plough has an easier pull than the conventional style.

One wonders what the ploughman, who "homeward plods his weary way," will think of this new agricultural implement. If it bear the same relation to an ordinary ploughshare as is the case with the safety razor compared with the "cut-throat" type. it would hardly be sufficiently robust to turn over the rich loam of the glebe. However, it would be strong enough to plough the sands à la Ulysses.

In the event of this new idea being generally adopted, what will be done with the old ploughshares? It will not be so difficult a problem as that concerning razor blades. The Golden Age when swords will be turned into ploughshares appears to be far distant. In these troublous times there is a much greater probability of ploughshares being turned into swords.

Anchor That Folds

AN anchor which Jack Tar could carry in his waistcoat pocket—if he had one—would be fit only for the navy of Lilliput. But there has recently appeared a folding light-weight anchor which will safely secure a moderately sized vessel. Made with joints, this anchor can be folded for stowage. Such an anchor, it is affirmed, weighing only 11 lbs., will hold a boat 38 feet in length. It would not. therefore, be necessary to weigh this anchor on a large scale.

A new "loud-speaker" stethoscope, known as the Cardiophone. It is equipped with a microphone (shown in the hand of the man) which can be controlled for faint heart beats, etc., by a volume control.

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

Safety Ash Tray

LADY NICOTINE is sometimes alleged to be guilty of arson. The incandescent end of a cigarette may necessitate a visit of the fire brigade. At least, it is justly held responsible for occasionally cauterizing the piano and the dining-room table. And even when deposited in an ash tray there spreads around a mephitic odour.

A new receptacle will keep the incendiary cigarette, or all that is left of it, in its place. This is a specially constructed ash tray with an internal collection of vertical cells. These cells are surrounded by a wall with a rim above the level of their tops. Thereby, it is ensured that a lighted cigarette placed on the cells will always fall inwards.

Such an arrangement may not induce the careless "cigarettist"—to use an American term—to repent in sackcloth and ashes; but it will certainly guide the latter into a fire-proof channel.

Refrigerator for Guns

THE newest use for dry ice is as a cooling agent for machine guns. A detachable jacket filled with this ice and slipped over the barrel reduces the temperature of the gun. It is asserted that this refrigerating cloak for artillery will enable fighting planes and bombers to carry fewer guns and yet to maintain continuous fire.

It is not a far cry from this ice-cooled jacket for machine guns to a new blanket designed to keep sleepers at an agreeable temperature. Originally intended for hospitals, this air-conditioned blanket cools the patient in summer and warms him in winter. A quiet fan blows warmed or cooled air into the blanket, on the underside of which is a porous lining. Through this the prepared air filters, adding materially to the comfort of the recumbent person.

Every Man His Own Builder

THE amateur bricklayer will be greatly interested in a new brick which enables him, without previous knowledge, to erect, on a level foundation, a perfect wall without the aid of plumb rule, line, or spirit level. And it is maintained that this can be done with greater speed than is possible by skilled labour using other types of bricks.

This special brick is cellular and interlocking. The fixing material is applied through the cells and fills the frog between the bricks. Solid columns are formed throughout the wall, which, together with the interlocking device, makes for great strength and renders the wall proof against settlement cracks. And it is affirmed that with this new brick one can build to any height without danger from weight or strain.

For A.R.P. the cells provide a means of reinforcement with steel rods.

An additional virtue of this brick is that it is specially economical as regards the cost of fixing material.

A.R.P. for Built-up Areas

THE air-raid shelter is still occupying the mind of the inventor. His ingenuity has recently been engaged in thinking out a method of furnishing protection in close built-up areas where there is limited accommodation for a shelter. In many cases, for example, it is necessary to construct a protected room within an existing building.

To deal with this limitation of space, there has been devised a method whereby a ground floor or corridor is selected and within it a reinforced arched shell is placed.

The space between the exterior of the shell and the walls and ceiling is filled with earth or other suitable material, which forms a cushion. The arched shell, which may span the whole width of the room, is formed of a number of arc-shaped ribs of reinforced concrete. This shelter may be speedily erected. The amount of concrete superimposed can be varied according to the degree of protection required.

Dog Collar and Satchel

ONE usually regards the dog as a pet or companion. But he is also capable of useful work. In the field he sets and retrieves. And, on the Continent, he has been found in the shafts of a small cart. If one desires to add to the usefulness of a dog in this country, it is now possible to equip him with a specially contrived collar which will enable him to carry small parcels without soiling them with saliva.

A dog-collar made in accordance with a new device has an additional strap-part with a releasable fastener and a holder. By means of this, light articles can be fixed securely to the collar.

The pigeon has been found useful in warfare. And the dog could be utilised for the purpose of carrying dispatches—a canine aide-de-camp.

Fighting the Flames

IF Armageddon, which our jittering Jeremiahs regard as imminent, should curse the human race, the incendiary bomb will, undoubtedly, play a leading part. To combat the man-made thunderbolt, there has been an interesting development in the construction of extinguishing apparatus. The new method consists in first applying to the flaming missile a fatty or oily substance, for instance, a high-flash-point petroleum oil. This would completely coat the bomb and isolate it from all contact with air. Then there is sprayed on the fire an extinguishing medium, such as methyl bromide. A twofold purpose is thus fulfilled. This liquid opposes the combustion of the mineral oil, which has necessarily been brought up to a very high temperature. And then it makes the extinction of the bomb complete.

The fatty or oily substance and the extinguishing medium are held in two containers mounted on a single shield. This protective screen permits the fire-fighter to approach and attack the devouring element with less risk of being burned.

Bad News for Insects

MANY effective poisons cannot be used to destroy insects because the poison is more or less soluble in water. If the article to be protected from these pests becomes wet owing to dew or some other cause, the poison at least partially dissolves. As a consequence, the organism to be treated is injured by the dissolved poison or the insect to be killed is warned by its taste and repelled.

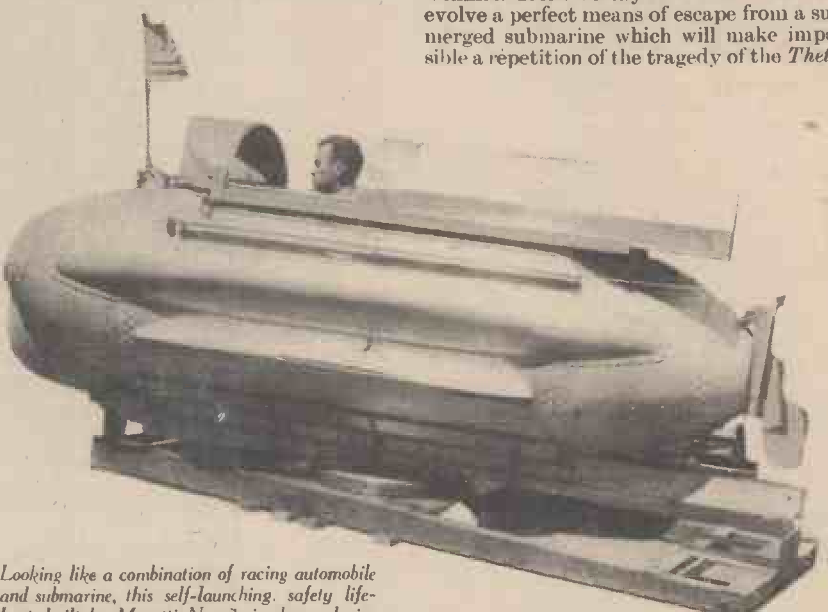
The problem of destroying insects without injuring what one wishes to preserve has apparently been solved by an inventor, whose method is the subject of an application to the British Patent Office. He furnishes particles of a poison practically soluble in water. These particles are coated with a substance which water does not affect. The dissolving is performed by the digestive juices, or by the ferments, in the alimentary canal of the insect. The unfortunate creature involuntarily extinguishes itself. It is possible thus to make products with the minimum of solubility in water. As a result, the objects to be protected from the tiny marauders, such as plants, will suffer no harm. And the victim of the insecticide does not get wind of the nature of the poison which is to destroy it.

An Eye on the Public

EXHIBITORS at world's fairs who desire a count of the visitors to their stands can register the number by means of what is termed a photo-counter. This is an electric eye which detects and records the attendances.

Such a method of keeping an eye on the public recalls the story of an overseer who superintended a gang of natives. This superintendent had a glass eye, and when absenting himself for lunch, he fixed his artificial optic on the trunk of a tree. And the artless natives thought they were still working under the observation of the ganger.

An antidote to "eye-service" in schools, not to mention offices, would ensure more work being done. The mice would not play, if they believed that the cat, though away, still had his eye upon the sportive rodents.



Looking like a combination of racing automobile and submarine, this self-launching safety lifeboat, built by Menotti Nanni, is shown during the first public demonstration. Mr. Nanni, who took years to develop the boat, says that any inexperienced person can launch the craft from the deck of a sinking or burning ship. It is unsinkable and non-capsizable. It can be manufactured in different sizes to accommodate any number of people. This is the first one to undergo tests.

Rainproof Leg Shields

SIR PHILIP SIDNEY, in the reign of Good Queen Bess, went into battle with a piece of his armour missing. And in the unprotected part of his body, the knight received his mortal wound. Now, the armour we provide against Nature's Lewis-gun—the rain—covers the whole body except the legs. The umbrella acts as a shield for the head and the mackintosh defends the trunk, but the legs lack greaves, as the shin-guards in the age of chivalry were yclept.

Consequently, an inventor has contrived an improved device for the prevention of cruelty to knee-caps, shins and calves. He provides leg-tubes formed partly by the folded-over lower back portions of a raincoat and partly by small flaps. They are so arranged on both sides of the central slit that they do not detract from the appearance and utility of the coat in its normal condition. By means of flaps and fasteners there is formed, when required, a pair of tubular leg-coverings giving complete protection against wind and rain. At the same time it allows the limbs perfect freedom of movement. Not only the pedestrian, but the cyclist will appreciate this portable air-raid shelter from inclement weather.

The Weak Spot

THE mention of an unguarded place in the armour of a knight moves me to refer to that ill-fated submarine, the *Thetis*. The nomenclature of the ships in our Navy is largely derived from mythology. Thetis, according to Greek legendary lore, was an ocean goddess. She was the mother of that illustrious hero, Achilles, whose statue may be seen in Hyde Park, and after whom one of the old Channel Fleet was named. Thetis plunged her infant son in the water of the River Styx, which rendered invulnerable those who were dipped therein. Unfortunately, the miraculous water did not touch the heel by which she held her babe. In that weak spot Achilles eventually received his death wound.

There may have been a vulnerable spot in the submarine named after the mother of Achilles. It is a worthy aim of the inventor to evolve a perfect means of escape from a submerged submarine which will make impossible a repetition of the tragedy of the *Thetis*.

A Photographic Gold Mine

THIS heading aptly describes the 1939 edition of "Minitography and Cinetography," which has just been produced.

Every still and cine photographer should own this splendid new 340-page book. It is packed from cover to cover with everything you want to know about your hobby. There are articles by the world's best-known photography and cinephotography experts in which they give instructive, plain-spoken advice about all your problems. There are hundreds of illustrations in art photogravure and technical data which will put you on the right road to successful photography. Also a special colour supplement. In addition, almost every latest camera and accessory is illustrated and fully described and accompanied by latest cash and easy payment prices.

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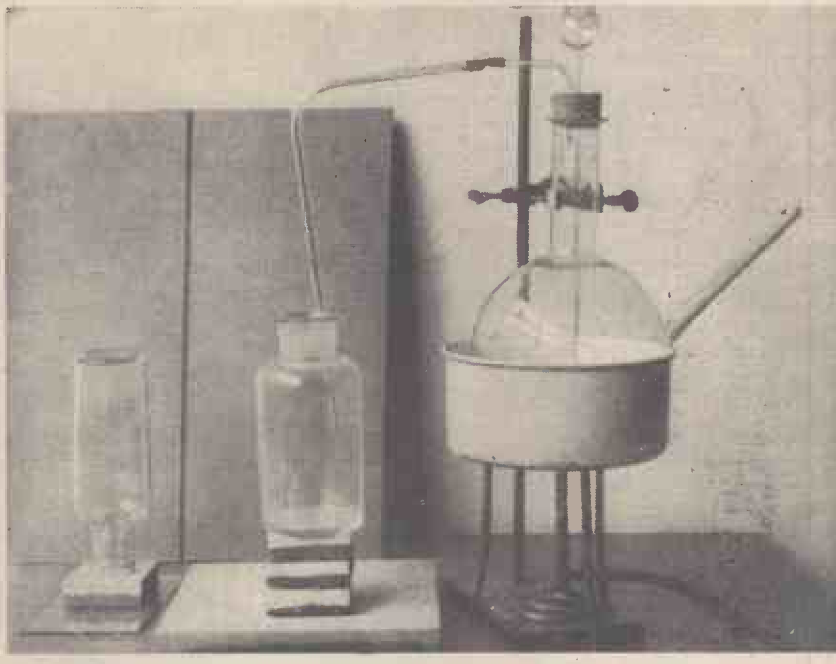
Demonstrating the powerful bleaching properties of chlorine, by dipping a wetted flower into a jar of chlorine gas.

Chemistry for Beginners

No. 5. Chlorine, the Active Element—How to Prepare it and Experiment with It



The orthodox method of preparing chlorine in the laboratory by heating a mixture of hydrochloric acid and manganese dioxide.

THERE is a very famous chemical family of elements known as the "Halogens," a name which is deprived from two Greek words, *Hals,* "salt," and *genes,* "producing." The name is applied because all these elements are found in sea water and because their sodium salts very closely resemble common salt, or sodium chloride.

The halogens are four in number—fluorine, chlorine, bromine and iodine. All are exceedingly energetic elements, readily combining with other substances and forming compounds which are, in the majority of instances, of great value in modern civilisation.

Fluorine and chlorine are pungent-smelling gases. Bromine is a heavy red liquid—the only non-metallic liquid element, incidentally—whilst iodine is the well-known dark-coloured flaky solid whose solution in alcohol is so greatly employed for antiseptic purposes.

In many respects, the members of the halogen family of elements are all very much alike in chemical properties, and, to a large extent, what may be said of one may be applied to them all. In this article, however, we shall only consider the most important member of the halogen family, which is the gas chlorine, a highly useful yet, at the same time, a somewhat sinister substance, for although chlorine is employed in the manufacture of many synthetic drugs and dyestuffs, as well as being a constituent of chloroform and other pain-relieving materials, it can also be used as a poison gas.

Unpleasant Characteristics

Although chlorine possesses such unpleasant characteristics, it can be made quite safely by the amateur experimenter, providing that ordinary commonsense precautions are taken.

In the first place, all experiments with chlorine should take place out of doors or in a shed suitably placed for such a purpose. There is not the slightest chance of the amateur being poisoned by chlorine, for the gas is so pungent in character that it is absolutely un-breathable. Consequently, although the experimenter may succeed in getting a few whiffs of the gas up his nose, the effect of this experience will be such as to set up an irritation of the nasal passages which, harmless and transient though it may be, will impel him to treat the gas with at least the amount of respect which is ordinarily paid to strong ammonia.

Chlorine is very easily made. It can be prepared very simply by dropping dilute hydrochloric acid on to crystals of potassium permanganate contained in a flask. A rapid stream of chlorine gas will be forthcoming, which outflow of gas will be still more abundant if the flask is slightly warmed.

The more usual, and the less expensive method of preparing chlorine in the laboratory consists in gently heating a mixture of manganese dioxide and strong hydrochloric acid. For this purpose, the manganese dioxide is placed in a fairly large flask, which, for convenience of heating, is placed in a saucepan containing warm water. The flask is provided with a soundly-fitting cork through which passes a delivery tube and a thistle funnel. Strong hydrochloric acid is poured down the thistle funnel a little at a time. Chlorine gas will be evolved abundantly and in a fairly steady stream, particularly if the water in the saucepan is maintained at an elevated temperature.

Reaction

The precise reaction which takes place and by reason of which the chlorine gas is liberated is a complicated one, but we may thus express the complete course of this chemical action :

MnO_2	$+ 4HCl$	$= 2H_2O$	$+ MnCl_2$	$+ Cl_2$
Manganese dioxide	Hydrochloric acid	Water	Manganese chloride	Chlorine

Instead of preparing chlorine gas from hydrochloric acid and manganese dioxide, we may make it from common salt, sodium chloride, which, as its name implies, is a simple compound of sodium and chlorine.

To this end, a mixture of roughly equal parts of common salt and manganese dioxide is placed in a flask, provided with a thistle funnel and a delivery tube. Strong sulphuric acid is poured down the thistle funnel, and the contents of the flask are gently warmed, as before, by being surrounded with a saucepanful of warm water. Chlorine will be released from the salt, the chemical reaction being expressed as follows :

$2NaCl$	$+ MnO_2$	$+ 2H_2SO_4$	$= Na_2SO_4$	$+ MnSO_4$	$+ 2H_2O$	$+ Cl_2$
Sodium chloride	Manganese dioxide	Sulphuric acid	Sodium sulphate	Manganese sulphate	Water	Chlorine

Finally, chlorine can be made by heating red lead with strong hydrochloric acid, the gas being liberated in accordance with the equation below :

Pb_3O_4	$+ 8HCl$	$= 3PbCl_2$	$+ 4H_2O$	$+ Cl_2$
Lead oxide (Red Lead)	Hydrochloric acid	Lead chloride	Water	Chlorine

Chlorine itself is a greenish-yellow coloured gas, the name being derived from the Greek word, *chloros,* meaning "pale-green." A very small quantity of the gas when released into the air of a room imparts to the atmosphere a pleasant and refreshing odour, and, what is more, acts as a good air-cleanser, since chlorine is a very powerful disinfectant.

Heavier Than Air

Chlorine is about two and a half times as heavy as air. It can, therefore, be collected in glass jars by simple displacement of the air therein. The gas is fairly soluble in cold water, also, one volume of water dissolving almost exactly three volumes of chlorine.

This solution of chlorine in water is known as "chlorine water." It is very readily prepared by allowing a stream of chlorine gas to bubble through cold water, until the liquid acquires the characteristic yellowish-green colour of the gas. Chlorine water has powerful disinfectant properties, but, unfortunately, it cannot be kept for any great length of time, since it undergoes slow decomposition, the dissolved chlorine combining with the hydrogen of the water, to form hydrochloric acid, oxygen being liberated :

$$\underset{\text{Water}}{H_2O} + \underset{\text{Chlorine}}{Cl_2} = \underset{\text{Hydrochloric acid}}{2HCl} + \underset{\text{Oxygen}}{O}$$

In sunlight, this decomposition of chlorine water goes on very rapidly, and bubbles of oxygen are not long in making their appearance. In the dark, the reaction proceeds with its maximum slowness. Hence, if we wish to keep a quantity of chlorine water for a few days, it is best stored in an amber-coloured bottle in the dark.

If strong and freshly prepared chlorine water is placed in a vessel surrounded by a freezing mixture of ice and salt, a solid crystalline compound of chlorine and water is formed. This material, which takes the form of yellow crystals, of the composition, $Cl_2 8H_2O$, is known as *chlorine hydrate.* It cannot be kept at temperatures above the freezing-point of water (0°C), since it decomposes into chlorine and water at higher temperatures.

Experiments

Many interesting experiments may be conducted with chlorine gas. In order, for instance, to demonstrate the extreme chemical activity of the gas we have only to saturate some tissue paper with warm turpentine and to drop it into a jar of the gas, whereupon the turpentine-saturated paper will take fire and will burn with a very smoky flame. In this case, the chlorine combines readily with the hydrogen contained in the turpentine, forming hydrogen chloride (or hydrochloric acid gas, HCl) and liberating free carbon or soot. A burning wax taper or a candle plunged into a jar of chlorine gas similarly gives rise to great volumes of soot.

Red-hot iron, copper, zinc and most other metals will burn vigorously when plunged into a jar of chlorine. Indeed, some metals, such as antimony, in their powdered form, will actually take fire when scattered into a jar of chlorine gas, whilst extremely thin metal foils as, for instance, Dutch metal, will behave in much the same manner.

In all cases, of course, in which metals burn in chlorine, the chlorine gas unites directly with the metal to form the metallic chloride. If, for instance, sodium metal is heated in a small iron spoon and then plunged into a jar of chlorine gas, it will burn with a dazzling brilliancy, forming *sodium chloride*, which is, of course, common salt. Thus :

$$\underset{\text{Sodium}}{Na_2} + \underset{\text{Chloride}}{Cl_2} = \underset{\text{Sodium chloride}}{2NaCl}$$

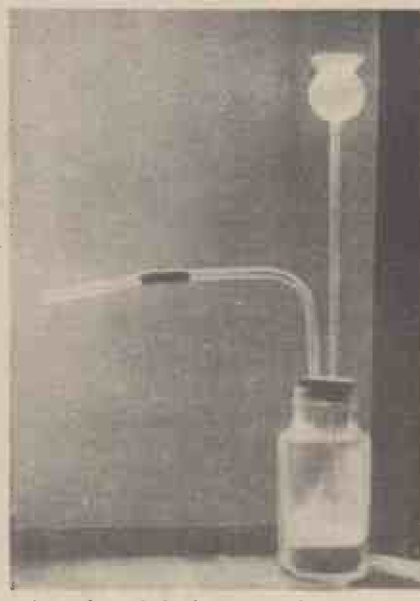
When a small piece of yellow phosphorus is dropped into a jar of chlorine, it first melts, and then inflames, burning slowly in the gas to form phosphorus trichloride, PCl_3, and phosphorus pentachloride, PCl_5.

The great chemical activity of chlorine having thus been demonstrated, it will now be clear why this gas is of so much use in large-scale synthetic chemistry for manufacturing many of the chemical products which civilisation now demands. For this purpose, chlorine gas is liquefied and stored in lead-lined steel gas cylinders.

Modern Bleaching

There is still another side of chlorine's activities which we must deal with, and this is its tremendous importance in modern bleaching.

If we dip a flower into water and then hold it in a jar of chlorine gas, the colour of the flower will be destroyed more or less rapidly. Again, if we immerse a coloured



A simple method of making chlorine gas by acting with hydrochloric acid on either bleaching powder (chloride of lime) or potassium permanganate.

rag or a sheet of paper containing pen and ink writing into a vessel of chlorine water, the same bleaching effect will be obtained. Chlorine, on this account, has become known as the "bleaching element," although, actually, it is not chlorine, but rather, oxygen, which performs the bleaching action.

The bleaching influence of chlorine entirely depends upon its great affinity for hydrogen. When a coloured material is moistened or wetted and then exposed to the influence of chlorine, the chlorine combines with the hydrogen of the water, liberating oxygen in an extremely active form. It is this liberated oxygen and *not* the chlorine which carries out the resultant bleaching or decolourising action, the oxygen oxidising the colouring-matter to a colourless form which is frequently soluble in water and which can, therefore, be washed away afterwards.

Upon this basic principle, many of the modern processes of bleaching are based. The chlorine, however, is usually applied in the form of bleaching powder or "chloride of lime."

Bleaching Powder

Any experimenter who cares to take the trouble can make bleaching powder or chloride of lime for bleaching or disinfectant work. All one needs is a shallow box some four inches wide, three inches high and from four to six feet long. The joints of the box should be made gas-tight by sealing them up with hard bitumen, wax, or some other suitable stopping composition. One end of the box must be made removable, and entry and exit tubes must be fitted at opposite ends of the box to allow for the flow of chlorine gas through it.

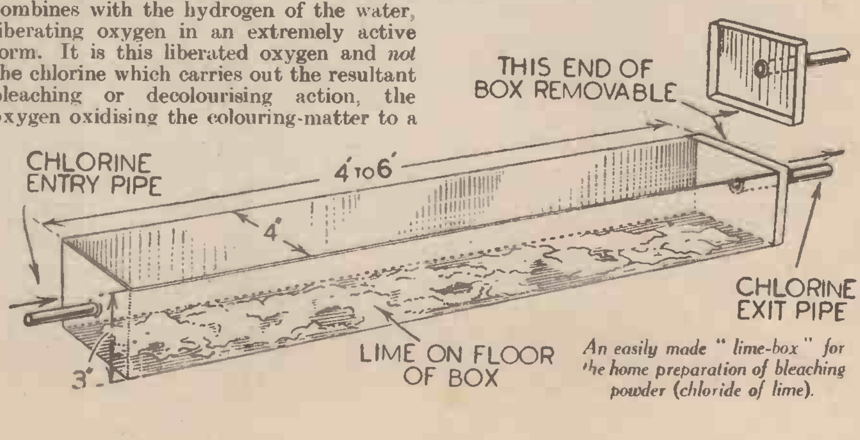
Good quality dry slaked lime is placed in the box to a depth of about three-quarters of an inch, the lime being slightly ridged in order to expose a maximum surface area of the material. The removable end of the box is then sealed on, and a very slow stream of chlorine gas is passed through the box for a period of from eight to twelve hours. From time to time it is advisable to shake the box so as to expose a fresh surface of the lime to the action of the gas.

At the conclusion of the above period, the bleaching powder should be placed into a well-stoppered container for storage purposes.

When treated with a dilute acid, the bleaching powder will effervesce, liberating chlorine gas, the chlorine being derived from a substance known as calcium hypochlorite, $Ca(OCl)Cl$, of which the bleaching powder chiefly consists.

Now if bleaching powder is dissolved in water and a coloured fabric is steeped in it and afterwards immersed in a bath of dilute acid, such as, for example, weak hydrochloric acid, the acid will liberate free chlorine in the fibres of the fabric. This chlorine will combine with the hydrogen of the water with which the fabric is wetted, liberating active oxygen, which, by oxidation, converts the colouring matter of the fabric into a colourless condition. In this way the bleaching is effected.

By passing chlorine gas into a weak solution of caustic potash in water, we can obtain a solution known as *Eau de Javelles*—"Javel Water," so called because this solution was first made at Javel, a suburb of Paris. This solution contains potassium hypochlorite, $KOCl$, and has powerful disinfectant and bleaching properties on account of the ease with which the potassium hypochlorite liberates chlorine when treated with acid.



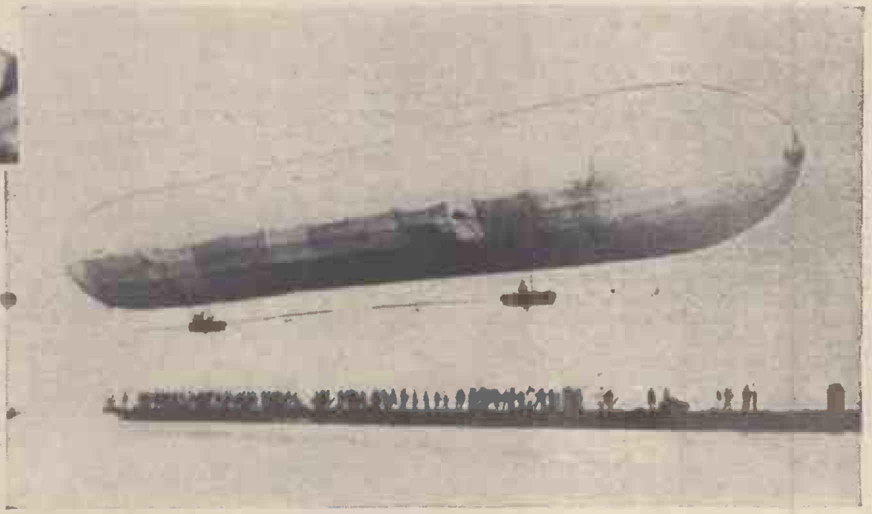
An easily made "lime-box" for the home preparation of bleaching powder (chloride of lime).

Ferdinand von Zeppelin. A late portrait, taken at the control of his airship.

MASTERS OF MECHANICS

No. 47. THE AIRSHIP PIONEER

Count Zeppelin, Master of Dirigible Flight



The first Zeppelin of 1900.

EVER since Man first entrusted himself to aerial navigation in a balloon, he was invariably wont to reflect upon the fact that it was many times a pity that his gas-filled monster could not be steered.

To ascend in a "free" balloon, that is to say, in one which was not tethered in any way to the ground, meant putting oneself, to a very large extent, at the mercy of every wind that blew, for, although the rate of ascent of a balloon could be controlled, there was, until the end of the last century, no practical means of impelling and steering the lighter-than-air contrivance through the atmosphere in a horizontal and pre-determined direction.

It was this fundamental fact which, in Victorian days, so greatly militated against ballooning in England and made it far less popular a sport than it became on the Continent. For our country, being an island, rendered it a very easy matter for a balloonist to be blown out to sea by any adverse or unexpected wind, and many were the disasters which overtook the too venturesome pioneers of lighter-than-air flight in Britain from this cause alone.

Strange Devices

Almost wistfully, some of the more imaginative balloonists sketched out on paper various devices by means of which they hoped to be able to steer their mammoth gas-bags through the air. Wings, fins, tails and other contrivances galore were fitted to balloons in an endeavour to make them steerable, but all to no effect, or, rather, perhaps, it would be better to say mostly to bad effect, for such devices usually made the balloons all the more unstable in high winds and sometimes upset the essential balance of such lighter-than-air craft altogether.

It is true, of course, that one or two pioneers such as, for instance, Henri Giffard, a Frenchman, in 1852, produced a sausage-shaped balloon which was propelled by an air screw actuated by a steam engine, but, generally speaking, the power developed by such necessarily heavy engine units was far too low to permit any speed being made against the wind.

Ballooning continued, therefore, the practice of merely a few enthusiasts, although for military observation purposes its value was becoming increasingly recognised.

The value of balloons from a severely practical standpoint first showed itself, perhaps, during the Franco-Prussian War of 1870-1 when Paris was besieged by the German forces. Many messengers were dispatched from the French capital by means of balloons, and even provisions were safely carried into the city, although this was made very difficult owing to the lack of means for controlling the direction of the balloons' flight.

Steerable Balloon Made Practicable

Curiously enough, the one individual who made the dirigible or "steerable" balloon really practicable took part (on the German side) in the Franco-Prussian war. He was Ferdinand von Zeppelin, a German army officer who had taken up soldiering as a life career, and who was more than usually interested in what we now call the "scientific" side of militarism.

Ferdinand von Zeppelin was born at Constance, in Baden, on July 8th, 1838. Being attracted by the army, he was educated for it, and in 1858 he distinguished himself by receiving, at the age of 20, an important junior commission in the German forces.

In 1863, Zeppelin went over to America on a military mission to Washington and he served as a volunteer in the American Federal army during the American Civil War of that year. It was here that he made his first balloon ascent. The balloon was a military observation one used by the Federal troops and although its use was very greatly restricted it sufficed to enable valuable information concerning the movements of the opposing forces to be obtained.

That single balloon ascent seems to have touched a hidden spring in Zeppelin's mind. From thenceforward, he became "balloon mad," as they would say nowadays.

Returning to his native land, Zeppelin attempted to interest his associates in the possibilities of balloons, particularly of navigable ones, but without much effect. Then came the Austrian war of 1866, in which the energetic Zeppelin saw fighting service.

Franco-Prussian War

Four years afterwards the Franco-Prussian War broke upon the Continent. Zeppelin, as we have already learned, played his part in this, and, without much doubt, the presence of balloons over the besieged city of Paris resurrected in his mind the dormant impressions received in America seven years previously. At any rate, after the cessation of hostilities, Zeppelin seems to have been able to give himself over more or less completely to what ultimately became the prevailing passion of his life—the designing and construction of a serviceable balloon or lighter-than-air machine which would not only ascend vertically into the air but would also be capable of being navigated and propelled therein in a horizontal direction.

In 1873, Zeppelin began to draft a plan for a navigable airship. This came to nought in actual practice, but it enabled him to draw up a Report for the German Government on the possibilities of dirigible or navigable airships, a Report which he finally presented in 1887.

The Report was either pigeonholed or turned down completely, for nothing came of it. Meanwhile, Ferdinand von Zeppelin, now a military man of standing, continued in the German army until he was retired in 1891 at the age of fifty-three years.

Zeppelin, ever an abstemious and a careful-living man, was but in his prime at this age. Immediately after his retirement he threw himself wholeheartedly and with tremendous enthusiasm into the voluntarily-selected task of devising an airship which would actually fly through the air as a ship voyages through the ocean.

The "L.Z.1."

His first activity after retirement was to draw up plans for a navigable airship, the *L.Z.1*. But these plans never passed the technical authorities of the day. In fact, the German Commission which reported on them, stated that they were practically useless!

Tables were turned somewhat, however, in 1896, when the Association of German Engineers, to which Zeppelin had revealed his airship plans, reported very much in favour of the proposition and actually aided a public subscription for the purpose of providing the necessary finance to translate the plans into actual practice.

About this time there came to Paris one Santos Dumont, a brilliant and wealthy young man of Brazilian origin. Santos Dumont had genius, enthusiasm, energy and the necessary monetary wherewithal for indulgence in the then hazardous practice of aerial flight. In quick succession, he constructed no fewer than fourteen light dirigible airships which were propelled by a petrol engine actuating an airscrew, and, on 19th October, 1901, he steered one of his cigar-shaped airships around the Eiffel Tower at a speed of nineteen miles an hour, raising, thereby, great enthusiasm among the Parisians and demonstrating to the world the inherent possibilities of the "steerable balloon," as it was then called.

General Zeppelin—for he had retired from the German army with that exalted rank—was working away busily when he heard of Santos Dumont's successful exploit. Backed by the interest of the German War Office and, also, by the enthusiasm of his own countrymen, Zeppelin, having floated a company, was constructing large hangars in which to house his airship-to-be.

A Spectacular Flight

Santos Dumont's airship soon proved to be unsatisfactory for general use, for it quickly became evident that his cigar-shaped gas-bag had a great tendency to buckle and even to collapse in the middle when driven against the wind. This fact, indeed, had been noticed, even before Dumont had accomplished his spectacular Eiffel Tower flight.

It was necessary to give a dirigible airship a sausage or cigar-shaped gas-bag or "envelope," since this formation had been found to be necessary to impart stability and speed to the machine. General Zeppelin, however, proposed to overcome the characteristic and highly dangerous buckling tendency inherent in a cigar-shaped gas envelope by building up his envelope within a rigid frame of aluminium lattice-work. This framework contained seventeen separate compartments or divisions and each compartment held a large number of drum-shaped linen gas-bags; the whole envelope construction being capable of accommodating 400,000 cubic feet of hydrogen gas. An air space was allowed between the gas-bags and the outer fabric which covered the aluminium girderwork. so that any sudden alterations of atmospheric temperatures and pressure, with consequent expansion or contraction of the hydrogen gas within the airship's envelope, could be dealt with.

Two cars were rigidly attached below the envelope, in each of which was fixed a 16 h.p. petrol motor actuating a couple of four-bladed propellers which were equipped with reversible gearing so that the airship could be driven forwards or backwards.

The rudder of the airship was attached to the stern of the giant envelope.

The First Zeppelin

In the June of 1900, this dirigible airship, the first of a long line of "Zeppelins," made its first test flight. It proved to be reasonably successful, and, over a short distance, it attained a speed of 18 m.p.h. Unfortunately, the air vessel was disabled on landing.

Zeppelin number two did not materialise until six years later, but in 1906, Count von Zeppelin, for he had now been given that honorary title, made history by making a successful flight of some 60 miles. The airship flew around the shores of Lake Constance, negotiating turns and undertaking other manuœvres with apparent ease.

This exploit upon the part of Count von Zeppelin attracted enormous attention. A National Zeppelin Fund was initiated in Germany and in 1908 another airship came into being: This travelled 250 miles in eleven hours, but, ultimately, it was wrecked in a storm. Nevertheless, its success turned the attention of the nations upon its builder and from henceforth Ferdinand von Zeppelin found himself to be the leading designer—and, indeed, the only really successful one—of lighter-than-air craft in the world.

End of his Resources

But at this juncture, Zeppelin, despite his growing fame, found that his private resources had come severely to an end. The ever watchful German Government, however, came magnanimously to his aid. Eventually, indeed, it made itself responsible for the financing of all his projects, so that Zeppelin ultimately obtained that veritable seventh heaven of the traditional inventor—a condition of affairs in which money was no object in the success of his schemes.

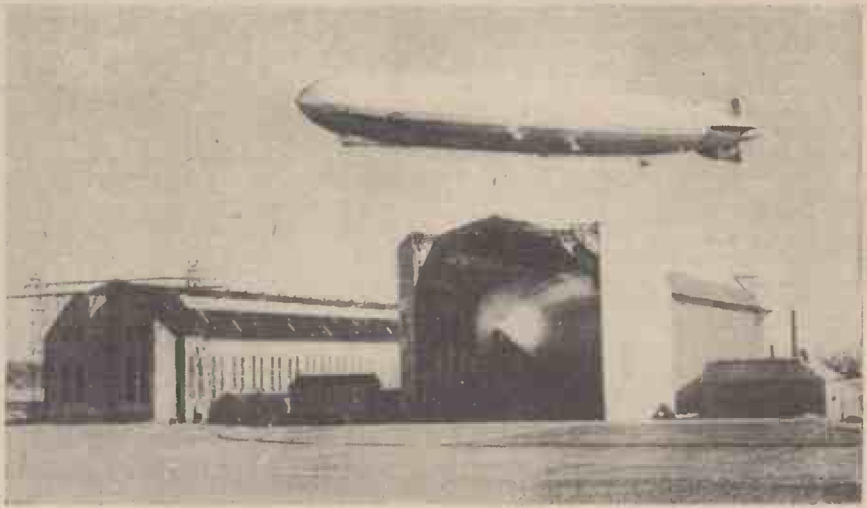
And so the development of the "Zeppelin," as the giant German airships now became almost universally called, proceeded apace. In 1909, Count von Zeppelin established the now celebrated airship works at Friedrichshafen, in which were built for the German Government a fleet of giant Zeppelins of unprecedented size.

Then came the Great War of 1914-18, and with it, the Zeppelin assumed a sinister status in the eyes of the British public. For it was these monsters of the air which carried out several destructive bombing raids over England and particularly upon London.

For a time, the Zeppelin airship seemed to have entirely justified itself as an effective aerial weapon of German military strategy. But its success proved to be a very limited one, however, for the great bulk of the Zeppelin made it an easy target for anti-aircraft guns, whilst the quickly-flying aeroplanes which were then rapidly coming to the fore and which proved themselves to be capable of manœuvring with almost the celerity of a lightning flash, flew around the more cumbersome "Zepps" and poured incendiary bullets into their envelopes, releasing from therein the highly inflammable hydrogen gas and igniting it, with the inevitable total destruction of the airship.

As military scouting machines, too, the Zeppelins were not a marked success. In those days, their maximum speed was only about 70 m.p.h., so that, in many instances, it was not easy for them to escape from the enemy's attentions.

To the German officials and, in particular, to their renowned designer, Count von Zeppelin, the monster airships which bombed London during the tragic years of the Great War proved a disappointment, and Zeppelin himself, died, it is said, a somewhat worn-out man, at Charlottenburg, on March 8th, 1917, almost, indeed, in the middle of the hostilities between the Nations.



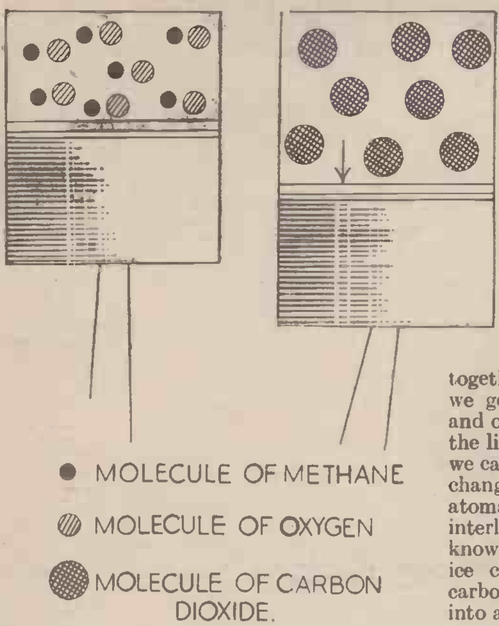
The last two Zeppelins to be built. The "Graf Zeppelin" flying over the hangar containing the "Hindenburg." Both of these airships, however, met with serious accidents.

Despite the enormous popularity and development of the aeroplane, or heavier-than-air machine, the dirigible airship still has its many uses. For long-distance travel, for the transportation of heavy freight or a large number of passengers, the Zeppelin type of airship is still unsurpassed and there is little doubt that more will be heard of it in the future.

The majority of airships which have been built since the War have been of the original Zeppelin type, since, structurally, this constitutes by far the soundest design.

It is, without a doubt, unfortunate that the acknowledged genius of Ferdinand von Zeppelin should have been turned to devices of aerial warfare rather than to the convenience and advancement of nations in times of peace. But Mankind, unhappily enough, seems to be incurably stricken with the strange knack of converting the fruits of genius to evil ends. Let us hope, however, that ere long, this deplorable trait will subdue itself. Then and only then will the name of Ferdinand von Zeppelin arise and rightly constitute itself that of one of the world's great benefactors.

How Gases Have Helped the Engineer



If we combine the solid dots with the hatched spots we can fill a greater area by turning the solid dots into lines and combining them with the hatched spots to give larger spots with cross hatching. There is more white space with the cross hatching. So is it with the molecules.

AT first thought there is little connection between gases and engineering. When one pauses to think about it, however, one marvels that engineers were able to do without the useful properties of a gas so long. And by a gas is not meant, of course, town gas, or that which one burns in the kitchen oven, for there are many dozens of varieties, from the very harmless nitrogen that occupies one-fifth the volume of the air we breathe, to those of which a mere whiff is sufficient to stop us breathing for ever. In between these two extremes lie a range which man has put to many useful purposes. The aeroplane or motor car would not have been possible, but for this elusive substance; all our bread would be brown, and there would be no white, were it not for certain gases. In fact, not only has the engineer found them absolutely essential to progress, but they play a part in everybody's life and have been responsible for much of the progress of civilisation.

What Exactly is a Gas?

The fact that many of them are invisible, such as oxygen, nitrogen and hydrogen, is apt to make the average engineer overlook their essential importance and properties. Gas is only another or third stage of matter, the other two being solid and liquid. Now in a solid, as for instance steel, the atoms are all packed closely together, so that they are difficult to separate. So closely are they interlocked that the material has the property of solidity. In a liquid the atoms are not tightly locked together but partly free to move about; so that like a vessel full of tiny ball bearings, they can slip and slide about. When the atoms are yet farther apart they exhibit no attraction for one another and tend to wander away, and so are gaseous; that is to say, the atoms are in the form of a gas. It is this third state of matter with which we are now concerned, and curiously enough, although it is that where we can, so to speak, see between the atoms, these being invisible, it is the most interesting state, both from the scientific point of view and that of the engineer.

One must not think of solids, liquids and gases as being three entirely separate states. One state can merge into another, and if we compress a gas, so that the atoms are forced together they then attract one another and we get a liquid. Oxygen, carbon dioxide and other common gases are often stored in the liquid state, after being compressed. If we carry the compression yet further we can change a liquid to the solid condition, the atoms being forced together so that they interlock, at least temporarily. The well-known "dry ice" used to-day to keep ice cream frozen, is nothing more than carbon dioxide which has been solidified into a material looking exactly like snow.

Expanding and Contracting

The value of a gas lies in the facility which it expands and can be made to contract. Here is the kernel of the subject. When one compresses a gas it rises with temperature; when it expands it cools. Then, again, if you mix two gases and cause them to combine, it may happen that the resulting volume is greater. The reason for this lies in the fact that the molecules in one of the gases may be relatively small in volume. When, therefore, it combines with a different gas the molecules of the ultimate gas may have a relatively large volume. Hence we get expansion. This is the principle that has made the internal combustion engine possible, enabled us to fire-guns and accomplish many other useful feats. Generally speaking, gases can be graded into types; combustible, incombustible, chemically active and those which simply do nothing, like nitrogen. It is perhaps the combustible gases, such as methane, hydrogen, ethylene, all of which are found in coal gas and two in petrol vapour, which have proved most useful to mankind.

If we mix methane and oxygen together and ignite them by means of a spark, the molecules of each combine together very suddenly and we get what may be termed an explosion. The methane molecule is made up of a carbon atom joined to four hydrogen atoms, but the whole occupy little volume. When this molecule combines suddenly with oxygen, there is formed carbon dioxide and water. Carbon dioxide is a gas that occupies a relatively large volume, and so one gets a violent expansion, or as already mentioned, an explosion. The sketch shows this process diagramatically and to illustrate how the expansion is made use of by the engineer, the "explosion" takes place in a cylinder closed at one end by a piston. The expansion drives down the piston which can then be used to actuate any mechanism, as for example, a crankshaft. So the internal combustion engine is born.

Compression

Now turn to the opposite case, compression. It has already been mentioned that when a gas is compressed it becomes warm. If this heat is dispersed by suitable means it will be possible to press the gas molecules or atoms together until they become liquid and finally solid. By storing the liquid in high-pressure cylinders we can draw it off as and when required in the form of a gas. But the latter escapes through the valve in a stream which behaves almost like a jet of water. Highly compressed air can be very dangerous, and has been known to bore a hole through a man like a bullet, if released in a jet without restraint.

Compressed gas is a handy way of storing energy, and the force released when it is allowed to escape can be utilised to drive pneumatic tools. The familiar drills used for road repairing are operated by compressed air. Huge weights are lifted by means of plungers that are driven up by compressed air. One can quote a number of uses for compressed gases, but the least known is that whereby the refrigeration engineer gets his low temperature. First of all he compresses a suitable gas, such as sulphur dioxide or carbon dioxide, then allows it to escape through a narrow jet into a chamber surrounded by the substance it is desired to cool. When a gas expands, its temperature falls, and if allowed to expand quickly this may soon fall below the freezing point of water.

> Not only have Engineers found Gases absolutely essential to Progress, but they have been responsible for much of the Progress of Civilisation.

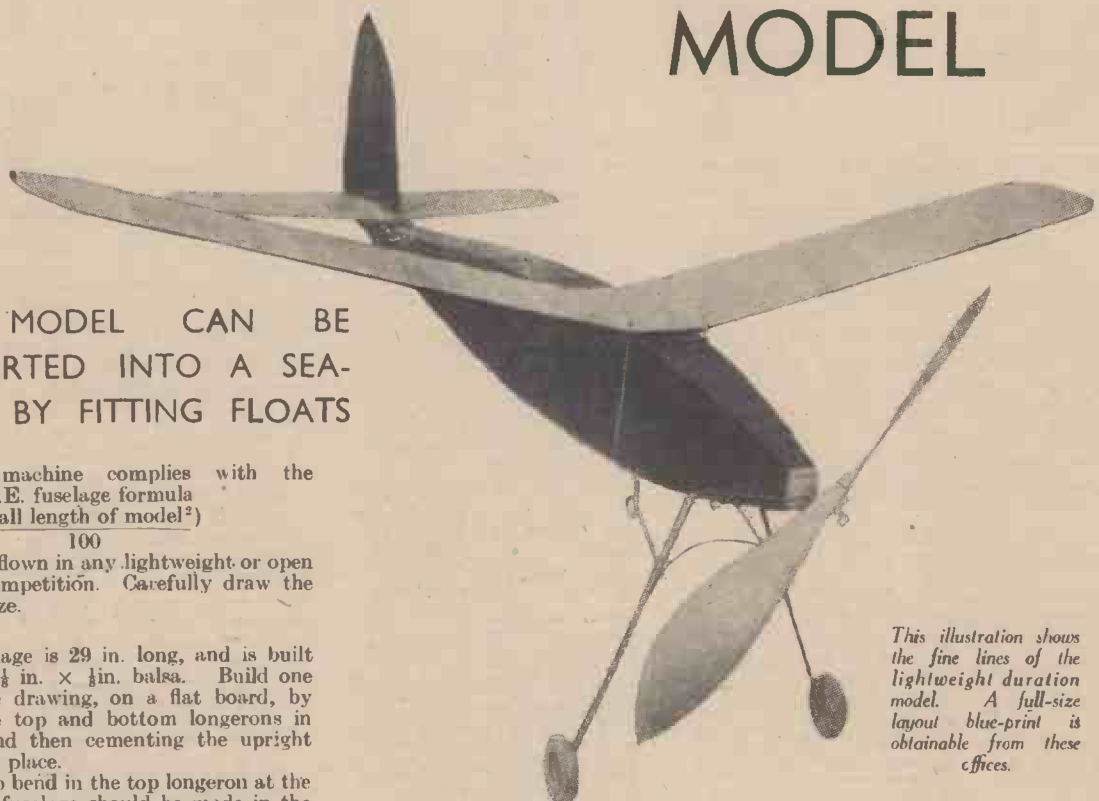
"Dry Ice"

An experiment sometimes carried out to demonstrate this phenomenon is to open the valve of a cylinder of carbon dioxide over which has been placed some loose sackcloth. The valve is gradually opened, until the gas escapes with a roar. After a very short while, there accumulates in the folds of the sack masses of snow-like substance, that is so cold to the touch that it gives the sensation of burning. This is "dry ice" or solid carbon dioxide, and at first consideration the experiment may seem to contradict the statement that when one compresses a gas it solidifies, for here one is confronted with a gas expanding and at the same time solidifying. What happens is that the rapid expansion causes an equally rapid drop in temperature of the gas in the vicinity of the cylinder valve and so the gas freezes. How great is the fall may be judged from the fact that solid carbon dioxide or "dry ice" is formed at 49°c. below freezing. Hence the superiority of this kind of "ice."

An important use of gas mixtures by the mechanical engineer which has not been referred to as yet is that of oxy-acetylene

(*Continued on page* 586)

A LIGHTWEIGHT DURATION MODEL



This illustration shows the fine lines of the lightweight duration model. A full-size layout blue-print is obtainable from these offices.

THIS MODEL CAN BE CONVERTED INTO A SEA-PLANE BY FITTING FLOATS

THIS machine complies with the S.M.A.E. fuselage formula

$$\frac{(\text{overall length of model}^2)}{100}$$

and can be flown in any lightweight or open duration competition. Carefully draw the plans full size.

Fuselage

The fuselage is 29 in. long, and is built entirely of ⅛ in. × ⅛in. balsa. Build one side on the drawing, on a flat board, by pinning the top and bottom longerons in position, and then cementing the upright members in place.

The sharp bend in the top longeron at the rear of the fuselage should be made in the steam jet of a kettle Cement the diagonals between uprights Nos. 2 and 3, and 4 and 6, and fit a piece of hard 1/16 in. sheet balsa between uprights Nos. 1 and 2.

Two pieces of hard 1/16 in. sheet balsa, with the grain of the top piece at right angles to that of the bottom piece, are fitted between uprights Nos. 10 and 11, and a ⅛in. diameter hole is pierced through them to take the bamboo peg for holding the rear of the rubber motor. Build a second side in exactly the same manner, making sure that both sides are identical.

The cross-member can then be fitted top and bottom. Make sure that the fuselage is true.

The nose, between the cross members Nos. 1 and 2, is strengthened with 1/16 in. hard sheet balsa. A paper tube, with about ⅛ in. diameter hole, is cemented at the tail and the wire tail-skid is fitted. Make sure there are no rough edges on the fuselage which may harm the rubber motor.

The two 18 s.w.g. brass tubes for the undercarriage are then fitted, and small pieces of 1/16 in. sheet balsa are fitted as shown on the drawing. Cover with tissue, dope, and apply two coats of banana oil.

Undercarriage and Wings

The undercarriage legs are of streamlined bamboo with 18 s.w.g. fittings bound and cemented to them. The wheels are of two laminations of 1/16 in. hard balsa, streamlined and bushed with 18 s.w.g. tubing. The cross piece is of 20 s.w.g., bent to give the required width of track.

The span of the wings is 40 in., with a constant 5 in. chord, giving an area of 194 sq. in. The section used is R.A.F./32. The leading edge is ⅛ in. by ⅛ in. sq. balsa set diamond fashion; the mainspar is ⅛ in. × ⅜ in. balsa; and the trailing edge is ⅛ in. × ⅜ in. balsa, shaped to the aerofoil section.

Cut the ribs from 1/32 in. sheet balsa (except where 1/16 in. is shown on the drawing) and space them 1.6 in. apart. Build the wing in two parts, and add the centre section afterwards. Reinforce the mainspar with thin plywood on each side, giving the wing 3½ in. dihedral and 1½ in. sweepback.

Add the tops, which are bent from 1/16 in. by 1/16 in. birch, the corner gussets at A and B, and the four birch pegs for the rubber bands used for wing fixing. Note that the tip rib on each wing is of streamlined section. Cover with tissue, dope, and apply two coats of banana oil.

A piece of ¼ in. sq. balsa is cemented about 1 in. from the leading edge to give the required incidence.

Tailplane

The tailplane has a span of 16 in. and tapers from 4 in to 3 in. giving an area of 53 sq. in.

The ribs are cut from 1/32 in. sheet balsa and spaced 2 in. apart. The leading edge is ⅛ in. × ⅛ in. balsa, the mainspar is ¼ in. × 16 in. and the trailing edge is ¼ in. × 1/16 in. shaped to the aerofoil section.

Bend two tips from 1/16 in. × 1/16 in. birch. and two small 22 s.w.g. hooks for the rubber bands. Cement these in position and cover with tissue, dope, and when dry apply one coat of banana oil.

The Rudder

The rudder is 7 in. high, ¾ in. wide at the tip, and 5 in. at the base. Shape the base to fit on the tailplane. The base is of ⅛ in. sheet balsa, and to this cement the leading edge ⅛ in. × ⅛ in. balsa, and the front spar ⅛ in. × ⅛ in. balsa, and a bamboo dowel, about 1½ in. long × ⅛ in. diameter, which fits into the paper tube at the rear of the fuselage. The ribs, which are streamlined in section and cut from 1/32 in. sheet balsa. are then cemented in position.

Add the rear spar, ⅛ in. × 3/32 in. balsa, and the trailing edge ¼ in. × 1/16 in. balsa. Bend the tip from 1/16 in. × 1/16 in. birch, and two small hooks for the rubber bands from 22 s.w.g. and cement these in position. Cover with tissue dope, and apply one coat of banana oil.

The Propeller

Lay out the block as shown in the drawing and test for balance. Carve the propeller carefully and make sure that it is perfectly balanced. Cover with tissue, apply one coat of thick banana oil, and test for balance again. Cement an 18 s.w.g. bush in position.

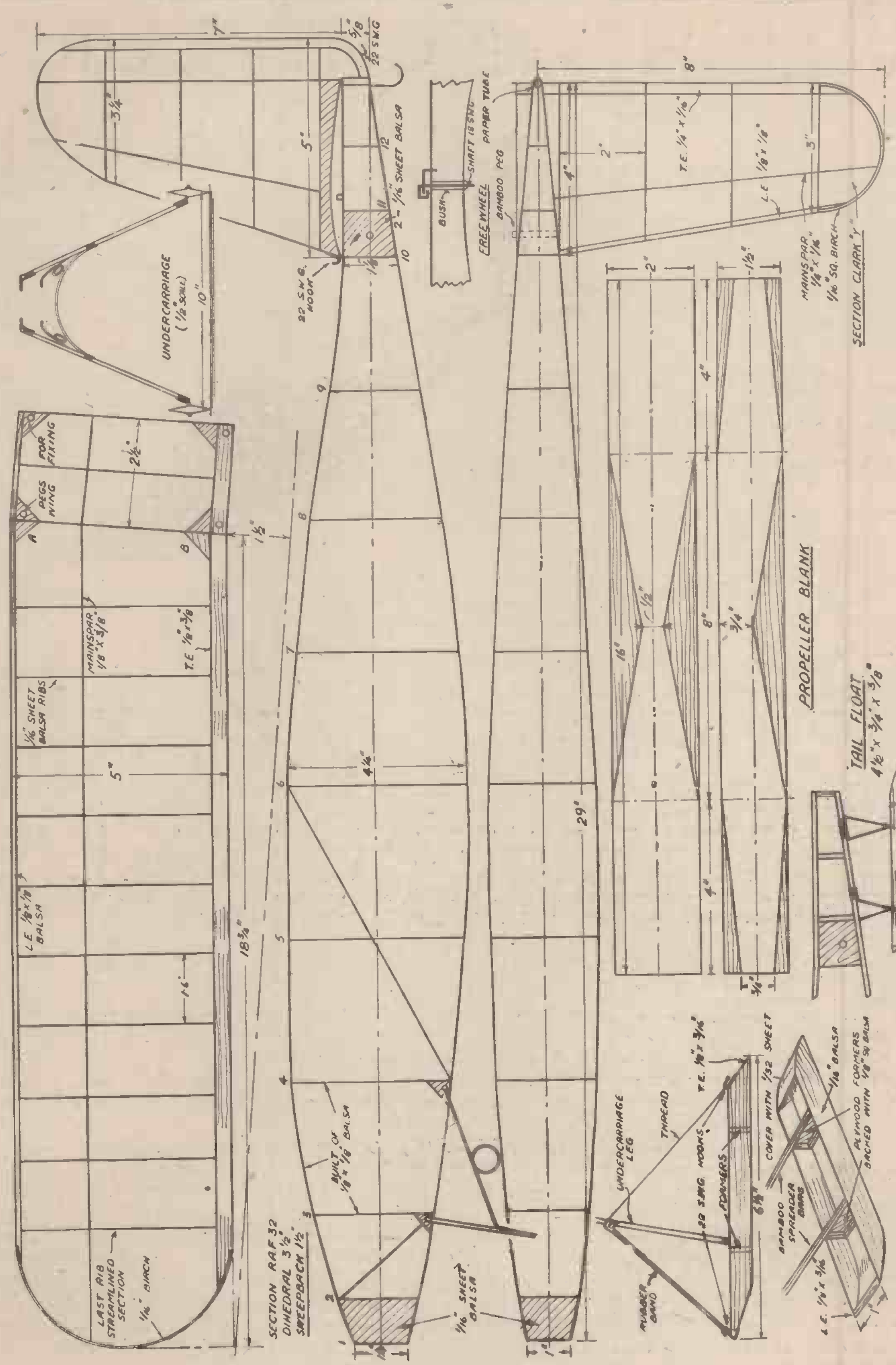
The noseblock is made from a block of balsa about 1 in. × 1¼ in. × ¾ in.; bush with an 18 s.w.g. bush. Fit a lightweight ball-race between the propeller and noseblock. The freewheel is self explanatory. The wing is fixed by a rubber band passing around the fuselage from peg to peg, at the leading and trailing edges.

The tailplane is held in a similar manner, by a band passing round the fuselage from hook to hook.

The rudder is held in position by fitting the bamboo dowel into the paper tube at the rear of the fuselage; and a rubber band round the fuselage fitted to the front hook holds the front firm. A rubber band is then passed from the rear hook around the tail-skid.

Adjustments to trim are made by moving the wing slightly, and the rudder is also movable.

The model flies best climbing in wide circles against the torque and is very stable. It has been flown without damage in a wind which crashed or grounded nearly all the other machines. The best power for the machine is 1½ ozs. of 3/16 in. flat rubber, made into 12 strands, about 44 in. long and



SCALE DIAGRAM OF THE LIGHTWEIGHT DURATION MODEL.

THIS MUST BE PLOTTED FULL SIZE; OR YOU CAN PURCHASE A BLUEPRINT FOR 2s.

" White " rubber rope tensioned. The weight of the machine with rubber, complete is 5 ozs.

Weight	1¼ ozs.
Fuselage	1 oz.
Tail Unit Comp. ...	⅜ oz.
Rubber	1½ ozs.
Undercarriage	⅜ oz.
Prop. with noseblock ...	¾ oz.
	5 ozs.

Lightweight Seaplane

This plane can also be used as a seaplane by fitting floats. Make two floats as shown in the drawing, cover with tissue, and apply a coat of banana oil.

Each float is built on a plywood former, backed with ⅛ in. sq. balsa. The rear former is built in the same manner, and the bamboo spreader bars are bound and cemented to these formers. The sides are of 1/16 in. sheet balsa and the top and bottom are of 1/32 in. sheet.

The brass tube (18 s.w.g.) is bound and cemented in position, and two small 22 s.w.g. hooks are bound and cemented to the front and rear spar (⅛ in. × 3/16 in. balsa) to take the rubber band in the front and the thread at the rear. Make sure that this rubber band is tight and that there is no " give " when the 'plane is taking off. The rear float is made in the same manner, but is fixed firmly to the fuselage as shown.

The latest type of autogiro, the C40, can land and take off from very restricted spaces indeed and descend very nearly vertically. The illustration shows the "differential tail" and streamlined fairing on the rudder of the plane.

THE MONTH IN SCIENCE AND

An All-electric Church

HOLY TRINITY CHURCH, Walton, Aylesbury, will shortly have the distinction of being the only all-electric church in the country. Eight electrically-operated tubular bells are to be installed in the belfry to replace the present three bells, and they will have a range of five miles. With these bells it will be possible to play hymn tunes and other melodies. They can be controlled by a switch in the vicar's study at the vicarage which is 50 yards away. By means of an electrically-operated gramophone in the church the vicar can press a button and select appropriate music for the service. The church will also have an electric clock.

Preventing Decay

TO avoid mortar crumbling, the Greeks and Romans used to mix a volcanic dust with it where it was exposed to chemical attack, soil containing sulphides, or to sea water.

The Building Research Board have, after numerous experiments, obtained a similar dust by burning certain clays at a controlled temperature, which is now being produced commercially. The Board have also discovered a new fine spray process for cleaning buildings. With it, carvings of intricate design can be completely cleaned without causing the slightest damage.

Experimental Trolleybus

AN experimental vehicle has been designed by a London Transport engineer to overcome the problem of running buses through the tunnel at Kingsway, London, W.C.1. The chief problem is that of the island platforms at Aldwych and Holborn, which are on the offside of the vehicle; that is, the side opposite to that used in the street. It was found necessary to provide a special entrance in the offside for use only at these two stations. This entrance has folding doors of the jack-knife type which are opened and shut by compressed air, and only the driver and conductor are able to open them.

Radio-controlled Car

A RADIO-CONTROLLED motor car is one of the latest productions of Mr. H. J. R. Rieder, the Sea Point radio experimenter and his partner, Mr. J. Boyle, a mechanical engineer, at Cape Town, S. Africa.

A radio-controlled warship and hydroplane have already been demonstrated by these two ingenious experimenters. All experiments are with large-scale models, fulfilling all the functions of the real thing, and no crew or operator is required on board.

The experimental trolleybus which has been designed with a special entrance in the offside of the vehicle as well as the normal entrance. The special door is of the jack-knife type and is opened and shut by means of compressed air.

Cows with False Teeth

AMUSING though it may seem, three cows fitted with false teeth will be on exhibition at the All-Union Agricultural Exhibition to be held at Moscow in August. The dentist who has made the dentures for the cows last year made a complete set of false teeth for an old bull.

His experiments are now declared to be "of national interest."

A New Flying Boat

THE Golden Hind, first of three 31½-ton flying boats ordered from Short Bros. for Imperial Airways was recently launched at Rochester, Kent.

With an all-up weight of 70,560 lb., Golden Hind and its sister ships are 30,000 lb. heavier than the standard Empire flying boats, but nearly 12,000 lb. lighter than the Pan American Clipper which has opened the North Atlantic air service.

Britain has a chance with these large flying boats to take part in the development of the London-New York service over the northern route via Foynes, Newfoundland and Montreal.

Raising Submarines

M. DUSHAN KUSMANOVITCH, of Jugoslavia, states that he has perfected a device for raising sunken sub marines, even if they are at a great depth.

The inventor has carried out a number of experiments with the device in the Adriatic, where he has succeeded in raising heavy objects.

An Electric Lawnmower

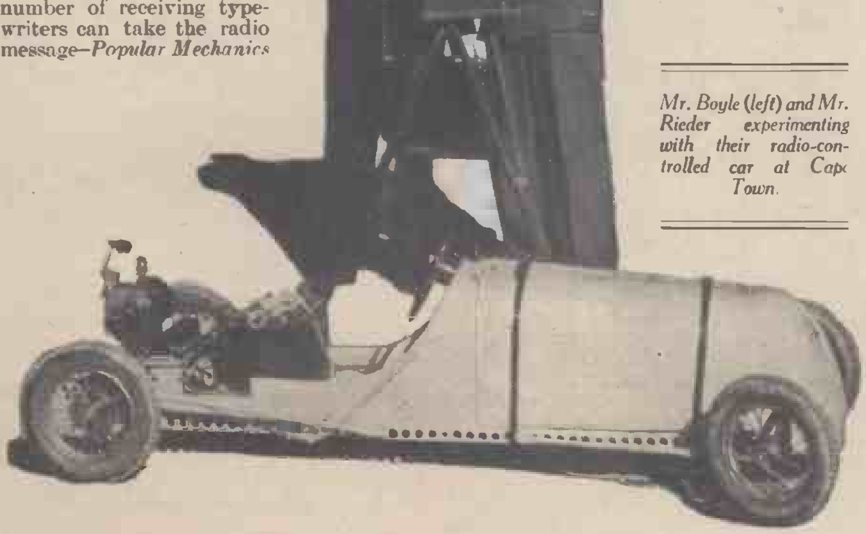
A LAWNMOWER driven by an electric motor, which is capable of cutting grass noiselessly and easily has recently been produced. It does not require pushing but is simply guided over the lawn by the operator. The cutting unit is of novel design and has a clearance of 1/3,000th in. The switch for the motor is conveniently placed on the steering handle, and if the blades become clogged with grass cuttings an automatic shut-off device comes into operation and stops the motor. A long length of flex is supplied with the lawnmower.

A Radio Typewriter

AS fast as a stenographer in New York can punch the keys of an electric typewriter, a letter can be transmitted by radio to a receiving typewriter as far away as Budapest. The radio typewriter, invented by a Budapest resident, is both transmitter and receiver, operating on about 150 watts. Each set has its own call-number combination and the connection is made by a dial like that of the automatic telephone. A small light bulb on the sender's instrument board indicates when the receiver is ready to take a letter.

THE WORLD OF INVENTION

The typewriter and radio equipment are portable, and messages could be exchanged easily between two sets in cars far apart. All signals are on the same wavelength, but interference is prevented by an "absorber" which not only cuts out other stations from receiving the message but eliminates fading due to atmospheric disturbances. If desired, however, any number of receiving typewriters can take the radio message—*Popular Mechanics*



Mr. Boyle (left) and Mr. Rieder experimenting with their radio-controlled car at Cape Town.

A Scientific Outpost

THE famous Mt. Fuji of Japan is not only an object of pilgrimages; it is also an outpost of science. On its summit stands a meteorological observatory. Twelve thousand four hundred feet above sea level and draped in perpetual snow, it is manned by four young meteorologists and a radio operator. It boasts the highest elevation of all the stations of the world devoted to this branch of science.

Every hour, from five in the morning till ten at night, the "weathermen" make observations of the sky, chart their findings, make their reports. These are immediately transmitted by radio to the central observatory in Tokyo. And it is these reports, predicting fair weather or giving warning of approaching storms in the surrounding area, that make civil aviation safe in Japan.

The temperature here ranges from 20 to 30 degrees below zero Centigrade, the wind velocity all the way from 20 to 80 meters a second depending upon the atmospheric pressure from the continent of Asia. Food and other necessaries have to be lugged up the steep and slippery slopes by human pack. But the place is well equipped. Most of the stuff needed to carry on the work throughout the year is carried up during the summer. Once a month a shift in personnel is made.

At this scientific outpost on top of the world, weather reports are transmitted by radio to the Central Meteorological Observatory in Tokyo. There information is checked with reports from Japan's more than 200 other stations, and passed on to aviation circles as well as broadcast at regular intervals.

Electron Stream Harnessed

RESEARCH engineers of the Westinghouse Electric & Manufacturing Company have made electrons obliging actors for the visitors to the New York World's Fair. To show what goes on inside a three-electrode valve, and the effect of a magnetic field on a stream of electrons flowing through a vacuum, the engineers have built a triode twenty-seven inches high and seven inches in diameter. It is similar to a standard radio valve, except that it has two filaments and two grids on opposite sides of the plate so that the action is visible from both directions.

The surface of the plate is coated with fluorescent material, so that wherever electrons impinge on the plate, a green colour shows. By changing the negative biasing voltage supplied to the grid, the stream of electrons to the plate can be varied from zero to the maximum of which the valve is capable. A pattern on the face of the plate shows the area normally bombarded by electrons.

By placing a permanent magnet near the valve the electron stream can be deflected by the magnetic field. The effect of the field on the electron stream can be seen plainly. This effect varies according to the way the magnet is applied to the valve. The circuit used is similar to that in audio-amplifiers. A 60-cycle frequency is applied to the grid, and the valve out-put is connected to a loud-speaker. The loudness of the audio signal corresponds to the area of the green glow on the plate of the valve.

Re-Conditioning Small Motors

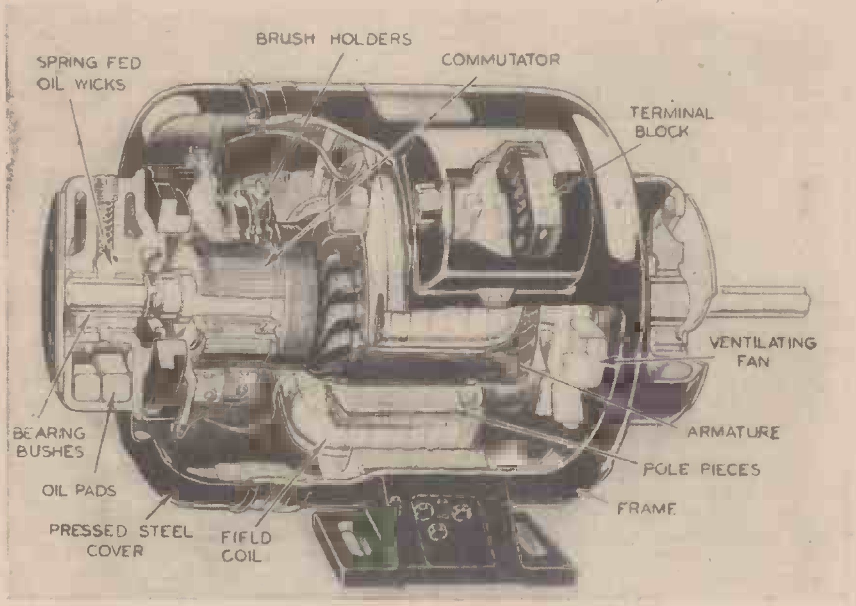


Fig. 1.—A D.C. commutator type motor.

By A. H. AVERY
A.M.I.E.E.

Providing You Have the Correct Testing Equipment As Detailed in this Article, it is Quite a Simple Matter to Service Small Electric Motor

FIRST aid to a broken down fractional horsepower motor consists in diagnosing its ailments. Hunting about in a haphazard manner in search of trouble leads nowhere, therefore it is essential to obtain a definite idea of the cause of breakdown, before attempting to apply any cure. Faults are not always visible to the eye, and certain simple electrical tests will in most cases be indispensable, so that those attempting home repairs will find it advisable to provide themselves with the following items of equipment, if not already to hand :

1. A megger, for testing insulation resistance.
2. A voltmeter with a range of about 25 to 250 volts.
3. An ammeter, range between 0 and 3 amperes.
4. A milli-voltmeter, reading to 150 milli-volts.
5. A variable "slider-type" resistance of 250 volts 1 ampere carrying capacity.

If a watt-meter of 250 volts 5 amperes range is also available, it will be found also helpful in certain tests on A.C. motors.

Principal Troubles

When a small motor stops work, it is because of one of three causes : 1, failure of electric supply; 2, mechanical trouble; 3, electrical faults. As regards item 1, do not at once jump to the conclusion the motor is itself at fault, as it may be due to nothing more serious than a blown fuse, or a temporary interruption to the supply from the outside.

Having cleared up point 1, deal next with item 2, that is, troubles of a mechanical nature. These are generally fairly easy to locate, since they mostly occur in some visible form, such as seized up bearings, armatures rubbing against the frame internally, or bent shafts due to the belt being too tight. Such matters lie within the experience of all mechanically-minded persons and call for no special tests such as electrical failures might involve.

A good many readers will be sufficiently acquainted with the internal construction of small motors to recognise the principal parts from a description alone, but to aid those who have less experience, two views are here given, one showing a partly dissected direct-current motor (Fig. 1), and the other an induction motor of the squirrel-cage type, such as used for alternating current work (Fig. 2). Divergences in minor details will naturally be found in small motors of different makes, but the accompanying diagrams will make the individual parts generally recognisable. Machines with a commutator and brushes are used both for D.C. and for A.C. circuits; those which have a squirrel-cage rotor are employed on A.C. only.

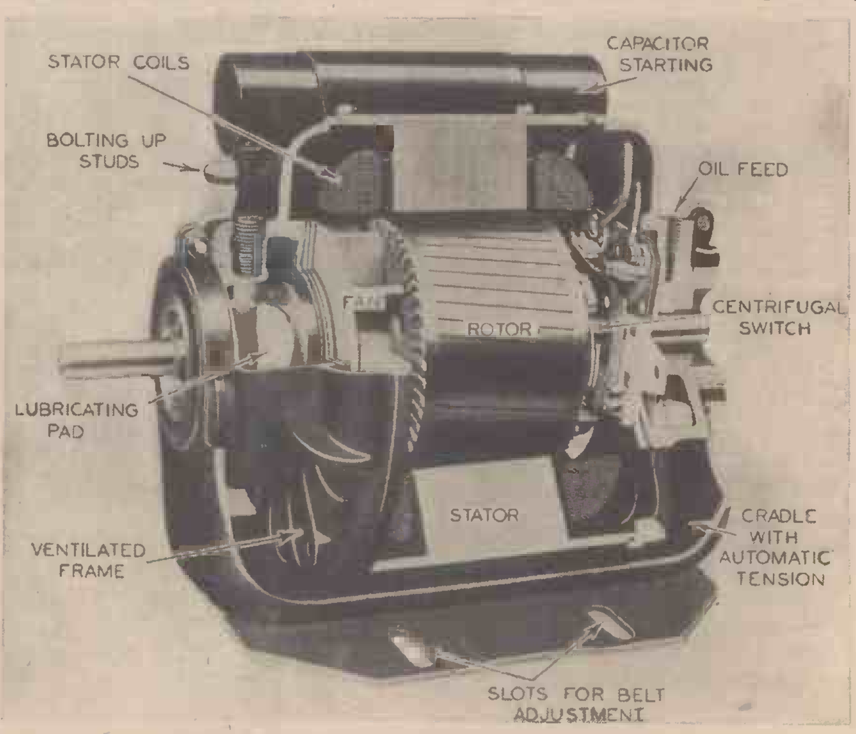


Fig. 2.—An induction type "capacitator-start" A.C. motor

Examining the Motor

With the present trend of motor design, where everything is more or less enclosed inside the frame for protection, it will be necessary to expose the interior by first removing one of the end frames when making an examination. In carrying out the following instructions for opening up the motor, it will assist if Figs. 1 and 2 are carefully studied.

1. If the motor has a commutator and brushes, withdraw the brushes first, by taking off the brush caps, if any, and marking the brush "R" or "L" according to whether it belongs to the right- or the left-hand side, when facing the motor from the

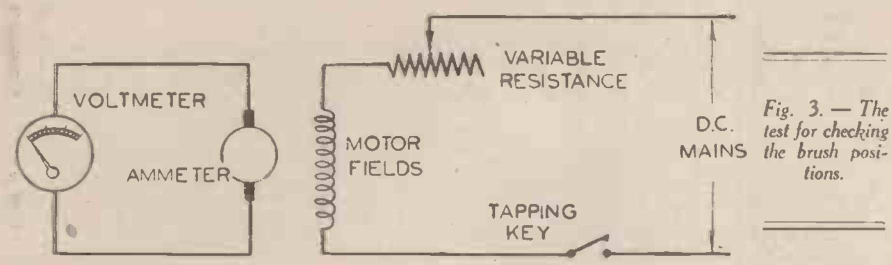


Fig. 3. — The test for checking the brush positions.

commutator end. It is important that the brushes should be re-assembled in exactly the same positions when they are replaced.

2. Remove any screws holding the cover at the pulley end, and draw the armature or rotor out of the frame along with it. If the machine is fitted with ball bearings there may be a nut on the front end of the shaft holding the inner ball race. The majority of bearings are of the sleeve type, however, with nothing to restrain the shaft from drawing out quite easily.

The general condition of the armature or rotor, and of the bearings and journals on the shaft can now be conveniently examined. The mechanical faults to look for are, principally, too much side play in the bearing sleeves, possibly allowing the armature when at work actually to rub against the side of the field stampings in the direction of the belt pull, in which case it will have made a bright ring round the armature stampings or on the field poles indicating where rubbing took place. Owing to the very small airgaps customary between rotor and stator stampings in A.C. induction motors, compared with those in D.C. motors, there is more likelihood of this occurring in the induction type machines. The normal airgap in these seldom exceeds 0.015 in. all round, while the airgaps in D.C. motors are practically twice this figure. Next, look to the lubricating arrangements. Lubrication of the "pad" type is most popular, Figs. 1 and 2 being an example. In these the space round the bearings is packed with oil-soaked wool or yarn, which may require replenishing after twelve months use. Some small motors make a feature of "Oilite" bearing bushes, the sleeves being composed of spongy phosphor bronze which takes up a considerable quantity of oil and so provides an automatic supply to the journals. In all cases whatever oil grooves there may be, as well as feed and drainage holes, must be cleared of any obstructions so that oil may circulate without restraint.

Should the armature or rotor show any signs of rubbing against the tunnel, although there is no appreciable slack in the bearings, there is likely to be incorrect alignment of the end frames or dirt under their seatings.

Commutator Troubles

The foregoing remarks apply generally to D.C. and A.C. motors in equal measure. When, however, the motor is of the commutator type, no matter whether for D.C. or as a "Universal" D.C./A.C. motor, the first of all places in which to look for trouble is the commutator, and the condition of its surface and that of the brushes. A commutator in good condition should exhibit a smooth bronzed surface under the brush track without any burnt edges to the copper segments, and above all it should be truly circular. Also, the brush faces themselves should present a well-polished appearance over the whole of their contact surface. A very careful skimming up of the commutator surface in the lathe, using the lightest possible cut and an oilstone finish to the lathe-tool will often effect a great improvement. But care must be taken that the tool really cuts and does not drag the copper across the mica separators setting up a lot of minute short-circuits. After turning, polish the surface with the finest glass-paper, not with emery, as the latter is a partial conductor should any particles become embedded in the commutator or the mica. Note that oil on the commutator surface is fatal to good results as it carbonises under heat and becomes a partial conductor. Often the mica separators between the copper segments will be found

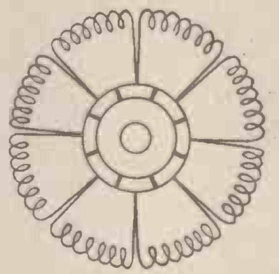


Fig. 4.—In the majority of small D.C. and Universal motors the coils consist merely of a series of separate groups of turns connected in series in a ring.

slightly undercut in order to avoid the trouble known as "high mica." Should the copper wear away faster than the mica the latter will soon prevent the brushes from making proper contact with the copper bars and disastrous sparking will result. Machines employing soft carbon, or copper-carbon mixtures for the brushes, also all

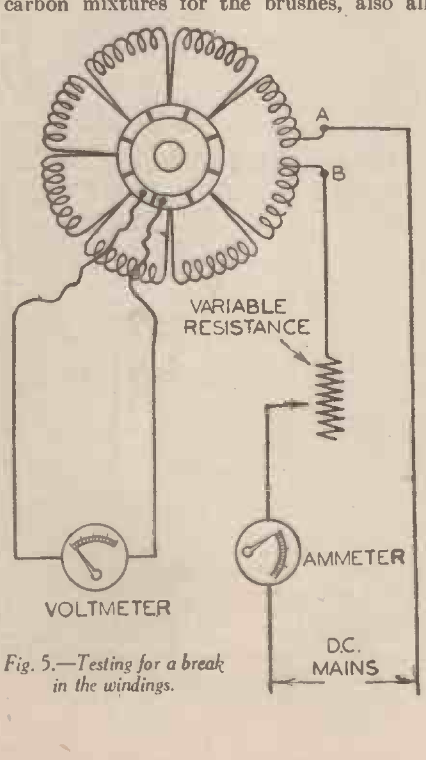


Fig. 5.—Testing for a break in the windings.

motors which are designed to run at very high speeds such as vacuum cleaner motors, and electric drills are better for the micas being recessed to a depth of 1/32 inch.

Brush Sparking

Even when the commutator seems in excellent condition commutation troubles in the shape of severe sparking at the brush tips may be present. In such cases first look for brush-holder faults, or worn-out brushes. All brushes are liable to wear out in time and as they get shorter the spring tension which keeps them pressed to the commutator face may require increasing to compensate for wear and shortening of the effective length. Test the brushes to see whether they slide quite freely in their holders or guides. The correct pressure of a brush on the commutator surface varies with the grade of carbon, but averages 2½ lbs. per square inch of contact area. With this condition maintained, the brushes should feed up to the commutator with a crisp, snappy action, yet with sufficiently light pressure not to set up heating from undue friction. Any tendency to sluggish action is bound to invite trouble. It may be found when copper flexibles or pigtails are fitted to the brushes that these have a restraining action, especially when the brush gets shorter through wear. Above all when replacing old brushes with new ones see that the original grade of carbon, as supplied by the manufacturers, is strictly adhered to. The distinguishing mark indicating the grade of carbon will nearly always be found impressed on the back end of the brush.

Brush Bedding

When new brushes have to be fitted, the square ends will need bedding down to fit the curved commutator surface. To do this cut a strip of fairly coarse glasspaper and strain it tightly round the commutator surface with the fingers, business side next to the brushes, and rock the armature to and fro by hand increasing the brush spring tension as much as possible. The face of the new brushes will soon assume a corresponding curve, after which the final running-in process must take place naturally whilst the motor is at work.

Checking Brush Position

Most small motors of modern design have a fixed position for the brushes and therefore do not require testing. Sometimes, however, makers provide a separate brush ring or rocker capable of being moved into more than one position, in such cases a set-screw or definite mark is generally to be found indicating the correct position, but if there is any doubt as to the brushes having been moved out of the original setting, they will need to be re-tested for "neutral" position. This test consists of flashing current momentarily through the field coils, while a voltmeter is connected to the brushes, the armature being otherwise disconnected and stationary. Fig. 3 indicates the method. If the brushes are pressing on the correct position of the commutator, there will be no deflection of the voltmeter needle. If the brushes are not on this neutral position a deflection will be obtained, first in one direction and then in the other, as the field circuit is first closed and then opened. The brushes should then be changed to a new position until the point where there is no voltmeter deflection, is found by experiment, and the rocker fixed there definitely.

Electrical Faults

Before looking for these first notice whether the "float" of the armature when running light is satisfactory, and that it is developing no unusual heat or noise. When the machine has ball bearings there is, of course, no lateral or end play to the shaft, but with sleeve type bearings end play varying from 1/32 in. to 1/16 in. should be present. This may disappear when the machine is at work through the armature or rotor not being magnetically centred in the bore, with the result that it is drawn hard over to one side or the other when electrically excited, giving rise to pressure on the heads of the bushes sufficient to cause overheating. The remedy, provided it is not due to the armature core being loose on the shaft, is to re-position one or both bearing sleeves so that the shaft shoulders

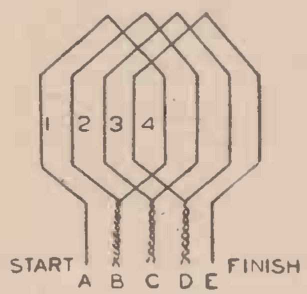


Fig. 6.—Four coils of basket wound stator. Drop tests applied between: A-B, B-C, CI-D and D-E.

are quite clear from contact with them when running.

The search for electrical faults begins with the "megger test." Attach one of the insulated leads from the megger to any metallic part of the motor frame, and the other megger lead to the motor terminals shorted together. The motor must be entirely disconnected from anything else during the test. On turning the megger handle the instrument should show a deflection on the scale indicating a reading of at least one megohm (one million ohms). If lower than this value the motor should not be put into service until corrected. A low "I.R." (insulation resistance) may be due to a damp, oily, or generally dirty condition, resulting in a partial short-circuit to the frame. Try the effect first of drying out the motor thoroughly by gentle baking in an oven at about 150 deg. F. for some hours. If then the I.R. test is still low it is probably due to oil soaked windings, generally those nearest the bearings at the bottom of the machine where oil may have collected. In such cases it is better to discard and replace entirely any oil soaked coils as they will never be reliable again. Another cause of low I.R. readings may be the collection of carbon dust which sometimes accumulates behind the commutator arising from wear of the brushes or sparking. Assuming the trouble cannot be traced to the foregoing causes the next step is to isolate the component parts of the motor and megger test them separately. For instance the armature may be withdrawn and a bare wire wrapped round the commutator which will put all the windings and commutator bars in electrical connection; the megger can then be used to test between this wire and the shaft to show up any electrical leakage. Next detach all connections from the brush-holders, carefully marking them for correct assembly later on, and test from brush boxes to the frame. Lastly isolate each field coil, or the stator windings if it is an induction motor, and try out the I.R. between coil ends and frame. One or more of these individual tests is fairly sure to reveal where the trouble lies.

Drop Testing

Faults other than those due to low insulation resistance include those due to some abnormal condition internally of the windings, which cannot be detected by the megger. There may for instance be partial or total short circuits between the coils or parts of the windings, not associated with any leakage to frame, and to bring these to light a method is resorted to known as "drop-testing," which means exploring the voltage drop between the ends of the coil when a measured current is passed through it. Since the passage of current through a resistance is always accompanied by loss of potential, the voltage drop is an indication whether the coil is of normal resistance or otherwise. A short-circuited coil would give a scarcely perceptible voltage drop and a partially shorted coil an abnormally low voltmeter reading, so that comparisons can easily be made taking a sound coil as the standard.

In dealing with ordinary 2-circuit closed-coil armature windings such as constitute the majority of small D.C. and universal motors, the coils and their connections consist merely of a series of separate groups of turns connected in series in a ring, as shown in the accompanying diagram, Fig. 4. Each of the junctions between two coils is brought down to one of the commutator bars in regular progression, and each of the coils should possess approximately the same resistance and give the same volt-drop between its ends when carrying the same value of current. Drop-testing usually is carried out, without disturbing any commutator connections, by passing current through the commutator from one side to the other and testing with a milli-voltmeter between adjacent commutator bars, corresponding to the respective ends of the armature coils. The results so obtained are susceptible to error except in expert hands, and a better way for the amateur is to lift one pair of connections to the commutator bar at any convenient point, and use these as terminals for applying the testing current. By this means it can be ensured that exactly the same amount of current is passing through each coil since all coils are now in series instead of the two halves of the winding being in parallel. In the latter case there might be one or more faulty coils on one side of the armature leading to an uneven division of the testing current, and misleading drop-tests. By unsoldering one junction from a commutator bar and separating the two ends A and B in Fig. 5, there is a certainty that this cannot happen. It also detects at once any actual break in the winding should one exist, since in these circumstances no current could pass at all. Arrange the instruments as shown in Fig. 5, using direct current from the mains for testing, controlling it by means of the series variable resistance to a value rather less than normal full load armature current. The milli-voltmeter is then used to explore the potential difference between each succeeding pair of commutator bars (representing one complete armature coil) and the resulting readings noted. Adjust the testing current until a half-scale voltmeter deflection is obtained, and if this varies more than about ten per cent. either way when going round the coils that particular coil may be considered faulty. When several coils show defects the best plan is to strip the armature entirely and rewind, according to instructions given in a previous article in the June issue entitled "Armature Rewinding." If, however, one or two coils only are at fault they can sometimes be lifted out of the slots and replaced with new ones, provided it is a "former-wound" armature. Much depends on the gauge of wire and whether they prove too hard and inflexible through age and heat.

Stator Testing

Drop-testing can also be used to detect faults in stator coils of small induction motors, current being passed through first the main running winding and then the starting winding, taking the voltmeter readings with the testing spikes between the junctions of one coil with another when they can be got at. It should be noted, however, that such tests will only give equal readings on successive coils when the stator is "basket wound," that is with all coils of the same form and length. With "concentric" windings where the coils are of unequal length according to the number of slots they span, the outer members of each pole group will naturally give a higher volt-drop than the inner members. Figs. 6 and 7 will make this clear.

Squirrel-cage rotors cannot be tested by such methods as the above since the ohmic

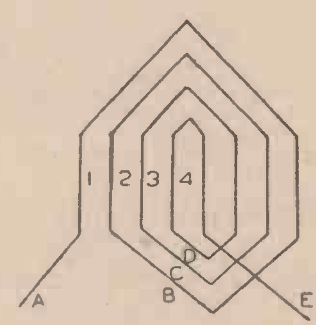


Fig. 7.—Four coils of concentric wound stator. Drop tests applied between A-B, B-C, C-D and D-E will give unequal values.

resistance from bar to bar is too low to give a readable potential difference unless with an enormous and unmanageable amount of current flowing. A careful visual examination should be sufficient to show whether the junctions between bars and end rings have been carefully soldered. Bad joints here can often introduce quite a lot of trouble.

Direct current and universal field magnet coils can also be drop tested in the same way as with armatures, but as a rule the voltmeter readings will be much higher and a full range voltmeter needed instead of a milli-voltmeter.

No. 1 OUT TO-DAY

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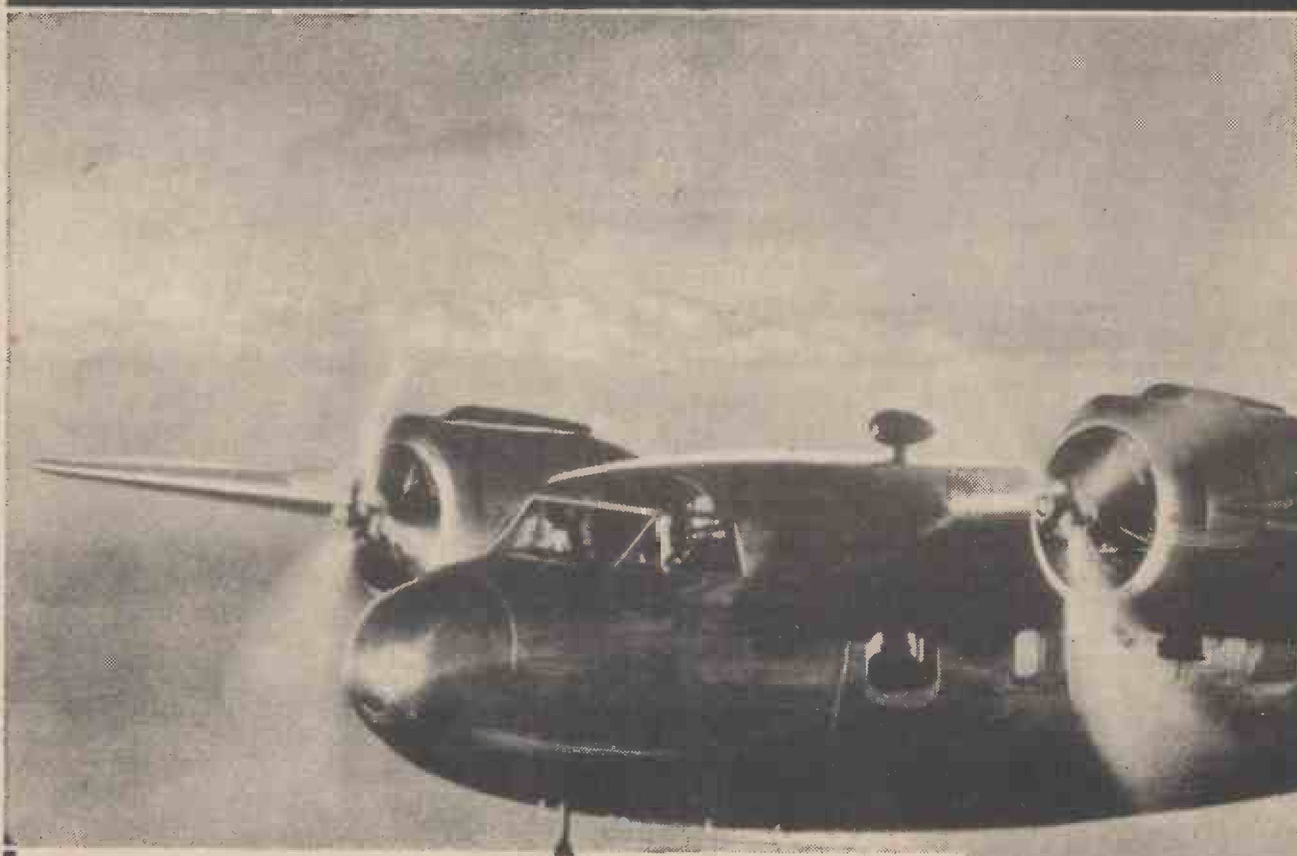

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SHOOTING ELECTRONS

One Hundred Thousand Miles per Second

IT is one of the facts in the life of a scientist to-day that science is moving too fast for him. Discoveries are being made here, there, and everywhere, and it is not surprising that he should find it difficult to keep pace with the work of his colleagues all over the world. But if the pace is too great for a scientist then what of the average man who only hears of a new discovery when it flows across the headlines of his newspaper or weekly journal?

The electron diffraction camera, for instance, is a case in point. How many readers of this journal have ever heard of the apparatus? And yet it has been discovered exactly ten years and has been probing into the unseeable to provide information of the greatest importance to every one of us.

A Fascinating Invention

When X-rays were employed to examine materials in the engineering world, everybody thought : well this is the limit of man's eyesight, surely. X-rays could reveal the structure of, say, a piece of metal down to its atoms. But it now appears that X-rays are only the beginning of a voyage of exploration into the unseen, which may ultimately lead man to a complete understanding of living matter and what is more important, an understanding of diseases. The electron diffraction camera is a fascinating invention, both from the scientific point of view and from that of the amateur mechanic. Quite simple in its construction, the work it accomplishes is really astonishing.

In appearance it is in no way like the popular conception of a camera. It is called a "camera" because it has a section in which photographs can be taken. It resembles a small, iron pillar standing on a box like base. Reference to Fig. 1 will show the principle on which it is constructed, the whole apparatus being about six feet high and about nine inches wide at the middle. For simplicity, some of the accessories, such as the mercury vapour pump, have been left out of the diagram, because they do not directly concern the working of the "camera."

The Use of the Camera

Now before describing how it works a word of explanation is necessary about what it is used for. All substances in nature, whether they are metallic or otherwise are made up of atoms. Usually, these atoms are arranged in the material in a definite way. Thus, they may be in neat rows or in some more complicated, but nevertheless symmetrical, arrangement. In a particular material the atoms will always be arranged by nature in the same way. Its arrangement, in fact, determines the appearance of the material, so that if we are examining with the naked eye a cube like crystal of rock salt, for instance, we can say that the atoms within the crystal are arranged in rows parallel to each other, so that they make up a cube.

If we shoot particles of a sufficiently small size at such a lattice of atoms the particles will strike the atoms and, so to speak, bounce off or in technical terms be "diffracted." The trouble is that the atoms are only of a billionth of an inch in size and, therefore, we must have something correspondingly small which will bounce off the atom when it strikes the latter.

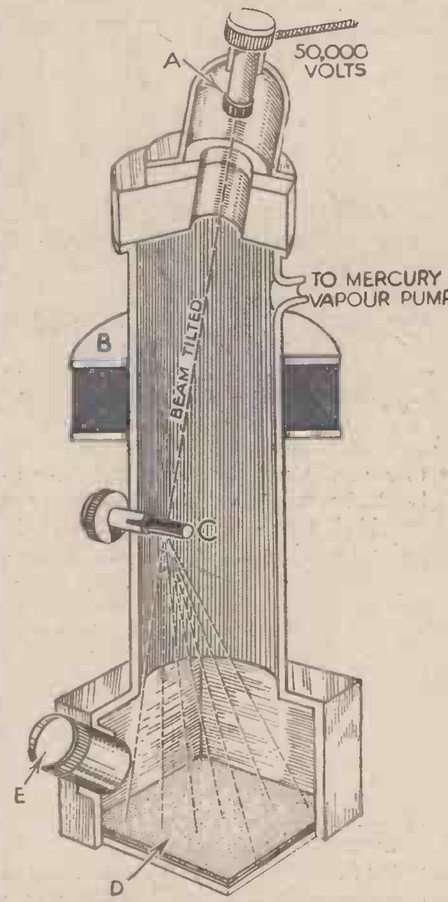


Fig. 1.—An el ctron defraction camera.

X-Rays

X-rays are really tiny wavelets which behave like corpuscles, and if they are shot like bullets at the lattice of atoms in the rock salt, they are deflected by the atoms as desired. If we catch them on a photographic plate as they bounce off, and develop the plate, the result is a striking pattern of lines, circles, or dots. This was the way in which scientists explored the atomic structure of materials up to 1929. But it became increasingly clear that X-ray waves were not quite fine enough to detect all atoms. Our knowledge would have stopped at that point, but the surprising discovery was made of a way of shooting electrons like bullets.

Electrons were much smaller than X-rays, and so an apparatus was built to shoot them like a gun at materials to find out how the atoms were arranged in the latter. The result was the electron diffraction camera shown in Fig. 1.

At A is a cathode, maintained at about 50,000 volts. This ejects electrons which hurtle down the path shown by the dotted line, at the phenomenal speed of nearly one hundred thousand miles per second. The beam of electrons has to be directed on to the material which it is desired to examine, and for this purpose field coils are built around the outside of the apparatus at B. These focus and can move the beam to any desired position by suitable alteration of the magnetic field.

Electrons Deflected

Having been duly focused, the beam then strikes the specimen of material held in the holder at C. The electrons strike like bullets the atoms in the material and are deflected. They pass down to the bottom of the apparatus and are caught on a photographic plate at D. The whole process, is, of course, carried out in the darkness of the apparatus and when the photographic plate is developed a beautiful pattern of spots, stripes or circles is revealed.

So that the scientist can examine the results of the collision of the electrons with the atoms a fluorescent screen is sometimes placed in front of the photographic plate. By looking down through the porthole at E carrying a glass window he can see the pattern which is going to be obtained on the plate, on the screen beforehand. The electrons having passed through or over the surface of the specimen at C, strike the fluorescent screen which glows just where the electrons strike it, so producing a pattern, which can be studied at leisure.

This pattern tells the scientist exactly how the atoms are arranged in the material he is examining. You will say : "But how does that help us?" It tells us practically all we want to know about a process. For example, we can discover whether the atoms in, say, a piece of iron have shifted after heating.

If they have we know that the iron will have different properties which can be predicted. Thus is such information valuable to engineers. Then, again, by watching the movement of the atoms in a material that has been corroded we can learn a great deal. And when it is known that corrosion of one sort or another costs man millions of pounds in wastage a year the importance of knowing all about this will be realised.

Perhaps the most wonderful contribution to knowledge, however, made by the electron diffraction camera is the curious behaviour of aggregates of atoms, that is to say molecules, and here the apparatus will help to unravel the mystery of diseases. As it is, a mass of information about substances has been built up by the use of these "electron bullets" which can be fired at any desired speed. In truth we can say that the diffraction camera is a milestone in the march of science into the unknown.

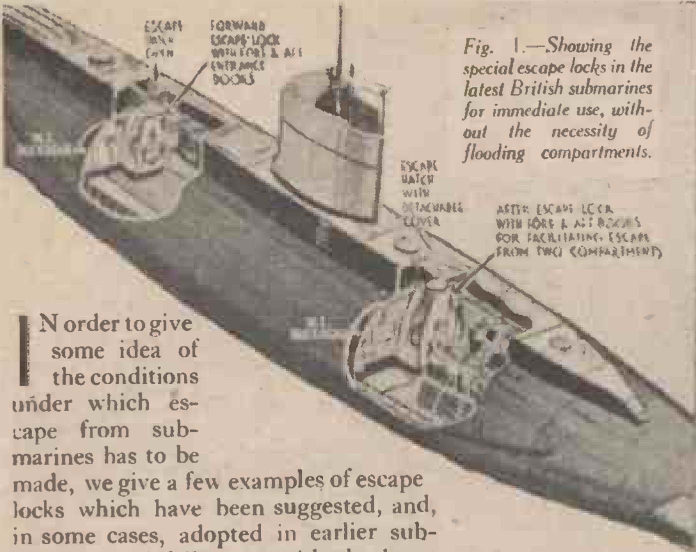


Fig. 1.—Showing the special escape locks in the latest British submarines for immediate use, without the necessity of flooding compartments.

IN order to give some idea of the conditions under which escape from submarines has to be made, we give a few examples of escape locks which have been suggested, and, in some cases, adopted in earlier submarines, and follow on with the latest arrangements that are being provided in new vessels building to-day.

It should first be explained that if a vessel is damaged at the top (Fig. 10), the incoming water will gradually replace all the air in the vessel. But if the damage is below the highest point (Fig. 11), then the water, as it enters, will compress the air until the pressure of the latter is equal to that due to the depth of water in which the vessel is sunk. Thus, if the vessel be sunk at a depth of 33 feet=say, 15 lb. per square inch, or +1 atmosphere, the air will be compressed to one-half its original volume; if at 66 feet=30 lb. per square inch, or +2 atmospheres, to one-third; if at 100 feet=45 lb., or +3 atmospheres to one quarter, and so on.

Compartments Flooded

If, through any other cause than the accidents described, the vessel is unable to rise, the compartments will have to be deliberately flooded (unless they are provided with special escape locks), in order to bring about the conditions—i.e., equalisation of pressure, etc.—necessary to enable the hatches to be opened, and the crew to make their escape.

Figs. 12 and 13 of an early design of vessel show longitudinal and cross-sections of a partial bulkhead forming an air-lock in which the compressed air was trapped, and in which the crew's escape apparatus was hung in readiness. A compressed air supply-main was connected with the air-lock, so that the water flooding the vessel could be kept down to a level which left the men's heads in an air space. Oxygen storage cylinders were also connected to the air-locks to enable the men to charge their apparatus, and so conserve the supply in their individual oxygen cylinders.

When the compartment was completely flooded, and the hatch opened, the men, in turn, ducked under the bulkhead and made their way out.

Another Escaping Arrangement

Fig. 14 shows another arrangement consisting of a tubular extension from a hatchway forming an air-lock, trapping air in the upper part of the compartment, in which are fitted valves and con-

Fig. 2.—(Below) Leaving for the surface by way of the latest type of escape chamber.

Fig. 4.—Showing the trunk extended and in use.

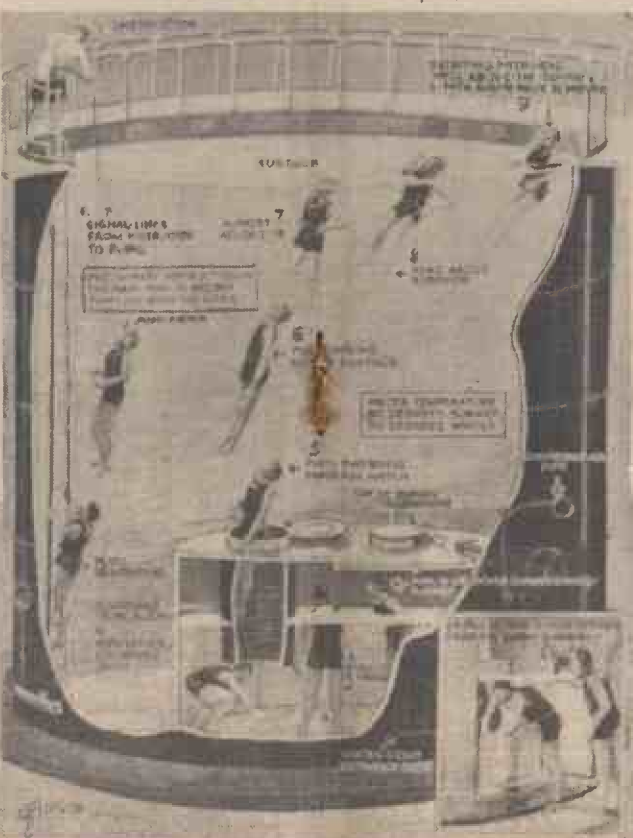
Fig. 5. — (Right) Training men in submarine escape in a special tank.

ape from
UBMARINES

Fig. 7.—The Davis escape apparatus, showing the check vane used for both hands and one hand.

Fig 8.—Having reached the surface, the man, wearing Davis apparatus, turns automatically with his face upwards and clear of the water.

Fig. 6.—Man with Davis apparatus ascending, with check vane extended in order to retard speed.



nections for charging the crew's individual escape apparatus from oxygen storage cylinders placed adjacent to the lock. After releasing the hatch-fasteners, water is admitted into the compartment by opening the flood valves. As the water enters, the air in the compartment is compressed, and when the air pressure is about equal to that of the water, the hatch will be practically balanced between the two. Air will be trapped in the top of the compartment by the hatch extension, the depth of this air pocket depending, as already explained, upon the depth of water in which the boat is sunk; the greater the depth of water, the smaller the volume to which the air will be compressed. In this air-pocket the men stand, waiting their turn to leave the vessel. The air in the hatch extension having been released and replaced by water, the hatch can now be opened, and the crew, having already put on their apparatus, pass under the skirting and make their way to the hatchway, and so to the surface. It has been suggested that a buoy, with a line attached, might be sent up through the hatch before the men begin to escape; they would then use the line as a guide.

Lock Outside the Vessel

Another type of escape lock (Figs. 15 and 16), is one built outside the vessel and with or without an extension, or skirting, into the interior of the vessel, forming an air-lock for men waiting to escape.

Now, in considering the question of submarine escape, we have to remember that a submarine is a vessel of war, and that in designing safety devices one must also have strict regard to available space and limits of weight, so that the vessel shall not be hampered to such an extent as to impair her fighting efficiency.

One point upon which all nations are agreed is that the saving of life, in the event of accident, must be the first and paramount consideration; that the salvage of the vessel is of secondary importance. Many different devices for

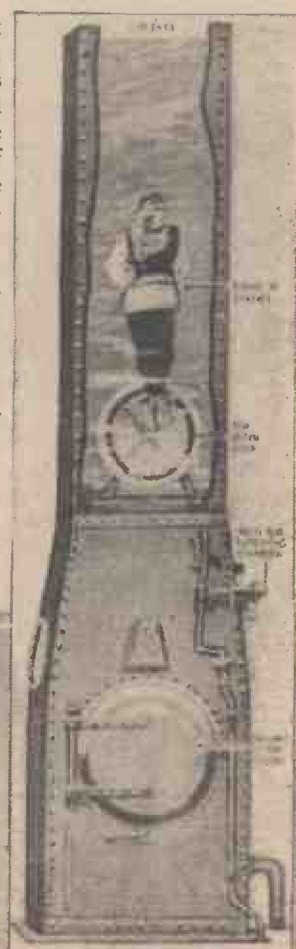
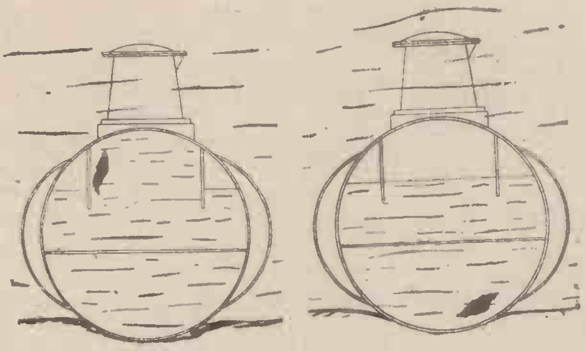
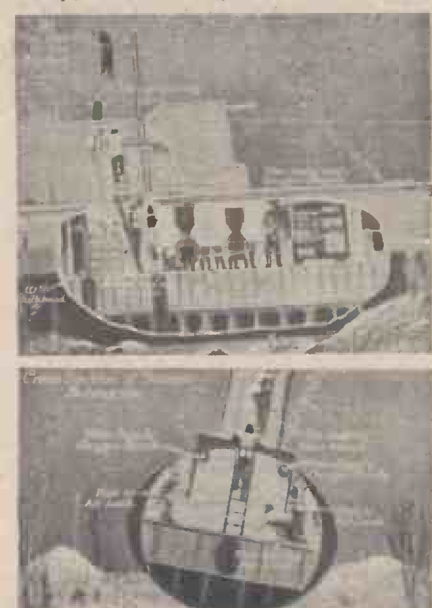


Fig. 9.—A training tank with latest type of escape lock, as built in new submarines in the British Navy.



Figs. 10 and 11.—(Left) Vessel holed at the top and (right) low down.

the saving of life in submarines have been suggested from time to time, among them detachable steel chambers and the like, which, owing to their size and shape, would have to be carried as superstructures, and so would be very vulnerable, and in the likeliest position to get damaged in case of accident. Indeed, some of the safety devices which have been submitted by inventors, have been so elaborate and so bulky that there would have been room for little else in the vessel.



Figs. 12 and 13.—(Above) An early arrangement for escape. Longitudinal section, showing air lock, and below, a cross section.

Safety Measures

Most experts are agreed that the greatest measure of safety is provided by making every man independent of the others, by equipping him with a self-contained apparatus, which, while amply strong,

(1) Is as compact and light as possible consistent with efficiency.
(2) Can be instantly and easily put on, without assistance.
(3) Has adequate air regenerating devices to ensure the wearer a supply of pure air.
(4) Will render him immune against any poisonous gas which may be generated in the vessel.
(5) Will allow him to breathe freely under water, no matter what the pressure.
(6) Will enable him readily to pass through hatchways.
(7) Has means to retard the velocity of his ascent—an important consideration.
(8) Will, when he reaches surface, keep him afloat without any effort on his part, face upwards, so that, if exhausted through any cause, his head will not droop forward with his mouth and nose under water.
(9) Will not prevent him from moving through the water if he wishes to swim.

Davis Escape Apparatus

The escape apparatus, designed by R. H. Davis, which is used in the British, French, Italian and several other navies, is here illustrated, every rating in the submarine service being taught, theoretically and practically, the use of the apparatus.

He is first instructed in the details and working of the apparatus itself, and is taught to wear it in "the dry" in order to accustom himself to the breathing arrangements. Then, with the assistance of instructors above and below water, he is taught to use the apparatus in a great tank, which is fitted with air-locks to enable actual escape from a submarine to be simulated.

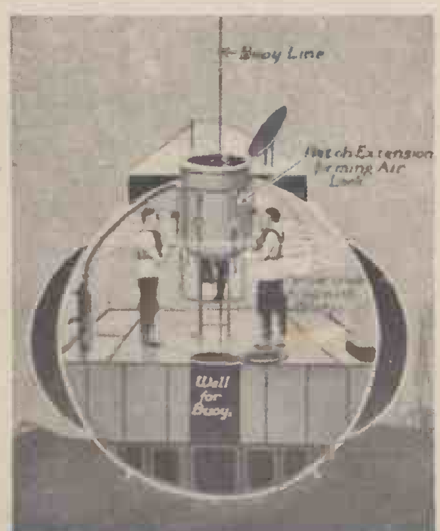


Fig. 14.—Another early design of escape lock.

In Fig. 5 we see men undergoing a course of training at Fort Blockhouse, Portsmouth. The steel tank is 16 feet in diameter, and about the same in depth. Should any emergency demand it, the opening of sluice valves would drain the tank completely in 30 seconds.

At the bottom of the tank is a steel chamber representing a compartment of a submarine. The chamber is entered through a watertight door in the wall of the tank as shown in Fig. 5.

Over four thousand ratings have been trained in the British Navy, and out of that large number, only four have been unable, for various reasons, to become fully competent in the use of the escape apparatus.

Fig. 15.—Another early design. Escaping man has just entered air-lock which he will flood to equalise pressure.

The Training Tank

Filtered water is used in the training tank, in order to ensure good visibility, so that every movement of the men at the bottom can be clearly discerned, and it is warmed in order the better to train the men to breathe correctly under water. Once they are competent to do so, they find no difficulty in breathing when working in cold water.

Every man has to requalify annually. A requalifying tank has been erected at Hong Kong, and a similar tank will shortly be installed at Malta.

The number of sets of escape apparatus carried in each submarine is one per man (stowed as convenient to his diving station) plus 33 per cent. additional sets which are stowed—half at either end of the vessel.

Most of the submarines of the British Navy are provided with collapsible trunks fitted water-tightly to certain hatches. They are conveniently stowed, ready for instant use, and take up very little space in the compartments. Fig. 3 shows a trunk in the collapsed position. When required for use in emergency, it is pulled down and secured (Fig. 4), the submarine compartment is flooded, air trapped in the trunk is released by the opening of a valve, and the hatch is then opened. In Fig. 4 the air locked in the trunk has been released, the trunk is completely flooded, the hatch has been opened and a man is escaping to the surface. When he has left the trunk, the next man, who, with his comrades, has been standing round the trunk in the air compressed in the upper part of the compartment will duck under the trunk and follow.

In Fig. 5 a trunk of this description is shown in use in the training tank at H.M. Submarine Depot, Portsmouth.

In the latest type of British submarine, however, two specially designed escape locks are built into the vessel. These are steel chambers built against the main bulkheads, fore and aft, as shown in Figs. 1 and 2, and having watertight doors giving access to adjacent compartments in the vessel. The controls of the escape locks are arranged so that they can be operated from either of the compartments or from the interior of the locks themselves. With these locks there will be no need to flood the compartment before the men can make their escape; they can be used immediately. The procedure in case of emergency would be for two men to enter the locks wearing the Davis apparatus, close the watertight doors, flood the locks and release the trapped air, and, when equalisation has thus taken place, to open the upper hatches and, floating through them, escape to the surface. The hatches would then be closed and the locks emptied by draining the water in the bilges; the next two men would enter the lock, and the procedure would be repeated.

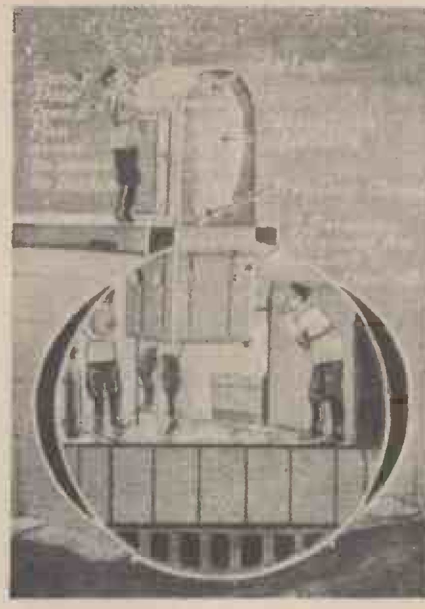


Fig. 16.—Lock flooded showing the man leaving for surface after closing outer door. The lock will now be emptied of water, and the procedure repeated.

—From Sir Robert H. Davis's "Deep Diving and Submarine Operations."

MODEL AERO TOPICS

Tangent Spoked Wheels

WE learn that rubber-tyred tangent spoke model aeroplane wheels are obtainable from Model Craft, of 37 Goldsworth Road, Woking. They are reasonable in price and are stocked in three sizes.

The Wakefield Fund

THE Wakefield Fund totalled over £600 at the time the team left for America. Lord Wakefield subscribed £300.

Slough and Windsor M.A.C.

MEMBERSHIP of this club has increased and attendances are high at the new clubroom and workshop. Local readers should get into touch with the honorary secretary, R. W. Horne, of 32 Buckland Crescent, Windsor, Berks.

Registration of Petrol Models

THE question of the registration of petrol models used by the trade during testing purposes has been considered by the S.M.A.E. A registration fee of 10s. has been agreed for this purpose, this to cover any number of models the trade may desire to fly during the year, but it does not permit a trade-registered model to enter competitions. Members of affiliated clubs owning petrol models should register these through their respective secretaries.

The Lady Shelley Cup Result

1. R. Copland, Northern Heights, 221.16 points.
2. J. Worden, T.M.A.C., 153.53 points.
3. E. Chasteneuf, Blackheath. 148.15 points.
4. R. Mackenzie, Blackheath. 147.416 points.
5. J. O. Young, Harrow, 137.45 points.
6. M. W. White, Blackheath, 135.3 points.

Area Representation Scheme

DURING the transitional period to direct representation on the Area Scheme, clubs who have not yet commenced to operate under the Area Scheme are at a disadvantage. Every club, therefore, is urged to join in the Area Representation Scheme as soon as possible.

"Flight Cup" Result

1. J. M. Coxall, Hayes.
2. A. J. Hayes, Surrey.
3. C. R. Jeffries, Midland.
4. N. P. Reason, Leeds.
5. —. Crosthwaite, Darlington.
6. J. Wainscot, Cranwell.

Short Bros. Cup Result

1. D. Lees, Halifax.
2. R. W. M. Mackenzie, Blackheath.
3. J. Marshall, Hayes.
4. A. D. Piggott, T.M.A.C.
5. G. Cook, Blackheath.
6. C. W. Needham, Bristol.

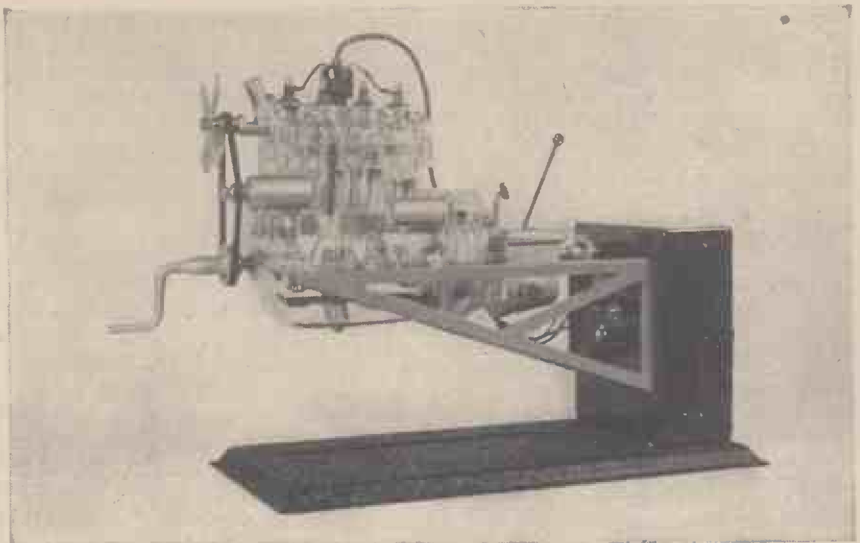
Hamley Trophy Result

1. A. L. Dalton, Hayes, 150.0 points.
2. J. Coxall, Hayes, 120.15 points.
3. F. Thomson, Brighton, 116.2 points.
4. Mrs. Robertson, unattached, 102.6 points.
5. H. Norman, Hayes, 87.0 points.
6. J. F. H. Mahony, Hayes, 86.55 points.

The S.M.A.E. Area Scheme referred to last month.

"MOTILUS" PEEPS INTO THE MODEL WORLD

Our Popular Model Fan tells you Again of his Adventures Among the Model Makers, and News from his Correspondents Abroad in the "Model World"



A scale model 4-cylinder car engine, built up in sectional parts of a new transparent material.

THIS month I seem to have quite a budget of continental news. Trix trains are now in Paris and the illustration on the next page shows the control portion of an interesting layout in the Trix Paris showrooms. The two gentlemen are Monsieur Gaston Gobin Daudé and Monsieur Nouvelet, who are specially interested in the development of this smart "00" gauge train in Paris. Mr. Gaston Gobin Daudé has an interesting ancestry. His grandfather was a surgeon in the French Army during the Napoleonic wars and when binding up fractures with leather found the lacing pulled through the leather. To overcome this trouble he invented the eyelet, called in French the *ocilet*, and started to manufacture these. Throughout three generations his family have been the largest manufacturers in France of the eyelet, though of course Britain and America and other countries now manufacture this invaluable fitment for boots and shoes.

French Toy Industry

The Foire de Paris which is always held in May draws buyers from all parts of the world. It is not so large as the Leipzig Fair or the British Industries Fair, but it is a true index of the development of the French toy industry. Below is shown the exhibit of Messrs. Jeps, the foremost manufacturers in the country—in fact the counterpart of Hornby in this country. The designs however are entirely French and do not cater at all for the foreign country. The trains run at high speed—this seems to be the chief feature of the French toy railway, and Jeps confine themselves to gauge "0" equipment of an inexpensive character. The background of the stand shows a large drawing of the map of Europe, with model aircraft and toy boats attached. An attractive idea, but a disturbing background for the swiftly running model railway.

Yachting

French boys I find are no less enthusiastic than their English brothers when it comes to the model yachting season. Every English town I should think has its model boating-lake, and at fine week-ends and on Sundays you see every kind of model boat put through its paces. Most famous of all English model boating-lakes is of course the Round Pond at South Kensington. No, the photo on the left is not of the pond, this is the famous French ornamental lake in the gardens of the Luxembourg, but it serves just the same purpose, and from the photo seems just as popular!

Messrs. Jeps exhibit in the toy section of the Foire de Paris.

A model yacht getting under way on the famous French ornamental lake in the gardens of the Luxembourg.

Large Gauge Railway

Returning to England. From the sea to the land is always a complete change, but when one's profession has been on the sea for a period of thirty-five years and mostly

A smart " 0 " gauge model railway layout in the Trix showrooms in Paris.

nnder it, as is the case with Captain A. B. Lockhart, D.S.C., R.N. (who has retired from His Majesty's Navy and is now a director of the board of Bassett-Lowke. Ltd.) it must be a pleasure to be able to indulge in his favourite hobby—gauge 1 live steam locomotives. "The Commander," as he prefers to be known, is an Associate of the Institute of Locomotive Engineers, and is now constructing a 1¾-in. gauge railway at his new home, the Pond House, Old Duston, near Northampton. His track will be of German silver with slide-on chairs and has a circuit of 266 ft., which means approximately 20 laps to the mile. All the main stations, etc., are under cover and the outdoor trestling for the track is now being erected. He has brought down from his previous home in Scotland much of his old railway, including his electrically-driven steam outline locomotive, which he proposes to use for shunting and marshalling, and beside this is having two new high-pressure gauge 1 steamers constructed, an L.M.S. "Royal Scot" and a 4-4-0 type Midland Compound locomotive, the latter practically completed and already in the paint shop. The Commander's locomotive is fitted with Smithies water tube boiler of the usual type, fired by methylated spirit, the lamp being supplied from the reservoir in the tender on the automatic displacement principle. Steam is distributed by full Walschaerts gear. and in addition to the usual fittings the locomotive has an axle-driven feed pump.

A bypass valve is also fitted to control the amount of feed water delivered to the boiler. Lubrication is by mechanical pump of the L.B.S.C. type. and the model also has cylinder drain cocks. This "Royal Scot" locomotive has already successfully passed its bench trials, and will be undergoing its track tests in the course of the next few days. Captain Lockhart's Midland Compound has similar fittings to the "Royal Scot," except that the reversing is effected by slip eccentric and lubrication is by displacement lubricator in the cab.

Workman busily shaping the hull of a ¼-in. to the foot model of the R.M.S. Andes.

A Motor Car Engine

Always on the search for model novelties, I have just come across one which emanates from the continent, of a scale model four-cylinder motor car engine, built up in sectional parts of new transparent material. Thus the interior working of the engine is visible, and the cylinders are complete with sparking plugs which actually spark, worked from the concealed flash lamp battery. This model has a working friction clutch and movable gears, and on the opposite side to that shown in our picture is the carburetter. The engine is generated from a simple motor starting handle, or can be belt driven from a motor. The size of the mounted model is : length 8 in., width 4 in.

Two young enthusiasts admiring a ¾-in. scale model of a road tractor.

and height 6¼ in. The engine overall with gearbox is 6¼ in. long, 4 in. wide, and 6½ in. high.

This model is a beautiful little job and would be invaluable for demonstration purposes. I understand that Messrs. Bassett-Lowke, Ltd., who have a model in their London shop, are obtaining a supply of these to retail between four and five pounds, and they also hope to obtain sets of finished parts to build up the model.

Model Tractor

Visiting a friend the other day in London I found his two small boys the enthusiastic owners of a three-quarter inch scale road tractor, the making of which has been described by your editor in these pages. The construction of a scale model like this is certainly a model maker's job—marking out, drilling, fitting, boring, screw cutting, silver soldering and assembling—but the manipulation of the finished model was quite within the ken of these two lads, both of them well under ten years of age. They did not need much assistance from their father, who seemed just as keen about the model as they were.

Model of the *Andes*

One of the finest British-built ships to be launched this year was the new R.M.S. *Andes*, which makes her maiden voyage to South America in September. I looked in at a model shipyard in Northampton and found the model craftsmen just engaged on a large ¼-inch to the foot model of this vessel for Royal Mail Lines, Ltd., for their offices in Leadenhall Street. Here you see the hull being shaped and it will soon be ready for dressing and painting. I hope to show you more details of this and other models in a later issue.

WING SECTIONS

Valuable Data on Airfoil Characteristics

TO the seriously minded modern aero-modeller, the question of airfoil characteristics is of great importance. In these enlightened days much valuable data is available to those who seek knowledge in this respect.

I have selected a few sections that have proved themselves popular, and very effective. Particularly does this apply to the R.A.F. 32, and for the light duration model, Clark "Y." Let us take first, that popular section, Clark "Y." It is undoubtedly a clean section and one can easily observe models using this section while in flight. Until the last year or two, the popular idea was to set this section at a neutral position (0° incidence), but builders have found a general improvement in performance by incorporating approximately 3° positive incidence. When this section is used, one can expect a fairly steep climb, and, if the model is correctly trimmed, a reasonable glide.

A very popular airfoil used on the Continent is Göttingen 549, and it is now being used extensively in this country.

Obviously, a high lift section, petrol enthusiasts would find it well worth their while to use, and its glide is definitely superior to that of Clark "Y." Also, its depth will appeal to the builder who wishes to use a deep spar.

If you look closely at the chart of this section, you will find that the centre of pressure travel is small and this is one of the reasons for its stability. I favour the use of this section very much.

Another very popular continental section is Göttingen 497. This shows many characteristics of Göttingen 549 with a climb that is more associated with that of Clark "Y." The glide is definitely superior to the sections already mentioned, but the discerning modeller of to-day must always look at the construction of a model besides the advantages that added aerodynamic efficiency may offer. For a machine that has a heavy wing loading it is obvious that the builder would have to be ingenious in avoiding the flexing of his wings, but I would suggest that this is an admirable section to use on machines with a light wing loading.

Another admirable wing section in this category is Eiffel 400, only in this case its weakness lies mainly in the thin trailing edge.

However, by using the modern method of wing construction (that is, a thick shaped L.E. and a wide shaped T.E.) this weakness can be largely eliminated. It is by using this method, that Eiffel 400 has become so popular with the King Peter Cup type of glider. used to-day.

N.A.C.A. 6412, a very well-known American section can be used on the general purpose type of machine with great success. It is a very stable section and produces a good climb, followed by a reasonable glide.

I have purposely left R.A.F. 32, until the last, because it is undoubtedly the most used section in the model fraternity. This essentially English section is used throughout the world, most contest models incorporating it, although some modify it slightly to suit the requirements of their design.

Indeed, it has been used on many gliders with success, so one must conclude that the gliding characteristics of this section have proved to be most satisfactory.

It is most noticeable for its steady climb, which gives the illusion, that one is watching a full-size plane, instead of a model. Particularly is this so in the case of the rubber driven machines.

It offers no trouble, from a construction point of view.

F. W.

GÖTTINGEN 549

Angle of Attack	Cl	Cd	L/D	C.P. in % of Chord from L.E.
—2°	.3	.015	20	52
0°	.43	.02	21.5	44
2°	.6	.033	18.4	40
4°	.73	.045	16.4	37
6°	.88	.06	14.6	35
7°	.95	.07	13.5	34
8°	1.0	.078	13	33
10°	1.15	.098	11.8	32
12°	1.25	.118	10.4	31
14°	1.34	.15	9	30.5

CLARK 'Y'

Angle of Attack	Cl	Cd	L/D	C.P. in % of Chord from L.E.
—2°	.25	.019	13.25	52.5
0°	.4	.022	17.8	42.5
2°	.55	.03	18.75	38
4°	.69	.04	17.2	35
6°	.825	.054	15.25	33
7°	.88	.06	14.3	32.5
8°	.95	.069	13.9	32
10°	1.075	.085	12.95	31
12°	1.175	.105	11.1	30.5
14°	1.24	.122	10.1	30

GOTTINGEN 497

Angle of Attack	Cl	Cd	L/D	C.P. in % of Chord from L.E.
—2°	.4	.021	18.6	54
0°	.55	.031	17.9	48
2°	.725	.045	16	44
4°	.86	.06	14.3	40
6°	1.0	.078	13	38
7°	1.05	.09	12	37.5
8°	1.125	.098	11.5	37
10°	1.225	.12	10.2	36
12°	1.31	.142	9.2	35
14°	1.35	.164	8.2	35

R.A.F. 32

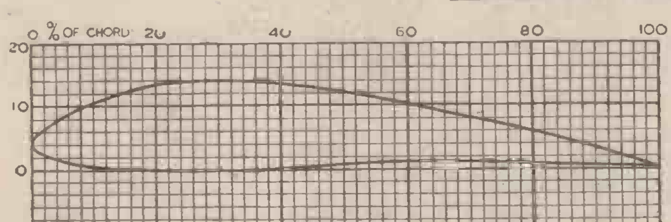
Angle of Attack	Cl	Cd	L/D	C.P. in % of Chord from L.E.
—2°	.4	.022	18	63
0°	.55	.03	18.1	53
2°	.675	.045	17.2	43
4°	.84	.053	16.3	39
6°	1.0	.07	14.9	38
7°	1.06	.078	13.7	37
8°	1.12	.085	13.1	36
10°	1.21	.11	12	34
12°	1.275	.12	10.6	32
14°	1.3	.14	9.3	31

EIFFEL 400

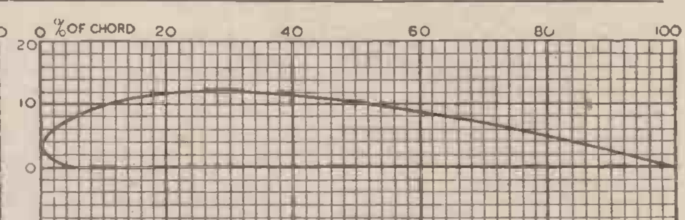
Angle of Attack	Cl	L/D	L/D	C.P. in % of Chord from L.E.
—2°	.4	.018	21.3	48
0°	.54	.025	21.7	44
2°	.69	.036	19.1	40
4°	.85	.048	17.8	38
6°	-.94	.062	15.18	36
7°	1.0	.07	14.1	35
8°	1.08	.082	13.2	34
10°	1.12	.103	10.7	33
12°	1.14	.13	8.85	32
14°	1.12	.172	6.5	31

N.A.C.A. 6412

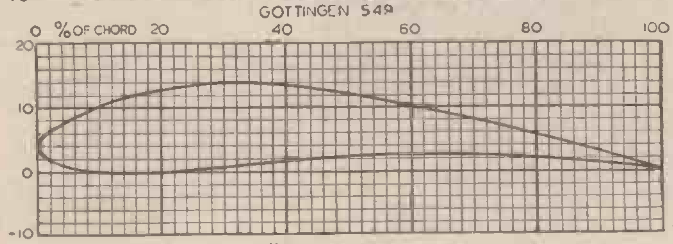
Angle of Attack	Cl	Cd	L/D	C.P. in % of Chord from L.E.
—2°	.3	.018	17	70
0°	.02	.02	21	55
2°	.6	.03	20	45
4°	.75	.041	18.3	42.5
6°	.88	.056	15.8	40
7°	.93	.06	15.5	39
8°	1.01	.07	14.3	38
10°	1.1	.085	13	36
12°	1.28	.098	12.3	34
14°	1.41	.13	10.9	32



GOTTINGEN 549



CLARK Y



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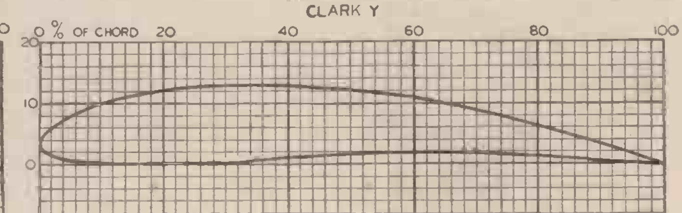
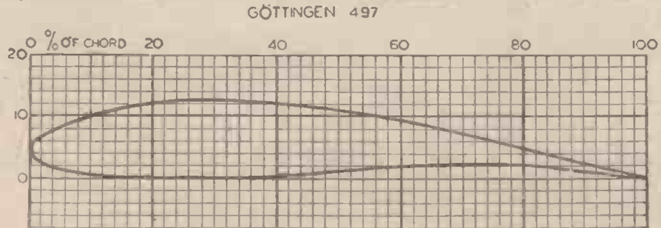
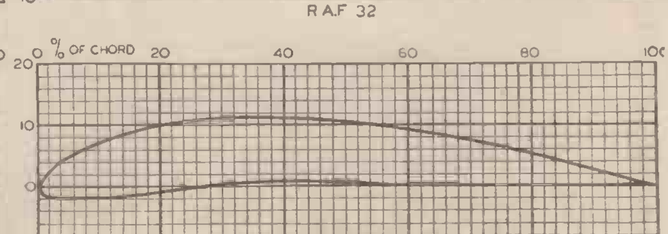


R.A.F 32



EIFFEL 400



N.A.C.A 6412

SENSATIONAL MAGIC AND ITS SECRETS

Fig 9.—The stabbing trick. By means of a hollow metal belt and a sword with a thin, flexible blade, the illusion of thrusting a sword through an assistant's body can be produced.

By Norman Hunter
(The Well-known Conjuror of "Maskelyne's Mysteries")

Further Articles on the Secrets of Conjuring will appear Regularly and Exclusively in this Journal

Fig. 14.—The human hen. The egg seen in the assistant's mouth is a half shell, which he draws back with his tongue as the conjurer brings the palmed egg into view as if taking it from his mouth

TRICKS that seem to have a strong element of danger always attract the public, and of these the feat of catching marked bullets fired from a gun is one of the most notable. There are several methods designed to make the trick not only effective, but safe for the performer. In spite of this latter point, however, a number of conjurers who have performed the trick have in the past been killed as a result of some mishap. Stringent precautions are, therefore, advisable whenever the trick is attempted.

One method makes use of a muzzle-loading pistol and round lead bullets. The bullets have been split by cutting each half-way through with a hacksaw and prising the halves apart, as shown in Fig. 1. One bullet is chosen and marked by a member of the audience, after which the pistol is loaded with powder and the bullet rammed home.

Bullet and Ribbon

Taking his stand some distance away, the conjurer holds up a length of ribbon in one hand and asks the person holding the pistol to fire at it. Immediately following the report, a bullet is seen attached to the lower end of the ribbon and, on examination, it is found to be the marked one.

The trick in this form, as in all the methods, divides into two parts. First, there is the means of securing the marked bullet and rendering the discharge of the pistol harmless. Secondly, there is the matter of producing the bullet dramatically.

In this trick a special pistol is usually employed. This is constructed as shown in Fig. 2. The barrel proper of the pistol does not reach down to the flashpan, being blocked an inch or so in front of it. Anything placed in the barrel cannot, therefore, be exploded by the spark and the charge remains intact. There is a second barrel under the first which does connect with the flashpan, and into this secret barrel, before the performance, is placed a light charge of powder; just enough to make a reasonable report.

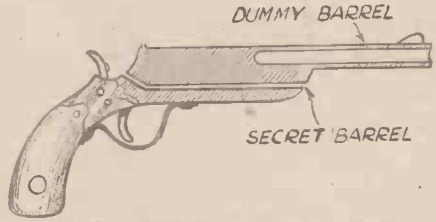


Fig. 2.—Details of the special pistol employed in the bullet trick.

Fig. 3.—The bullet-catching trick. The marked bullet secretly attached to the end of a ribbon threaded through a ring. When released the bullet drops by its own weight and appears attached to the lower end of the ribbon.

BULLET CUT AND PRISED OPEN

Fig. 1.—Showing how the bullet is cut and prised open.

Catching the Bullet

In performing the trick, when the marked bullet is given to the performer he changes it by sleight of hand for a duplicate and retains the marked bullet himself. The duplicate bullet is then placed in the pistol barrel and remains there along with the powder openly loaded in, when the pistol is discharged.

Fig. 3 shows the way in which the marked bullet is apparently caught on the ribbon. There is a knot at each end of the ribbon, which passes through a small metal eye. The knots are large enough to prevent the ribbon being pulled completely through the eye. When the performer goes to fetch the ribbon, he places one end of it in the gap in the bullet and presses the sides of the bullet together, thus jamming the bullet on the ribbon.

The ribbon is held as shown in Fig. 3. The metal eye is gripped between thumb and finger while the bullet end of the ribbon is concealed by the fingers. As soon as the pistol is fired, the conjurer releases the bullet, which drops by its own weight, pulling the lower end of the ribbon up through the eye. The movement is so rapid that the bullet seems to be literally caught on the ribbon, especially if a slight swinging movement is given to the ribbon as it falls.

Dangerous

The element of risk in this method lies in the possibility that the pistol may become damaged or deteriorated with use and some connection be made between the flashpan and the barrel proper. In such an event the charge in the barrel would explode and the duplicate bullet would be fired.

Another way of performing the same

effect consists in using an unprepared pistol and a special ramrod. The rod is hollow and of such internal diameter as to pick up a bullet when it is rammed firmly down upon it. There is a plunger in the ramrod by means of which the bullet so picked up may be extracted. See Fig. 4.

In this method only one bullet is used. This is marked and openly dropped into the pistol. In the act of ramming it home the performer extracts the bullet and at the same time leaves the barrel empty except for the harmless charge of powder. Going behind a screen for the ribbon, he extracts the bullet from the ramrod ready for the *dénouement*.

Providing a small amount of powder is used and a reasonable distance kept between pistol and performer, there is no danger in this method, as the conjurer knows that he himself holds the bullet. Watch should, however, be kept upon any member of the audience who may be asked to fire the pistol, in case through some misguided idea of exposing the trick he should think of dropping a bullet of his own or any other object into the barrel just before firing.

Producing a Bullet

Another method of producing a bullet is to catch it on a china plate. This is simply a matter of palming the bullet in one of the hands holding the plate and releasing it explosive removed beforehand, or even be a complete dummy.

"Sawing Through a Body"

"Sawing" a body in two is another popular sensation. In one method a plain deal box may be used in which a man lies full length, while his neck and feet are tied through holes in the box. A sheet of plate glass is now thrust through slits in the middle of the box, apparently passing through his body, and finally the box is

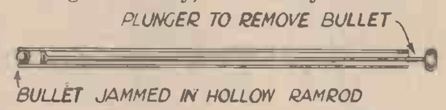


Fig. 4.—A ramrod for extracting the bullet from the pistol.

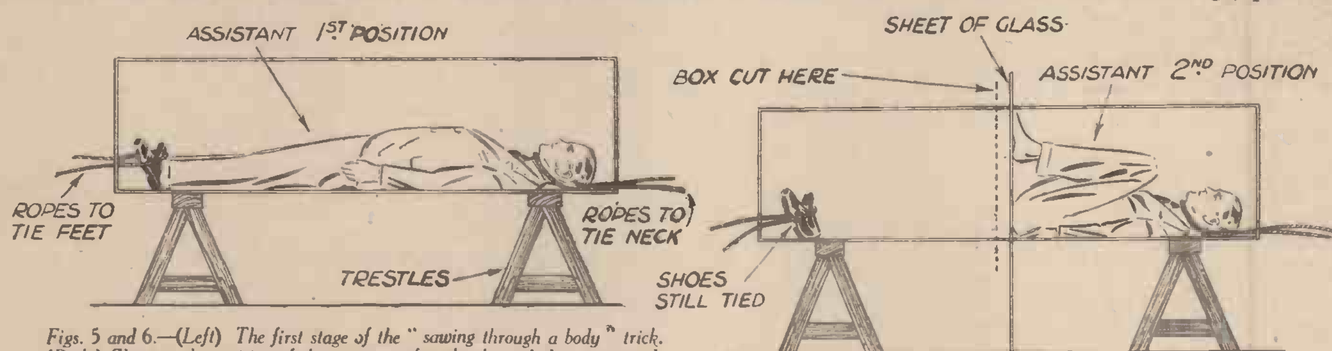
sawn in two. The parts are separated and the man comes out unharmed.

The insertion of the sheet of glass is actually part of the secret. As will be seen from Fig. 5, the box is considerably deeper than is necessary to contain a human form. The fastening round the man's neck is genuine, but at his feet the cord passes round his shoes, which are specially designed so that he can slip his feet out of them easily. As soon as the lid of the box has been closed the man takes his feet from the shoes and brings his knees up, thus lifting his feet to about the centre of the box. The while it is being sawn and afterwards when the two halves of the box are separated.

Here two men are employed, as must be obvious if a little logical thought is given to the trick, otherwise it would mean sawing up a new man every night and the supply would eventually run short. The fact that the legs do not belong to the same men as the head is cleverly camouflaged by the performer tickling the feet, whereupon the head makes faces. Sometimes the toe of one sock is cut off, and after the illusion the restored man is seen to have one sock minus the toe.

In this version the box is a more elaborate affair and stands on a wheeled platform. The platform is hollow and deeper at the back than the front. In the left-hand section as shown in Fig. 7, another man is concealed. When the first man gets into the box, he raises his legs in the same way as the man in the version already described. Wooden panels are then slid down much in the same way as the glass in the other method, and the man rests his feet on them. Meantime the hidden man in the other section puts his feet out through the hole provided at the other end of the box. The effect to the audience is that of one man with head and feet protruding from the box. Needless to say, both men wear the same colour socks.

The box is then cut through, platform



Figs. 5 and 6.—(Left) The first stage of the "sawing through a body" trick. (Right) Showing the position of the assistant after the sheet of glass is inserted.

when the pistol is fired. No cutting of the bullet is necessary for this method.

The bullet-catching trick with breech-loading firearms is similar in general principle to the foregoing. The cartridge containing the marked bullet is secretly changed for a duplicate and the marked bullet extracted behind the scenes. Incidentally the marks of the pliers used for this purpose will passably imitate the grooves cut in the bullet by the rifling of the barrel. The duplicate cartridge is then placed into the breech of a specially made rifle which, when the trigger is pressed, explodes a blank cartridge in a secret barrel under the true one, leaving the other cartridge intact. For further safety the cartridge for which the marked one is exchanged may have the sheet of plate glass is now inserted across the centre of the box through slots provided. As soon as it is in place the man can rest his feet against the glass comfortably during the rest of the trick, as shown in Fig. 6.

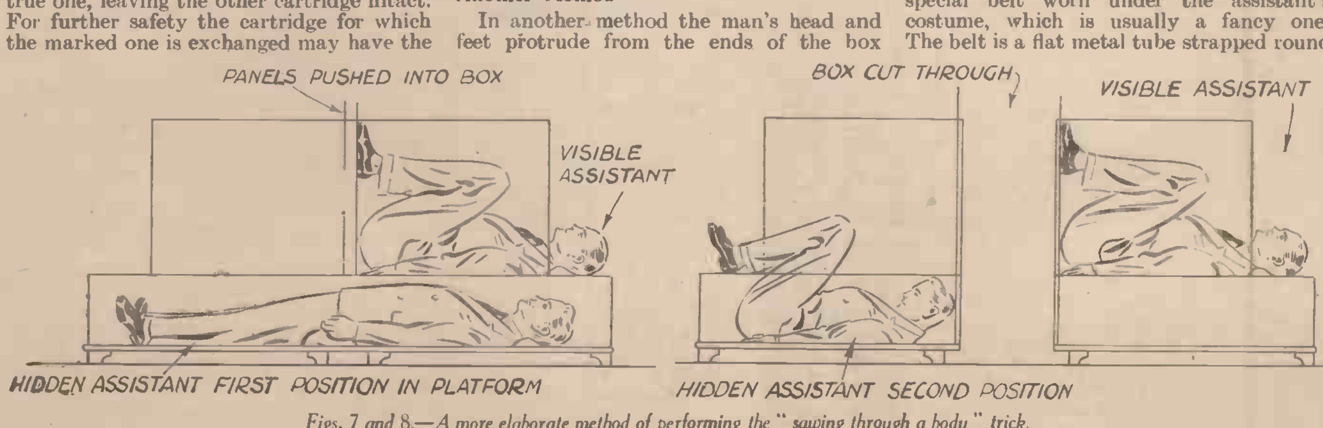
A two-handed saw is now brought on the stage and the box is genuinely sawn through at the side of the glass where there is no man (see Fig. 6). The glass is then withdrawn, the man drops his feet and slips them into the shoes. The halves of the box are eased apart and the man shown to be occupying the full length of the box.

Another Method

In another method the man's head and feet protrude from the ends of the box and all, and the two halves separated as shown in Fig. 8, the two wooden panels previously inserted masking the cut ends. The halves are then placed together and the panels removed, whereupon the hidden man draws in his feet and the man whose head is visible gets out of the box, having first put his feet down to the other end. Convincing presentation is a good part of the secret of success of the illusion.

Swords Through a Body

Fig. 9 illustrates the feat of thrusting a sword through the body of an assistant without harming him. The secret lies in a special belt worn under the assistant's costume, which is usually a fancy one. The belt is a flat metal tube strapped round



Figs. 7 and 8.—A more elaborate method of performing the "sawing through a body" trick.

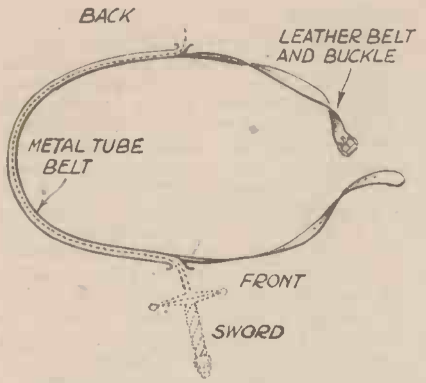


Fig. 10.—The construction of the tubular belt, showing how it is used.

the waist. In front is a funnel-shaped opening, with guides to direct the blade of the sword, while at the back is another opening from which the point of the sword emerges. Both openings are concealed by ornaments on the dress. The sword has a very long and very flexible steel blade.

In presenting the illusion, the performer makes a pass at the assistant, who grasps frantically at the blade and in so doing guides it into the slot in the belt. The flexible blade now passes round his waist through the tube and emerges from the centre of his back. The effect to an audience is exceedingly sensational.

Sometimes a large bodkin is used instead of a sword and ribbon threaded through the eye of the bodkin is passed apparently through the assistant's body. Fig. 10 shows the construction of the tubular belt and makes clear the method of its use.

Another Sensational Trick

Shutting a girl in a small cabinet and thrusting a spear and swords through it in

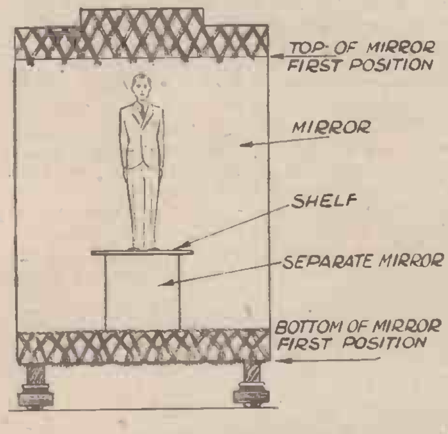


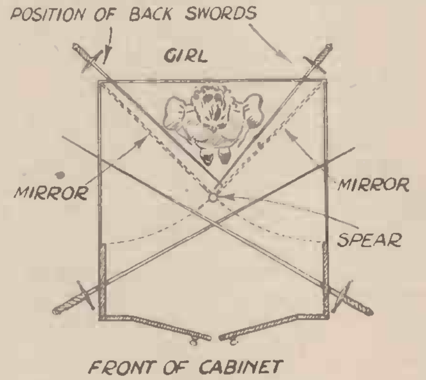
Fig. 12.—The first stage of the "walking through the mirror" trick.

all directions is another sensation. When the cabinet is opened, the girl has vanished, but when the swords are withdrawn she steps out smiling.

Fig. 11 shows a plan of the cabinet. The spear which is thrust through first goes from top to bottom through holes provided. As soon as it is in place the girl, who is in the cabinet, pulls open two panels in the sides of the cabinet. These are hinged at the back corners and when opened meet just behind the spear, the shaft of which conceals the join. The sides of the panels now visible are mirrors and reflect the sides of the cabinet, so that when the doors are opened the girl cannot be seen. The swords thrust through the front and sides of the cabinet are reflected in the mirrors and represent those at the back which are hidden. The swords put in at the back are short ones and go through slots in such a manner as to pass at either side of the girl.

Walking Through a Mirror

Walking through a mirror is an illusion of a different type. A large mirror on a stand is wheeled on the stage. There is a small bracket against the mirror front and back. A girl stands on the bracket and screens are put round her as well as round the bracket at the back of the mirror. Now although the mirror can be seen all round and under the shelf, the girl passes through the glass and emerges on the shelf



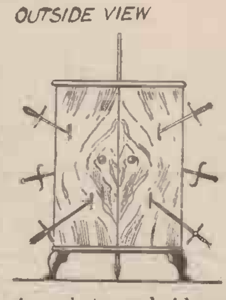


Fig. 11.—A plan and front view of the cabinet. The spear which is thrust through first goes from top to bottom through holes provided.

at the back. The mirror is turned sideways for the presentation. At the finish the mirror is intact once more.

A study of Figs. 12 and 13 will reveal the ingenious secret of this illusion. The large mirror has a piece cut out of the centre of the lower edge just large enough for the girl to crawl through. In its normal position the mirror appears whole, because the part under the shelf is a separate piece of mirror that fills in the gap. The ornamental base of the stand conceals the fact that the mirror passes farther down than it appears to do.

When the screens have been placed round the shelves, the girl lifts the mirror, counterweights in the frame taking most of the weight. The mirror raised as in Fig. 13 leaves space just above the bracket through which she can crawl. The ornamental top of the frame hides the movement of the mirror and the separate section of mirror underneath the bracket does not move.

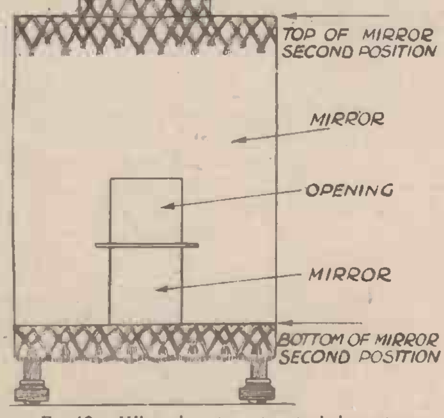


Fig. 13.—When the mirror is raised the assistant crawls through the hole in the back.

The Human Hen

Among the minor sensations of conjuring is a trick known as the human hen. The conjurer's assistant is seated on a chair and holds a bowl or basket. The performer taps him on the head and an egg appears in the assistant's mouth. This is removed and instantly another egg appears. The production continues until the bowl is full of eggs.

Fig. 14 explains the chief part of the

Fig. 15.—The shell used for the "human hen" trick.

mystery. The assistant, just before the trick, slips into his mouth either a small imitation egg or, more usually, a half-shell egg. This half-shell represents one end of an egg, as shown in Fig. 15, and is painted red inside. By having the open end towards the front of his mouth, the assistant can shows his mouth to be apparently empty before the first egg appears. He produces the egg by turning the shell round with the tip of his tongue and pressing it forward. In the meantime the conjurer has secured from a bag suspended behind the chair a whole dummy egg, which he palms. In seeming to take the egg from the assistant's mouth, he simply allows the palmed egg to come into view and the assistant retracts the shell into his mouth. While this is being done the conjurer with his other hand secures another egg from behind the chair, which he produces in the same manner, with his left hand. And so the production continues until the hidden store is exhausted.

How Gases Have Helped the Engineer

(Continued from page 565)

welding. In this the combination of the oxygen with the acetylene, or coal gas when used, is brought almost as near as possible to the source at which the heat is required. When the molecules of the oxygen combine with the molecules of the acetylene they throw off a great amount of heat, and so a flame of intense value is formed, which is sufficient to melt the metal in the immediate vicinity.

Bleaching

One hears a great deal about poisonous gases these days, but relatively little about the good work some are performing in everyday life. Sulphur dioxide which is a very pungent colourless and acid smelling gas is employed for bleaching materials, particularly straw, while chlorine which is a visible green gas has for a long time been used for this purpose. A deadly one that smells like almonds, and ranks high among the poison gases, is widely used for disinfecting : this is hydrocyanic acid, sometimes called prussic acid gas. These and other uses are not so much in the field of the engineer as the chemical engineer, but they are often called upon to help the former.

The role of gases in engineering is a long one and leads into fascinating byways. That they are proving valuable and promise to do so even further is shown by the amount of money spent in research on their properties and their applications to industry.

Watch Repairing and Adjusting—7

Timing a Watch for a Kew Certificate

HAVE you ever noticed on the back plate of an ordinary grade watch the words "timed in two positions"? These words mean that a watch so marked has been tested for accuracy of timekeeping, during a certain number of hours, in two positions. The two positions are dial-up and pendant-up. Very inferior watches are not subjected to these positional tests, whereas higher grade watches are often stamped with the words "timed in six positions for all climates."

These definitions are inclined to convey the impression that watches so marked are absolutely accurate in the various positions. The margin of error is, of course, unknown to the purchaser. It may be small, or it may be as much as a minute a day. Unless the purchaser knows the conditions in which the watch was tested, he may be buying quite an inferior timekeeper. A watch that holds a Kew Certificate is, however, in quite a different category.

The "A" Test

Any watch that is of a sufficiently high standard may, of course, be entered for a Kew certificate. Originally the tests took place at Kew Observatory, from which the certificate took its name. To-day, the tests are carried out at the National Physical Laboratory at Teddington. The "A" test which occupies 45 days is divided into 8 periods. In the first three periods the watch is placed in different vertical positions. In testing wristlet watches 6 o'clock corresponds to 12 o'clock in pocket watches.

During the next four periods the watch is laid on its face and on its back, and finally placed in a vertical position. Most of the testing takes place in a temperature of 67 degrees Far. After 15 days the watch enters an ice-cooled chest. Here the temperature is brought very nearly to freezing point. A further period of normal conditions, and then into the high temperature room where the temperature is 90 degrees Far. The last days are spent under normal conditions.

Testing is rigorous, and the margin of error has to be small. The general layout of the movement has to be carefully studied, the hardness of the jewels, the correct gearing of the wheels, the action of the mainspring and the function of the escapement. Changes of temperature will naturally cause a variation in the size of the watch in general (of course, very minute), but the greatest effect will take place in the balance and balance spring.

The Balance

Before submitting a watch to even preliminary trials, it is essential that the balance be correctly poised. In other words, that the weight of the balance be evenly distributed. The fact that a balance is heavy at one point will have no effect upon its going when in a horizontal position. When tested in a vertical position there will be a decided gaining or losing according to the position of the error.

For example, assume a watch "pendant up" (vertical position 12 o'clock uppermost) with the balance at rest. If the heaviest point is at the bottom, the balance will go slow if its vibration is more than a turn, and it will go fast if its vibration is less than a turn. If the heaviest point was at the top the result would be reversed. Some ordinary grade watches which are only timed in two positions have the balance purposely thrown out of poise to create a slight gaining rate in the "pendant up" position. An effective but very undesirable practice, as the watch would be quite unreliable in any other vertical position. From the foregoing it will be seen that the slightest error will affect the timekeeping.

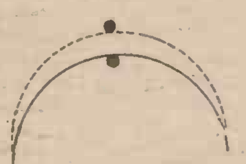


Fig. 1.—A losing rate is caused by the hairspring beating against two pins as shown.

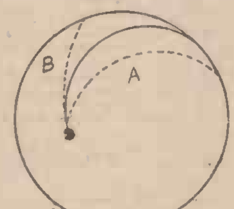


Fig. 2.—The short arcs are slow at A and fast at B.

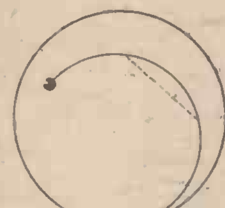


Fig. 3.—Some adjustors make an inward curve in the overcoil as shown.

Chamfering sinks in the underside of the balance rim or the use of the file both detract from the appearance of the balance. The neatest way is to cut the slots of the temperature screws deeper. The quarter screws should never be touched, but always left the same distance from the rim. (A poising tool was described in article 4.) Not until a balance is perfectly poised should any attempt be made with timing.

A Losing Rate

There should be no play between the index pins of the regulator, but just sufficient freedom for the regulator to move without kinking the spring. With a wide gap, considerable variation will take place during the long and short vibrations of the balance. If during the short vibrations the hairspring is stationary on one pin or beating slightly on one pin, it is more than probable that the spring will beat against the two pins during the long vibrations and so cause a losing rate. (See Fig. 1.)

Now that the balance is perfectly poised, preliminary tests can be made in different temperatures, and adjustment made by altering the position of some of the temperature screws. The centre bar of a brass and steel balance is made of steel. Therefore, during an increase of temperature the screws near this bar will move slightly outwards. The cut or free ends, together with their screws, will move inwards. There is, however, a middle position in which certain screws remain at the same distance from the centre.

Should a watch gain in heat, it will be necessary to move one or more screws from the free ends towards the fixed ends. If during a higher temperature a loss is experienced, screws will have to be moved from the fixed ends towards the free ends. Under no circumstances must screws be moved except in pairs, in order to retain the poise of the balance. After temperature tests the screws in the unaffected area may be used for mean time adjustment.

Temperature Changes

Preliminary positional tests can be made

	1	2	3	4	5	6	7
1	1—6	*Pendant up*	68.30	+1.61		0.02	
				+1.73		0.10	
				+1.61	+1.63	0.02	0.032
				+1.63		0.00	
				+1.61		0.02	
2	6—11	*Pendant right*	68.40		+1.95		0.091
3	11—16	*Pendant left*	67.80		+1.73		0.114
4	17—22	*Dial up*	42.15		+1.57		0.101
5	23—28	*Dial up*	67.76		+1.66		0.033
6	29—34	*Dial up*	94.70		+2.00		0.095
7	35—40	*Dial down*	67.77		+1.93		0.040
8	40—45	*Pendant up*	67.65		+1.90		0.061

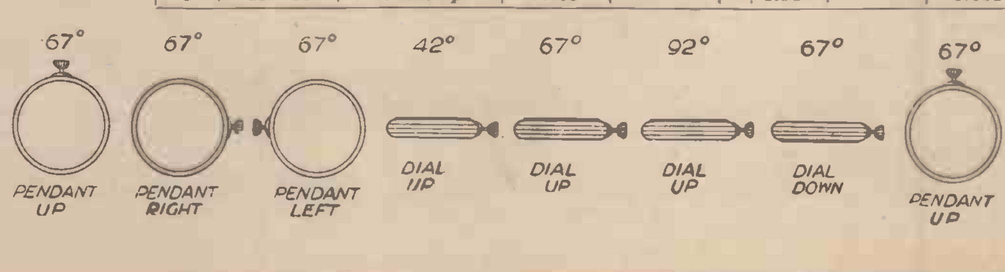


Fig. 4.—The eight testing positions of a watch during the Kew test and above is shown an imaginary table of results of a watch undergoing a test.

after corrections have been made for temperature changes. Change of position has its effect upon the action of the escapement, and in many instances pivot friction is increased. The rate, that is the time of vibration of the balance, must be uniform as the mainspring gradually runs down, as it must also be in various positions. Isochronism, the performance of the vibrations of the balance in the same time in both the long arcs and the short arcs, is, therefore, of prime importance.

A "dial up" position usually represents the long arcs, and the vertical positions the short arcs. To test for isochronism the mainspring should be wound about one turn and the watch placed in a vertical position, as this will produce the shortest possible vibration. The watch should be set and the subsequent gain or loss noted. A test in the horizontal position with the mainspring fully wound will produce the longest vibration. The gain or loss should be noted.

Positional Errors

Positional errors may be due to a multitude of causes—escapement faults, excessive friction in balance jewel holes, damaged jewels, uneven end jewels, or careless oiling. Often the sides of the lever and the banking pins become so sticky as to retard the action. A little friction may take place between the fork and the roller. A ruby pin very slightly out of upright may rub the fork as it passes in and out in certain positions. Should there be an error in one vertical position only, or should the error in one vertical position be greatly in excess of the other vertical positions, the trouble will probably be traced to a defective jewel hole. The only cure for a jewel hole showing the slightest imperfection is to replace it with a new jewel hole.

If the escapement appears to be in order, but the long and short arcs are still not isochronous, it will be necessary to alter the overcoil of the hairspring. If the short arcs are slow, the overcoil is bent inwards, at the same time forming a little more of the body of the spring into the overcoil as at A in Fig. 2. When the short arcs are fast the overcoil is made less curved as at B in Fig. 2. Some adjustors make an inward curve in the overcoil, as shown in Fig. 3, when the short arcs are slow. Special curved Brequet spring tweezers should be used, as any undue kinking will be almost certain to upset the timekeeping.

Reducing Vibration

A method sometimes used to reduce the vibration in the long arcs is to flatten the end of the balance pivot with an oilstone slip. This will increase the friction in the horizontal position, thereby making the long and short arcs of the same duration. There is, unfortunately, a possibility that the pivot so treated may cause wear in the endstone. An alternative method would be to reduce the size of the balance pivot and fit a smaller and thinner jewel hole, thereby reducing the friction in the vertical position to a minimum. Adjustment of the contact between hairspring and regulator pins, although not a desirable practice, can be effective. The hairspring is adjusted to remain on one pin in vertical positions, but to vibrate between both pins in horizontal positions.

From the foregoing it will be realized that considerable fine adjustment is necessary if a watch is to occupy a high position in the award list.

Fig. 4 is an *imaginary* table of results of a watch undergoing a test. Column 1 indicates the period, column 2 the various positions, column 3 the different temperatures, whilst the remaining columns show the various errors in timekeeping. In column 4 is shown the variation in seconds from standard on each of the days of the first period (actually the figures show a slight gain). From these daily variations is computed the "mean daily rate." The "mean daily rate" is, of course, the average of the five daily variations. The first figure in column 5 represents the "mean daily rate" for the first period, the other figures represent the "mean daily rate" for the other seven periods.

"Daily Variation"

Column 6 shows the "daily variation from the mean rate" for the first period. These figures are obtained by subtracting the daily variation from the "mean daily rate." The "mean variation of the rate for the period" is shown in column 7. This value is obtained by adding up the "daily variation from the mean rate" and dividing by five. The mean values for the other periods are obtained in the same way. For the purpose of allocating marks for position adjustment the six positions at the normal temperature are considered, viz., periods 1, 2, 3, 5, 7, 8. For temperature compensation only the periods 4, 5, 6 are used, but the average of the eight "mean variation of

(*Continued on page* 599)

The National Physical Laboratory

RATING DEPARTMENT

I hereby Certify

That a CLASS A KEW CERTIFICATE

has been issued to Mr. F. J. Camm.

London.

for the Keyless open-face "Solvil" pocket watch

No. ---739748--- , *which was submitted to a test at this Institution from* 1st April to 15th May, 1939,

and the results of its performance were such as to entitle it to this Certificate, in accordance with the Regulations for the issue of Watch-rate Certificates, approved by The National Physical Laboratory Committee of the Royal Society.

C. G. Darwin

DIRECTOR

RESULTS OF TEST OF WATCH No. ---739748---

Rated from 1st April to 15th May, 1939.

Period	Approximate Temperature	Position of Watch	Mean Rate. Seconds per day
1	67 F.	In the "initial" vertical position (see note on opposite page)	+1.2
2	67 F.	In a vertical position, turned clockwise through 90° from the "initial" position	+6.1
3	67 F.	In a vertical position, turned anticlockwise through 90° from the "initial" position	-6.0
4	42 F.	In a horizontal position, with dial up	-2.5
5	67 F.	" " " " " "	+0.2
6	92 F.	" " " " " "	+1.[illegible]
7	67 F.	In a horizontal position, with dial down	[illegible]
8	67 F.	In the "initial" vertical position	-1.9

Mean variation of rate (average for all periods) .... 0.20 sec. per day

Mean change of rate per 1° Faht. .... 0.090 " "

Maximum difference between any two individual rates during the test .... 13.0 " "

Note: + gaining — losing

MARKS AWARDED

In respect of consistency of rate 35.9

" " *constancy of rate with change of position* 28.1

" " *temperature compensation* 14.0

TOTAL MARKS 78.0

CLASS A CERTIFICATE ISSUED

Date: 19th May, 1939.

Observer

Reference: 23775.

C. G. Darwin

Director

Reproductions of the Kew A Certificate issued to Mr. F. J. Camm, Editor of PRACTICAL MECHANICS, who succeeded in obtaining 78 marks. A watch which only just passes the test receives none of these marks.

THE EXHIBITIONS AT LIEGE AND ZURICH

The steam locomotive used on the rack mountain railway up the Rigi—the first railway of its kind in Switzerland.

By W. J. BASSETT LOWKE, M.I.Loco.E.

NOT everyone can spare the time or money to visit the great World's Fair at New York, in which the British Government has made so fine a display. This gigantic fair, however, must not be allowed to overshadow two very interesting exhibitions now being held in Europe—namely the Swiss National Exhibition at Zurich and the International Water Exhibition at Liege.

Having occasion to go over to the Continent for a few days on business, I took the opportunity of spending a day in both Zurich and Liege and viewing each of the exhibitions.

The Swiss National Exhibition at Zurich is easily the finer of the two and has an almost unique merit. It is the first exhibition I have ever known to be absolutely finished on the day of opening. Devoted entirely to the activities of the Swiss people, it includes their work on the land, their trades, crafts and highly specialised industries, and also presents the life of the people in their intellectual and leisure pursuits.

"Fairy Tale" Surroundings

This exhibition is in "fairy tale" surroundings. Who has not heard of the beautiful lake of Zurich? The exhibition is situated on two banks of the lake. The right bank is devoted to industry and the left bank to agriculture, and these are linked—or should I say bridged—by a rapid series of motor boats, or by the aerial railway.

In this short article I can give only a brief review of the "high spots" to readers. Firstly—transport. The transport in the exhibition is by means of open electric cars on the "toast rack" principle, or by the very original method of a flowing water way. This attractive water route winds in and out the exhibition on the right bank, including a path through some of the pavilions, and the flow of water is maintained by pumping at a constant speed. The boats bearing the sightseers will hold about eight people. They are started off on a slope and are carried along simply by the speed of the water. I was enchanted by this pleasant and dustless method of making progress round the exhibition. The whole circuit takes only 25 minutes, and is very well patronised. It is certainly an idea, I think, which could well be developed for future exhibitions.

The first steam locomotive in Switzerland

World's Most Powerful Locomotive

The Swiss Railways are represented by an exhibition railway station, which is also used by excursion trains wishing to have direct access to the exhibition grounds. The latest rolling stock of the Swiss Federal Railways and the Simplon Railway is shown, together with the world's most powerful locomotive, 12,000 horse power. As a contrast, you can see the first steam locomotive ever used on the Swiss railways and the rack locomotive of the first mountain railway in Switzerland—the Rigi railway.

In the railway hall many statistics are made comprehensible by interesting models in low relief of the various scale and sizes of the locomotives. There was also some very fine model work displayed, much of it made by amateurs—the work of the various model railway clubs of Switzerland. Outstanding amongst this I might mention an excellent model of a Swiss electric locomotive to a scale of 1 in 30, exhibited by Mr. F. Zumbach.

The most powerful electric locomotive in the world (Switzerland).

Naturally the watch and clock pavilion

The largest gauge "O" railway in Europe—a working model of the picturesque Lorschberg Bahn in Switzerland.

is a wonderful exhibit, as might be expected from the nation which leads in this industry. Outside the building is a huge and wonderful clock with chimes.

There is a special hall devoted to aluminium and one to chemistry and in the electricity section I was particularly struck with a very fine model of a hydro-electric power station working with real water and demonstrating the working of locks, weirs, etc.

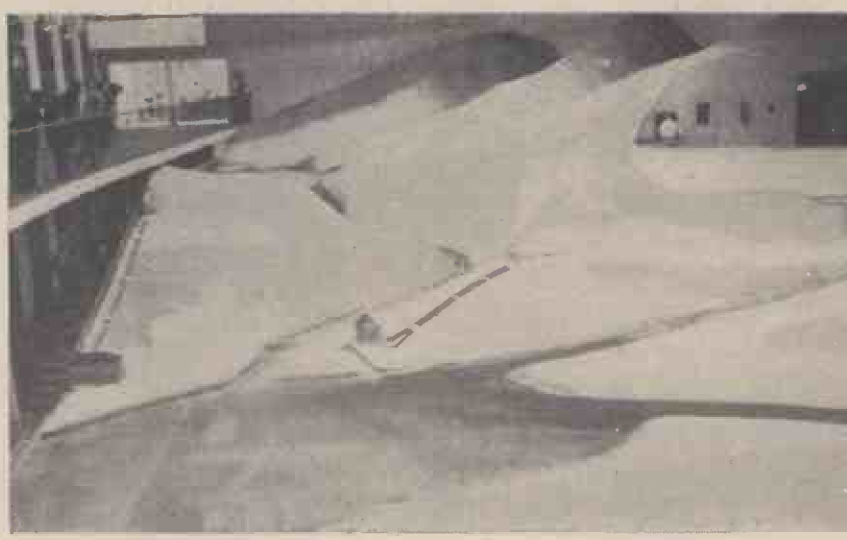
Model Hotels

Naturally enough, too, there are smart model hotels and restaurants at various points in the exhibition, where one can eat and drink among most picturesque surroundings.

The left bank is very beautifully laid out. Each canton has its pavilion designed to its individual style and showing the food and goods it produces. The attendants and waitresses, too, are dressed in the attractive garbs of their various cantons.

Altogether, the exhibition leaves an impression on the mind of being well planned, easy to see, and situate in the most delightful surroundings it would be possible to conceive. It is what Glasgow should have been, but wasn't!

Before leaving Switzerland, I would like to mention what I think is the largest gauge "o" scenic model railway ever constructed. It is built in the open air opposite the restaurant Belvoir, and is a miniature of the Lorschberg Bahn—one of the few privately owned railways still in existence in Switzerland. The model covers the space of 120 feet by 30 feet and is definitely one of the biggest attractions of the exhibition.



The model hydro-electric power station in the Swiss National Exhibition.

Now on to Liege! The International Water Exhibition there is not in such beautiful surroundings. It is in the heart of a busy industrial area in Belgium, and was inaugurated to commemorate the opening of the Albert Canal—linking Antwerp and Liege—a scheme which has taken ten years to complete at a cost of £15,000,000. This wonderful waterway over 70 miles long can accommodate 2,000-ton vessels, and puts the great industrial area of Belgium into direct communication with the sea.

Water!!

The exhibition itself gives a complete picture of the part which water plays in the life and work of a nation. Naturally enough it is near water, being situated on both sides of the Meuse, but it is far from finished. In fact the only two pavilions completed are the Dutch and the German ones. Great Britain and America are not represented (which the Belgians appear to regret). The Germans, being short of foreign currency, adopted an ingenious method of erecting their pavilion. Their workmen journeyed over daily from the German frontier together with their food supplies, returning each evening. The material, which was sent over as much as possible in finished condition, brought down work in Belgium to a minimum, and the German Pavilion is now practically the largest in the exhibition. Of severe external appearance, it is exceedingly well planned inside.

Model of the Belgian liner. "Baudouinville" in the Naval Hall of the International Water Exhibition at Liege.

Every country has made use of models in their various forms, but the standard of work, except perhaps in the German pavilion, in no way approaches that of Zurich. Much of the shipping modelling in the naval pavilion was, I should say, the work of amateurs. I was naturally rather interested in this pavilion because it contains a large model my company has recently made for Messrs. Cockerill, of Serang of the m.v. *Baudouinville*—largest vessel to be built in Belgium. I also saw models of a number of similar ships, including the Dover-Ostend mail boats.

Belgium has always been a popular holiday country for English visitors, being only a few hours from London, and Liege is reached in one hour and ten minutes from Brussels by a splendid hourly service of express trains, and a day at Liège would be most enlightening to all students of the use of water in all its forms—from the engineering, commercial and domestic points of view.

HEAT IN ENGINEERING

By F. C. SUTTON, A.M.I.Chem.E.

What It Is and How It Behaves

HEAT is, like electricity, not simple to define. We speak about electricity "flowing" and we know so much about its properties that we are able to predict its behaviour very accurately. But exactly what is electricity is difficult to say, and while we know what heat really is, it is difficult to explain. It is, however unnecessary to know this to be able to handle heat problems in the most competent way, just as we can calculate, for instance, the amount of electricity flowing in a circuit from Ohm's Law without knowing what electricity really is. Atoms can exist in two states : they can be "stationary" or they can be in a state of vibration. In the former the material, of which the atoms are made up, is said to be cold; in the latter the vibration represents heat. When we heat a metal bar the atoms in it acquire energy from one source of heat and begin to vibrate quickly. If we touch the bar the vibrating atoms give the sensation of warmth. Now continue to heat the bar and after a while it glows red. This means that the atoms are vibrating so violently that they can radiate pulsations of energy. These pulsations are of such a wavelength that we can see them; that is to say, they represent light. By continuing the heating the bar becomes white, which means to say that the atoms are vibrating at a very high speed, billions of times per second, and so the light emitted gets shorter and becomes white light, which is of smaller wavelength than the red light.

The Optical Pyrometer

This knowledge has been put to good use by engineers, for it is apparent that if the colour of the light emitted by a source of heat varies with temperature, we can determine the temperature of, say a flame too hot to test with any thermometer, by measuring the colour of its light. This, in fact, is the principle of the optical pyrometer, with the aid of which the writer of this article has determined daily the temperature of furnaces by looking through the pyrometer into the flames, such information being of great importance to industrial processes.

But, to come back to our subject, it is not necessary, as already stated, to know the exact nature of heat. Accurate measurements in the laboratory have established laws similar to those governing the behaviour of electricity. A word here about the different forms in which heat can be conveyed will be helpful to all those who, in the construction of mechanical equipment, have to contend with it in some form or another.

Conduction of Heat

First of all there is the commonest method of travel of heat, namely conduction and here the analogy with electricity is striking. We speak of a heat gradient through a metal wall, implying the same thing as when we talk of an electric potential. The amount of heat flowing through a barrier is proportional to the difference in temperature on either side. A warning should be given here of the danger of confusing "temperature" with "heat." Temperature is expressed in degrees and is *not* a quantity of heat. A quantity of heat is expressed by "calories," that is to say, the amount of heat required to raise one gram of water by one degree Centigrade, or by a larger unit, the "therm," the amount of heat for raising one pound of water by one degree Fahrenheit. Thus "temperature" is analogous to "volts" and "heat" to "watts."

The second way by which heat can travel is radiation. If we heat a metal plate and stand it up in air the heat flows into the air like wireless waves, as radiant heat. Here again, the behaviour of heat is governed exactly by the laws of radiation and we know that radiation varies as the fourth power of the temperature of a body. If we place an object in front of our metal plate the former will acquire heat by receiving the radiations which cause the atoms of which it is composed to vibrate. The technique of heating by radiation has grown greatly in the last few years and a few examples will be given below.

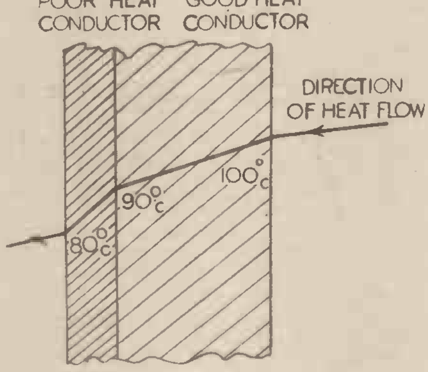


Fig. 1.—How heat flows through a wall of different heat conductivities. It will be observed that the drop of 10°c. on the better conducting layer is spread over a greater width than the drop on the worse conductor. Note the analogy between this temperature gradient effect and electric potential and resistance.

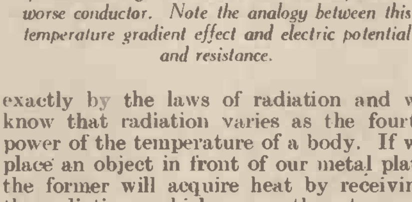


Fig. 2.—If heat passes to a wall in waves it passes into the wall as such, but the amplitude dies away. Note the analogy with the damping of electric waves.

Convection

The third and last method by which heat can be conveyed is convection. This is best imagined by considering a practical case, the fire in the grate at home. The coal burns and heats up the firebrick which diffuses by conduction to the surrounding walls. If the coal glows it will throw out radiant heat. In addition, however, air is sweeping into the fireplace from the room and as this passes over the hot coal it acquires heat, as well as from the hot brickwork, and passes up the chimney. In doing so it carries away heat by what is known as convection. The heat can only be transferred by this means when the medium heated is able to flow and carry it to another location.

We have now dealt with the various forms by which this heat can be transported. How has the engineer turned these to advantage?

Practical Heat Problems

Perhaps the most interesting example of heat occurring in all three forms and in relatively large quantities is that of the internal combustion engine. It is not generally known that about one third of the energy in engine fuel is lost by heat. That is why cooling water has to be used to carry away the heat from the cylinder walls and pass it into the air via the radiator. This heat is taken from the cylinder by conduction through the cylinder walls, the water side of the walls being kept at a relatively low value by circulating the water, so that the maximum heat flows through from the hot side. But not all the heat is absorbed by this means. The explosive gases become heated to a very high temperature and are passed out of the cylinders of the engine into the exhaust and then into the atmosphere. This represents convection, while in addition the explosion flame radiates heat to the cylinder walls which absorb it and pass it on to the cooling water by conduction.

The raising of steam to drive turbines, steam engines, and pumps is nowadays such a specialised job that a particular kind of engineer, sometimes referred to as the heating or combustion engineer, is detailed off for the work. He is familiar with the problems of fuel utilisation, the behaviour of heat and the characteristics of steam. It is one thing to generate steam in a boiler, but another thing to raise it on a huge scale with the utmost economy, so that electricity can be turned out for under a penny per unit. Boiler houses in modern power stations bear no resemblance to their ancestors where it was good enough if coal was shovelled periodically into the furnaces by grimy stokers wielding shovels. Nowadays the combustion of coal is carried out with scientific care, the amount of air and its temperature before entry to the furnace being controlled automatically. The flue gases are analysed continuously and recorded by mechanisms, and the rate of combustion controlled to a nicety.

"Dry" Steam

When the heat is extracted from the fuel, no less care is devoted to its use. The steam may be superheated, that is to say, raised to a temperature much above the ordinary value which is that of boiling water. It is then called "dry" steam because it does not behave like the steam we see issuing from a kettle of boiling water. Such steam can be transferred through pipes quite long distances and as is well known is used principally to drive turbines, at least in power stations. When it has performed its useful work it may be called upon to heat up the water which is passing into the boilers thus demanding less fuel to raise that water to boiling temperature.

The design of a boiler and its flues is of first-class importance to efficiency. The heat from the coal must be passed through the furnace walls, usually made of firebrick, without hindrance, and it is here that the laws of thermal conductivity are called upon to assist in the design. Much heat would be lost by convection if it were not for the fact that the combustion gases are made to traverse flues which run parallel to ducts bringing cold air to the furnace bed. Heat passes by conduction through the thin walls separating the two, and so the hot flue gases give up more of their heat to the cold air which then does not tend to cool the furnace bed. These flue gases are also used to heat the steam to any desired temperature in what are termed superheaters. It will be seen from this that the problem in steam raising for power purposes is how to get the utmost heat value out of the fuel.

Heat Not Wanted

There is, however, a type of work where heat is not wanted and where the problem is how to get rid of it as quickly as it is formed. In mechanical engineering the *bête noire* is friction that generates heat in bearings. Unless this heat is dissipated the lubrication may break down and seizure of the bearing take place. Consequently, a great deal of attention is devoted to the design of machinery which will enable frictional heat to be passed away by conduction. Oil is pumped through the bearings to carry away heat, and in addition the housings for them so designed that the heat can flow without difficulty to the outside of the machinery where it can radiate into the air.

The uses to which heat is put by engineers are manifold, and a volume can be written on just a few of them. It is one of the peculiarities of nature, nevertheless, that if she confers a blessing with one hand she usually offers difficulties with the other. For that reason the engineer is often confronted with the difficulty of generating sufficient heat in one part of his plant and avoiding it in another.

Man has not been slow to realise the value of having heat under his control. He has experimented with it and spent many years finding out all he can about it in the laboratory. An interesting case in point of science being applied directly to our comforts is offered by the development of heating appliances in the home. There was once a time when it was considered sufficient to make pipeclay red-hot in the earlier gas fires. Nowadays, they pass their heat to us largely in the form of radiant energy, which possesses the curious quality of not heating the air through which it passes, but warming only objects on which it falls. Thus, is an unhealthy stuffiness in the atmosphere of a room avoided. The use of heat rays of long wavelength, called infra-red, is now well-known in treating rheumatism, such heat being "invisible," but nevertheless very powerful. Many examples come to mind of science in heating to show how we have developed from the days of flint and tinder.

Amazing—But True!

Extraordinary Inventions that are Being Exhibited at the New York World's Fair for the First Time

DOWNY yarns made of milk! Eye-glasses made of wood! Shimmering fabrics made of glass! Startling, perhaps, but true. These are just a few of the things seen in the General Motors Highways and Horizons exhibit at the New York World's Fair. There, on an ingenious revolving stage, are presented the wonders of to-day.

For example, there is the egg trick if you want to call it that. Ernest Foss, who conducts the "Previews of Progress" performance, puts his hand on a cold disc. He breaks an egg in a frying pan and holds it above his hand. The egg fries to a sizzling turn, but his hand is unaffected. Mr. Foss explains in simple language that this "stove" is an induction coil. That when electricity passes through the coil it creates a magnetism that changes its course 3,200 times a second. When this rapidly reversing magnetic flow reaches the metal frying pan, it causes a disturbance, a molecular friction which produces heat. And, of course, Mr. Foss' hand is unaffected because it is flesh, not metal.

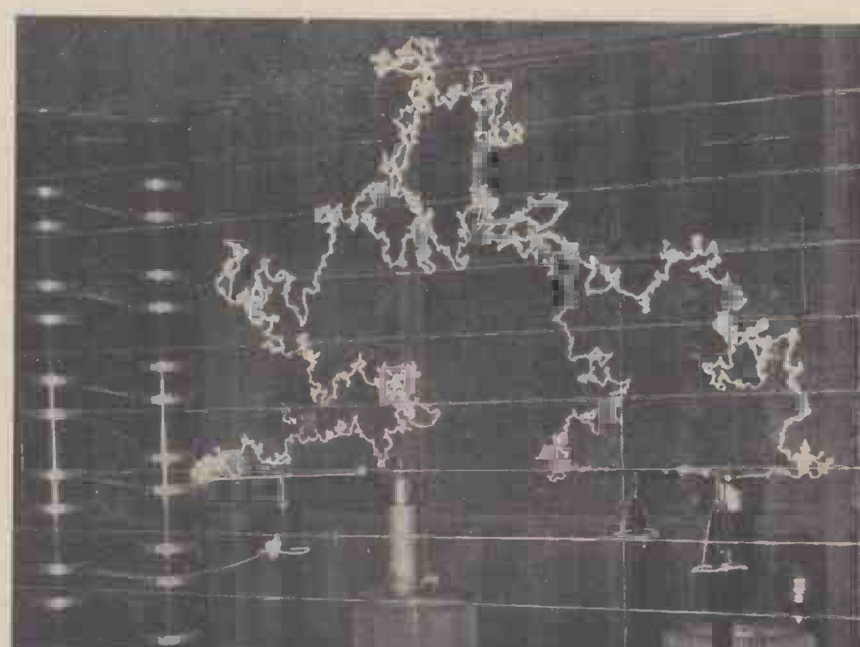
The Talking Flashlight

Perhaps the most fantastic demonstration is that of the "talking flashlight." The lecturer whispers into one end of the strange instrument, focuses its beam on a loud-speaker some twenty feet across the stage, and the auditorium resounds with voice. What happens is that the whisper is transferred into light, carried over the light beam to a photo-electric cell, and then changed again into sound, greatly magnified.

On an animated rainbow-like chart, spectators see that Mr. Goodyear's early experiments in vulcanizing have resulted in a rubber industry now employing nearly half a million persons. With the experiments of Bell and Morse and Marconi began a far-flung communication system giving work to almost a million more. From "Drake's Folly" sprang the petroleum industry and jobs for another million. With Franklin, Faraday, and Edison began a great electrical industry now employing a million and a half persons. Bessemar led the way for the steel industry with its three and a half million payroll. In 1895 came Steven Duryea's horseless carriage, and—woe be unto the prophets of the time—it came to stay. And more than six million persons now owe their livelihood to the automotive industry.

The Climax

And then for the climax of the show the audience is shown a breath-taking array of new inventions and discoveries, many things the spectators see for the first time. There is, for example, a pair of women's hose as shear as the finest silk, but stronger. And from what are they made? Coal, black coal, from mines! There's a yarn that looks like wool, feels like wool, and wears like wool. It even smells like wool when it burns. But it's made from milk. And the old joke about the wooden spectacles isn't a joke any more. There *are* wooden spectacles. The lenses are made of plastic "glass," a new non-breakable product that is clearer than glass and can be ground, cut, or moulded. And it is made of coal, air, and wood. Another synthetic glass that Mr. Foss shows his audience is the cold-light tube that can pick up light at one end and carry it through to the other while the tube remains cold.



Electrical fireworks of a weird beauty appear as a three-phase million-volt arc crackles between the tips of three five-foot spinning arms, which resemble elongated dumbbells, during a display of electrical equipment at the General Electric building at the New York World's Fair. This equipment has been reproduced from the three-phase million-volt arc used in tests in the high voltage laboratory of the General Electric Company at Pittsfield, Mass. It has been dressed up to accentuate its spectacular effects.

"PRACTICAL MECHANICS" WIRELESS SUPPLEMENT

A "STAND-BY" CRYSTAL RECEIVER

Fig. 1.—This view of the finished receiver gives a good idea of its size in comparison with a pair of headphones.

An Efficient Crystal Receiver Forms an Ideal Stand-by Arrangement for Emergencies

JUDGING by the numbers of inquiries received about crystal receivers, it would appear that they are again on the upward swing of the cycle of popularity. Whether this is due to the appreciation of the splendid quality of their reproduction, when used in conjunction with a good pair of headphones or a high-fidelity amplifier, the fact that they are not dependent on batteries or mains supplies for their operation, or the less pleasant realisation that they are ideal for emergency use in A.R.P. shelters, cannot be determined from available records. The fact remains, however, that a compact, sturdy, foolproof receiver is required by many of our readers; therefore, the model described below has been produced to meet those demands.

A Warning

For the benefit of those who have not yet used a crystal receiver and, incidentally, for those who have not used one since the day when they switched over to a more ambitious valve set, a few words of warning concerning what some might call the defects of this type of receiver would not be amiss.

It must be appreciated that during these days of high-powered transmitters the selectivity of a circuit plays a very important part in satisfactory interference-free reception. The required degree of selectivity is invariably obtained by the use of several tuned circuits employing coils designed to give the utmost selectivity; the fact that a certain loss in efficiency is often produced is not so serious in the case of a receiver using modern valves, as the overall arrangements can be so designed to provide an adequate surplus of power under normal or average conditions.

Selectivity

With the more simple crystal circuit, however, it is not possible, owing to its sensitivity and effective range of reception being within fairly definable limits, to obtain a degree of selectivity comparable with even a one-valve set using reaction. With some types of crystal set quite sharp tuning can be secured, but, generally speaking, the characteristics of the crystal, the fact that loosely-coupled circuits cannot be used *adlib* by reason of signal strength, and the remaining consideration of simplicity, make the selectivity of a crystal set a

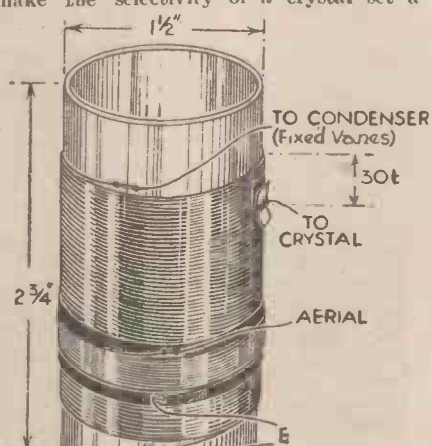


Fig. 2.—Details of the coil.

factor which tends to limit its application nowadays.

This does not mean that it is a one station arrangement except, of course, for those who are living within the swamp area of a transmitter, but it does mean that razor-edge tuning must not be expected by all users, and that local conditions can play a very important part in the performance of the set. At Tower House, both the London stations can be received without noticeable interference, though it is possible to hear, faintly, the other station when the one to which the set is tuned has a break in the programme. In S.E. London a higher degree of selectivity is obtained and, as a point of interest, Radio Normandie can be heard when the locals are off the air.

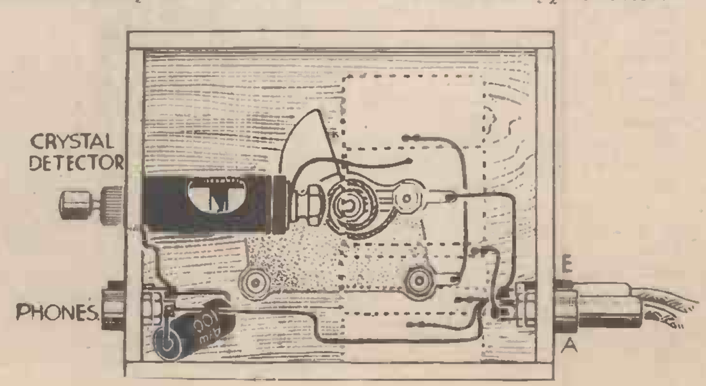
With the majority of crystal receivers, trouble is often experienced on the long waves by the "break-through" of the nearest medium-wave station. Admittedly this can be overcome by inserting in series with the aerial lead-in a suitable inductance and tapping the aerial well down the tuning coil, but as this only complicates matters and as the same programme as that of the long-wave National can be heard on the medium-wave National, it was decided not to include a long-wave section on the coil specified for the "Stand-by" receiver.

Design

To obtain the maximum amount of selectivity consistent with signal strength, the aerial is coupled to the crystal circuit by means of a small coil wound over the tuned section, while the crystal is tapped down its associated coil to reduce damping effect. The tuning is carried out by means of a .0005Mfd solid-dielectric variable condenser connected across the whole of the secondary winding.

For simplicity and reliability a detector of the semi-permanent type is used as it is far less susceptible to vibrations, and it allows a sensitive point to be obtained without the fiddling adjustments associated with the old cats-whisker type of detector.

Fig. 3.—Rear view, showing the layout of components and wiring.



The theoretical circuit is shown in Fig. 4, and owing to its simplicity it does not call for any detailed explanation.

Construction

To make the receiver as compact and robust as possible, all the components are mounted in a small wooden box measuring $4\frac{1}{8}$ x $3\frac{1}{2}$ x $2\frac{11}{16}$-in. The one used was fitted with a sliding lid and supplied in plain whitewood finish. The latter item is a consideration as it allows the case to be painted or finished off according to individual taste.

Assuming that the sliding lid forms the back of the receiver the tuning condenser is mounted on the centre of the front panel. Along the bottom edge of the left-hand side are fitted two small Clix sockets for the aerial and earth connections, while in a similar position on the right-hand side are fitted two more for the headphones. Terminals could, of course, be used for these connections but they would not give such a neat finish, and would be likely to work loose in the wood fixing.

Just above the headphone socket a hole can be drilled to accommodate the crystal detector, but before fixing this component in position, connections can be made between the earth socket, the moving vanes of the variable condenser, one telephone socket, and the .001Mfd tubular condenser can be joined across both headphone sockets.

After this, mark off the fixing hole for the coil on the outside of the bottom section of the box, taking care to see that it is located clear of the variable condenser and the lid. At the point thus marked a hole can be made to take a $\frac{3}{4}$-in. countersunk screw to hold the coil in a vertical position inside the case.

Once the coil has been fixed, the remaining connections, namely, the aerial, the crystal detector, one side of the phones, the fixed vanes of the tuning condenser and, finally, the earth connections can be completed. The receiver is now ready for testing.

Operation

With a set of this type it is very desirable to use an aerial of, at least, average efficiency but, on the other hand, don't use one of excessive length with the idea of increased signal strength unless you are well away from your local station, otherwise selectivity will be poor.

With the headphones in position, rotate the tuning condenser until a station is heard, and then adjust the crystal detector to obtain the most sensitive contact. When doing this, be sure to *withdraw the plunger* before *rotating* or else the crystals will be damaged. If the set is silent and you are satisfied that aerial and earth, and all wiring are in order, it is possible that the crystal is not making satisfactory contact, so make the adjustment as mentioned above.

Don't overlook the fact that the strength of the rectified signal allows nothing for wastage, so it is very essential to use a good pair of headphones.

LIST OF COMPONENTS FOR "STAND-BY" CRYSTAL SET.

- 1 Coil (T. W. Thompson), 2/-.
- 1 Perikon Crystal Detector (Electradix) 2/-.
- 1 .0005 Tuning Condensor (Jackson Bros.), Type 2093, 2/6.
- 1 Plain Wooden Case (T. W. Thompson), 9d.
- 1 Scale (Electradix), 2d.
- 1 .001 Fixed Condenser, Dubilier Type 4601/S, 1/-.
- 4 Clix Sockets, No. 8, with 4 extra nuts, 8d.
- 2 Clix Plugs, No. 35, 5d.
- 2 Clix Plugs, No. 1, 4d.

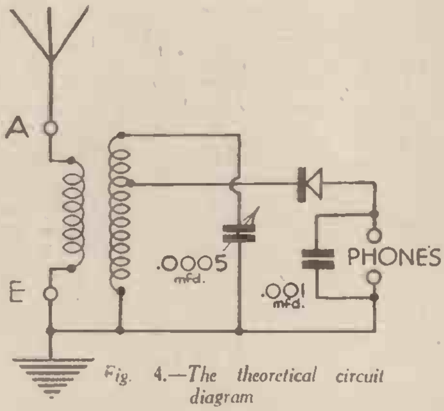


Fig. 4.—The theoretical circuit diagram

ITEMS OF INTEREST

World Glider Record

MR. T. BELLAK, a 27-year-old American pilot, recently set up a World record for the longest flight ever made over water in a soaring 'plane. He flew across Lake Michigan from Sturgeon Bay, Wisconsin, to Frankfort, in a German-built glider. The direct route is 54 miles and his flying time from shore to shore was 56 minutes, however he travelled 90 miles and was in the air 2 hours 39 minutes. The previous record for a glider flight over water was 31 miles, made last April by an Englishman who crossed the English Channel.

Liquid Coal

A NEW colloid fuel was recently demonstrated in America by the Armour Institute of Technology, consisting of 40 per cent. coal and 60 per cent. range oil. It is for use in cars, and during the demonstration no change in any part of the engine or carburetter was necessary except for the removal of one fine screen from the carburetter.

The "Colour Organ"

EXPERIMENTS were recently carried out in America with a new scientific instrument known as the "colour organ" which is capable of measuring the exact colour stimulus of sound. With this instrument it is possible to hear and see music at the same time, as the tones are made visible in various shades of colour.

Psychologists will find the colour organ of particular interest because it will enable them to study the co-relation between sound and colour.

Cataloguing the Stars

THE Astronomy Department of the Northwestern University of America have perfected a device called a "photometer," in which a light beam 1/100 in. in diameter is used to measure the brightness of stars 300 times fainter than those visible to the eye. This precision instrument is now being employed for cataloguing faint red stars and when concluded will include more than 300,000 stars, only 5 per cent. of which have previously been classified. The work will take about ten years to complete.

Undersea Exploration

RECENTLY launched at Nassau, Bahamas, was Mr. J. E. Williamson's new barge *Jules Verne III*, in which he will conduct underseas exploration sponsored by the Bahamas Government.

The barge which is rather an odd looking craft, the third of her type to be built at Nassau, is between 40 and 50 feet long, with approximately 17 feet beam, and is designed to operate as mother ship for the operations of the Williamson Submarine Tube and Photosphere, in which Mr. Williamson will conduct his underseas exploration.

A great hole in the bottom of the craft permits the lowering of the huge flexible tube and photosphere down into the sea, and when the mother ship moves along, the tube carrying observers and cameras move over the floor of the ocean. Many of the photographs which will be taken will be in natural colour.

Mr. J. E. Williamson's "Jules Verne III" during her launching at Nassau recently

INSECT FLIGHT

How High-Speed Cameras and Microscopes have Unravelled the Mystery of Insect Flight

THE flight of insects is even more wonderful and complicated than that of birds; but its study is more difficult. With the aid of a high-speed film camera taking about 12,000 shots a second, the microscope, and field studies, the "secrets"

The common housefly has the highest number of wing beats per second of insects with 160.

of insect flight have gradually been unfolded. That these are no mere casual flittings in the sunshine is obvious from the well-studied migrations of certain insects. The American monarch or black-veined brown butterfly (with a wing spread of 4½ in.) migrates from the Hudson Bay area of North America south to Florida and a few specimens even across the Atlantic to Britain and France, and westwards to Hawaii in the Pacific. There are the great migrations from North Africa and the Continent to Britain every year of swarms of silver Y moths, which have been noted passing the St. Catherines and Muckle Flugga lighthouses, of painted lady and red admiral butterflies, of Camberwell beauties from North Europe and numerous hawk moths. The death's head, our largest moth, has been caught more than 200 miles out at sea.

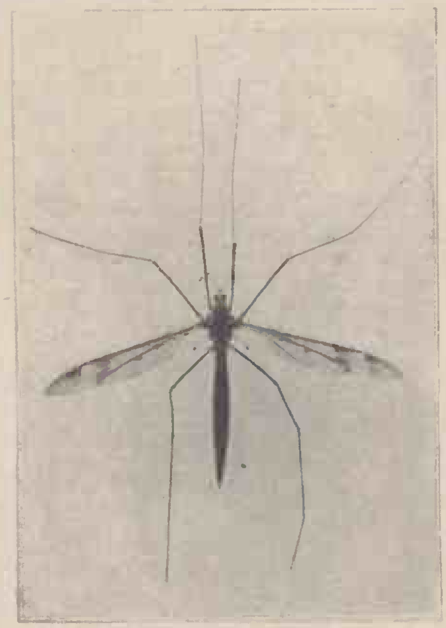
Bees and Moths

Did you know that the flying bee and some moths have each pair of wings hooked together by minute hooks, or hamuli, so that really they fly as a monoplane? The dragonfly, however, uses each wing separately, almost like an autogiro, and can thus hover and even fly backwards a little. The tails on the swallow-tail butterfly give it great speed on the wing. With flies two tiny microscope knobs on the thorax—the halteres, a degenerate second pair of wings lost in evolution—act as balancing organs, while the vibrating flap on the lower wing margin of bees, bot-flies, etc., gives their warning buzz.

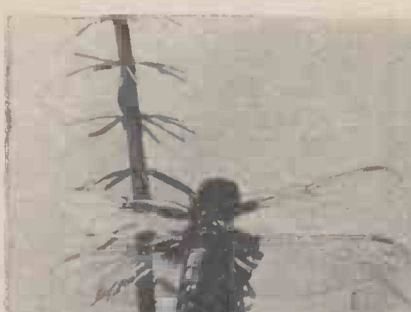
With the aid of ultra rapid ciné filming, taking 12,000 shots a second, Prof. A. Magna found that the highest number of wing-beats per second in insects is 160, with the stable and houseflies. Most two-winged flies make a wing vibration of over 100 per second; the crane fly or daddy long legs makes only 48, the bumble bee 128, the wasp 53, the silver Y moth 48, the painted lady butterfly 21, the dragonflies 20 to 40, and the mayflies 29. Beetles range from 33 to 72 vibrations per second.

Misnomers

These latter researches have corrected some misnomers of earlier workers who estimated much higher speeds, giving the housefly 330 wing beats a second, the drone fly 240, the bee 190, wasp 110, humming bird hawkmoth 72, dragonfly 28 and butterfly 9. One of the most useful corrections



The crane fly, which is more familiarly known as "daddy long legs," has a wing vibration of 48 wing beats per second.



The wing beats of a dragon-fly vary from 20 to 40 beats a second.

This butterfly, called the Camberwell Beauty, is capable of flying great distances during the migration period.

made by scientific research is its disproving of the widely quoted fallacy that the deer bot fly of North America holds the record flying speed at 818 m.p.h.! At such a speed it would, of course, puncture the skin of any human being with whom it came into contact; but Dr. Irving Langmur, Nobel Prize winner, working in the General Electric Company laboratories at New York, showed that because it is fat bodied, flat headed and without natural streamlining, the body of this fly could not withstand the air pressure at such speed and would collapse, crushed in by the weight of air. To maintain its fabulous speed it would need about one-half horse-power, and would have to consume 1.5 times its own weight of food each second to deliver the 370 watts or nearly half horse power of energy necessary! The fact that the fly is so fast that it looks but a blurr to the human eye is no guide to great speed, for laboratory light intensify measurements show that a deerfly in flight is invisible at speeds of 64 m.p.h. and above.

Speed is not just a matter of wing beats, however, but depends upon the relations of wing surface to body weight. The gnat or mosquito which does little more than gyrate up and down in the air in gatherings of courting males, has a body weight of 3 milligrams, a wing surface of 30 square millimetres, and a surface area per kilogram of 10 square metres. A more lengthy flier, a butterfly with a weight of 20 centigrammes, and a wing surface of 1,663 sq. mm., has a proportional surface per kilogram of 8⅓ sq. metres.

Respiration

One of the subsidiary uses the insect makes of flight is to aid its respiration and thus "refuel" for the extra energy required. Insects do not breathe by lungs as do the higher animals. Their bodies are permeated by a series of branching air-tubes, called the tracheae, which conduct the fresh air from inlets, or stomata, along the sides of the body. Thus when the wings are being raised and depressed by the body muscles—the body wall is contracted and expanded and thus pumps in and out of these air tubes a quicker flow of air than would otherwise be obtained. Thousands of tiny muscles are used to vibrate the wings. There are two chief dorso-ventral muscles working vertically from the back to the belly, and then muscles attached from the sides to a central keel, so that the body walls and the back are expanded and contracted independently and the wings, which are at the top of the sides, are raised and depressed accordingly. There are smaller muscles attached directly to the wing-roots.

Where there are two pairs of separated wings, the hindermost pair usually do the vibrating while the front pair are held out stiff like the wings of an aeroplane. This is very noticeable in beetles, which have the front pair hardened to form a protective sheath or elytra for the gauzy flight wings, and in the earwig the flight wings are very long, and fold under the elytra.

When you look at the wing of a bee or a fly you notice the outer margin is hardened by a strong costal nervure, which increases the vibration on the inner margin: also the main part of the wing is supported by a series of chitinus veins which have a definite branching formation with various species. When depressed against the air the latter part of the wing, soft and unguarded, naturally "gives" and the wing thus strikes obliquely and both supports and drives the insect forwards.

Twists in the wing are arranged in such a way that upon elevation the forewing practically cuts the air with its hard front edge, obliquely placed, and thus exposes as little resistance as possible, although when lowered the whole surface comes into action. For this reason the base of the wing, where it joins the body, is so much narrower than the extremities. When the body is contracted by the muscles from the back to the under surface, the wings are raised, and when those running longitudinally contract and thus alter the shape of the thorax, the wings are depressed.

COVERING MODEL AEROPLANE WINGS

Methods of Covering with Silk and Tissue, and of Applying Dope.

THE covering of model aeroplanes with Japanese tissue usually presents rather a problem to the beginner. Many well-built models, where the builder has exercised care in the construction of the framework, have been spoilt by poor covering. Wrinkled tissue spoils the appearance of the finished machine and most certainly does not improve performance.

Before the introduction of balsa wood construction, Jap silk and oiled silk were in wide use; in fact, the former is still sometimes used in the construction of petrol-engined machines, but even this has been superseded by bamboo paper, which is cheaper and more easily applied. The characteristics governing the application of bamboo paper are similar to those for jap tissue, except that stronger adhesives and dopes are used.

Atmospheric Conditions

First, consider how atmospheric conditions affect the tissue. Jap paper, of course, tightens under the application of heat and slackens under cold or damp, whether already shrunk or not. This obviously is due to the covering expanding when moisture is absorbed and contracting when moisture is drawn out. It is easily seen, then, that if the tissue can be applied in a humid atmosphere (expanded) and then dried (contracted) a good, wrinkle-free covering should result.

Doping, of course, must be done in a room with a temperature of about 70 degrees F., but how many beginners realise that it is foolish to do covering in such a temperature? The tissue will have had all the moisture drawn out and directly the model is taken into a colder, damper atmosphere, the covering will slacken and several coats of dope will have to be relied upon in an attempt to pull out the wrinkles, which will add weight, and then probably not remove all of them.

However, the methods described here have been found to be very satisfactory and should prove a solution to all the problems pertaining to covering with which the modeller is faced.

"Grain" of the Paper

Assuming that a wing half is about to be covered, the "grain" of the paper (which may be seen by holding a sheet to the light) should run parallel to the spars. Since the maximum contraction of jap tissue is always at right angles to the "grain," this will ensure a good tightening across the chord. A point worth bearing in mind is that it is always advisable when constructing a wing to sink the spars below the level of the ribs, to allow for the "sag" of the covering between. Sag is always present to a degree, whatever the direction of the grain. It is a good idea also to spend several minutes giving the frames the "once over" before commencing the covering, removing cement blobs, etc., and making sure that all joints are secure.

Keeping the Tissue Damp

As it is unlikely that the modeller will always have a humid atmosphere at his disposal, some way of keeping the tissue damp must be employed. This is the method used with success by the writer. Obtain several large sheets of blotting paper (or any other paper with an absorbent texture, such as newspaper). Lay them out five or six sheets thick, then get a clean cloth and, after wetting, wring it out and lay between the sheets. Next cut a piece of tissue sufficiently large to cover the section and, after removing the cloth, place between the sheets of paper.

Now apply the adhesive to the framework. Dextrine mounting paste is probably the best, except for the ribs of undercambered-section wings, where more strength is required. Waterproof glue or cellulose cement of the "not-too-quick drying" variety is best here, and will prevent the tissue from coming away from the ribs whilst drying.

It is a good idea to paste the framework in all places where the covering will contact, as this adds strength and makes repairing a damaged section easier. Now remove the tissue from between the sheets of paper and lay on the framework, fixing at the root-rib, pulling out towards the tip and working it smoothly on to the leading and trailing edges and tips with the fingers.

After a minute or two the covering will be found to be quite wrinkle-free. When the modeller gets used to this system, complicated curves may be covered quite easily, since the damp tissue will curve in two directions to a certain extent, without wrinkling. Sections about fifteen inches by 5 inches, however, should be covered with more than one piece. Larger pieces are difficult to handle and dry out too quickly.

This method is especially suited to lightweight models, where, perhaps, only one thin coat of nitro-dope must be applied.

Apply Evenly

It must be stressed at this point, however, that the tissue must not be allowed to get wet, as it becomes extremely fragile, and if it does not tear whilst being affixed to the framework, will split when drying.

The covering may now be sprayed with water. Brushes should be avoided for this, since the tissue is likely to give under the pressure of the brush. The tissue should be well soaked, but not so that pools of water form. If the tissue has been applied evenly, no warping should be evident; however, to be sure, it is best to pin the surface down to a flat board. If any "wash in" or "wash out" is to be employed. i.e. increase or decrease of incidence angle at the wing tips, this may be applied at this stage by placing small blocks under the wing in the required positions. Allow a good time for the water to evaporate. Do not try speeding up the procedure by holding the wing in an atmosphere of excessive heat. When dry, the tissue should be perfectly taut, requiring dope only for filling the pores, and thus rendering the covering airproof.

Doping

Dopes need only to be of the "nitro" variety, which have little or no powers of contraction. Although as in the case of cellulose acetate, these must be applied fairly quickly, since they dry in a few minutes. A brush is quite in order here, but should be soft and of good quality. Do not attempt to go over a part previously covered whilst doping, ugly brush marks will appear when dry.

Nitro-doped coverings have the advantages of not easily being affected by changes in humidity, thus making the tissue practically waterproof. Nitro-dopes such as banana oil may be applied over dry cellulose-acetate dopes, but as banana oil is soluble in cellulose, the latter should not be applied after a coat of nitro dope.

Since lightness is a chief factor contributing to the performance of an endurance model, coloured dopes, lacquer, or cellulose finishing paints are not generally used on this type. The appearance of scale models, however, and other types where duration of flight is not the main consideration, can be greatly enhanced by the application of gloss dopes or paint. As in the case of clear dopes, two thin evenly applied coats are better than one thick coat. Only paints which have been specially prepared or recommended for model aircraft should be used, of course.

QUERIES and ENQUIRIES

A stamped addressed envelope, three penny stamps, and the query coupon from the current issue, which appears on page 600, must be enclosed with every letter containing a query. Every query and drawing which is sent must bear the name and address of the sender. Send your queries to the Editor, PRACTICAL MECHANICS, Geo. Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2.

SHUTTER FOR POULTRY HOUSE

"I AM a poultry farmer on a small scale, and have designed a clockwork shutter which opens at any time desired.

"It is worked on the alarm clock principle, and I have had it working on four poultry houses for about 12 months and it has given every satisfaction. Does it form fit subject matter for taking out a patent?"—W. H. (Essex).

THE improvements in shutters for poultry houses forms fit subject matter for protection by patent, and, if novel, should have every prospect of being made a commercial success.

The cost of making a search to ascertain the novelty of the invention would be almost as expensive as filing an application for patent with a complete specification, and the official search for novelty is not made until after the filing of a complete specification. If you wish to ascertain the novelty of your invention as early as possible, it would be advisable to file the patent application with a complete specification in the first instance.

If, however, you desire to obtain protection at the least expense, you are advised to file an application for patent with a provisional specification which will give you protection for about twelve months, during which time you should be able to ascertain if the invention is likely to prove commercially successful before having to incur any great expense.

ILMENITE AND ILRAITE

"IS ilraite different from ilmenite?

"What is ilmenite used for?

"Where can I obtain rocket motors, particularly in small sizes?"—E. W. (Chatham).

ILMENITE is a naturally-occurring mineral of an almost black colour. It consists chiefly of titanite of iron mixed with titanium, iron and manganese oxides. It is so called because it was first discovered near Lake Ilmen in Siberia. As a source of titanium, ilmenite has, at times, been used, but it is nowadays very little in evidence.

The term "Ilraite" was at one time used to designate a synthetic plastic composition which is now more or less obsolete.

We presume that you refer to rocket motors for aircraft use. These, however, are not commercial articles in England, but you may be able to obtain advice regarding the possibility of obtaining one from Model Aircraft Supplies, Ltd., 171, New Kent Road, London, S.E.1.

COPPER TUBING

"IS copper tubing used in the manufacture of refrigerating machines using sulphur dioxide as the refrigerant?"—J. S. (Worcester).

COPPER tubing is frequently used in sulphur dioxide refrigerating machines, since sulphur dioxide gas has no action upon copper provided that the gas itself is reasonably dry—that is to say provided that it does not contain more than about 0.3 per cent of moisture. If the sulphur dioxide contains more than this amount of moisture, a portion of it will be converted into sulphurous acid which will attack the copper.

With dry sulphur dioxide, copper tubing may be safely used. It should preferably comprise the seamless variety of tubing.

INFRA-RED RAYS

"CAN you tell me a simple method by which infra-red rays may be made visible to the eye? e.g., by looking through a specially tinted glass.

"What is the principle of 'black' light? I recollect having heard of a substance which is only visible when this 'black' light is shone upon it. Can you tell me what this substance is?"—R.M. (Forest Gate, E.7).

THERE is no method by means of which true infra-red rays may, as such, be made visible to the eye. The very shortest infra-red rays (i.e. those existing just below the deepest visible red of the spectrum) may be perceived in a darkened room as an extremely faint dull red glow. Normally, however, infra-red rays do not produce the sensation of light. The only ways in which they may be made manifest are by temperature effects, photographic methods, electrical means and spectographic methods.

"Black light" is a term which has been erroneously used by journalists and others to describe the infra-red portion of the spectrum. There is no material which glows when exposed to infra-red rays, for the simple reason that such rays do not possess the necessary energy to set up glow-reactions. As mentioned above, however, infra-red rays may be rendered manifest by photographic means. It is now possible to purchase specially sensitised infra-red plates and films and thus to photograph objects which are "illuminated" only by infra-red rays. To the visual observer, such objects are photographed in complete darkness.

PRODUCING BLACK SMOKE

"I WOULD like to hear of some method of producing heavy black smoke, chemically or by other means, the apparatus to be small and light in order to apply it to flying model aircraft."—J. B. (Yeovil).

THE only method of obtaining *black* smoke is by applying some process of combustion. Heavy black smoke is produced by burning camphor, turpentine, naphthalene and similar materials. Utilising such means on model aircraft must necessarily bring about the risk of fire to the machine, but this is unavoidable.

For the smoke-producing material, we would recommend camphor, since it is light and compact. Alternatively you could employ a paste made of camphor and turpentine. You would have to design a special metal chamber to hold this fuel. Preferably it should have, also, an external lining of asbestos sheet in order to insulate the heat of the device from the remaining portions of the plane. The fuel would be burned at one or more broad jets, suitably screened, in order to prevent the flame from being extinguished by the rush of air.

We feel bound to state that the above "combustion" method of producing black smoke has many inherent difficulties and drawbacks, and you would do better to confine yourself to the white "smoke" which can be obtained without fire by the use of chemicals such as tin chloride, titanium chloride, etc.

MAKING JOSS STICKS

"I SHOULD be very pleased if you would kindly forward me instructions for making joss sticks and perfumed incense cones." J. P. (East Dulwich, S.E.22).

THE perfumed sticks to which you refer are best prepared by soaking thin wood shavings in a moderately strong solution of saltpetre for a few days. They are afterwards dried without rinsing and immersed for a few hours in rectified or surgical spirit containing in solution a few drops of some pleasantly odiferous essential oils, such as oil of lemon, oil of rose, oil of musk, oils of thyme, bergamot, cloves, orange, cinnamon, etc. It is also advisable to dissolve a little gum benzoin and storax in the spirit.

The easiest way to make incense cones is to purchase a little genuine incense powder and to mix it with about a quarter of its weight of saltpetre. Then make the mixture into a stiff paste with gum water or shellac solution and mould it into a number of cones. These, when lighted at the apex, will take fire and will smoulder, emitting the characteristic perfume of incense. The rate of smouldering is largely governed by the quantity of saltpetre contained in the mixture.

Powdered incense can be obtained at the majority of church furnishers, or from The Cellerar, Prinknash Abbey, Gloucester, price about 3s. 6d. per lb., in the cheapest grades.

PROJECTING STEREOSCOPIC MOTION-PICTURES

"I HAVE produced a device for taking and projecting stereoscopic motion-pictures. Do you think it has any commercial possibilities, and do you consider it novel and fit for patenting?" G. B. (Lancs.).

THE improved method of taking and projecting stereoscopic motion pictures, is thought to be novel and, provided it is a workable arrangement in practice, forms fit subject matter for protection by letters patent. Subject to the practicability of the invention it should have great commercial possibilities. You are advised to make a thorough search amongst literature and patent specifications to ascertain the real novelty of the invention, as very considerable research work has been devoted to this subject particularly by a Dr. Ives.

It is presumed that the invention has not yet been reduced to practice or proved by actual experiment, because it is thought that some difficulty will be experienced in actually making apparatus to carry out the theory.

You are probably aware that two sets of pictures, each corresponding to the left or right view, projected simultaneously or alternately upon a screen, will not produce a stereoscopic effect when viewed by the naked eye.

EXTRACT FROM SEAWEED

"I BELIEVE that certain gelatine-like substances can be derived from seaweed. Can you tell me how to extract two of these:

"The gelatine-like extract with the lowest melting point. At what temperature does this substance flow freely?

"The gelatine-like extract with the highest melting point.

"Is the latter substance soluble in sea-water and, if so, what could be added in order to render it insoluble but still maintaining a fairly high melting point?" J. G. (Glasgow, C.4).

IT is impossible to answer your queries exactly, since we are not aware of the precise species of seaweeds from which you propose to extract your jellies. However, in general, the mode of procedure which you should adopt is as follows:—

Obtain the seaweed as fresh as possible, wash it well in order to remove saline matter and then shred it up. Now gently simmer the weed for about an hour in clean water. About 40-60 per cent. of it will go into solution. Add now to the simmering liquid a handful of powdered animal charcoal and simmer the solution for a further quarter of an hour. Finally, strain it through cloth. A nearly colourless liquid will result, and this will set on cooling. The solution will flow easily at a temperature of approximately 60 degrees C.—the exact temperature depending upon the strength of the solution, its composition, and whether it contains any inhibiting impurities.

By extracting only the *stems* of seaweeds in the above manner, you will get a low-melting jelly. Extracting the entire bulk of most weeds gives a jelly of fairly high melting point.

Also, by cautiously adding hydrochloric acid to a seaweed jelly, its constituent pectin will be precipitated as pectic acid, and the residual solution, after filtration, will "set" only at a lower temperature and on greater concentration.

These jellies are moderately soluble in sea water, but can be to a certain extent insolubilised by adding to them about two per cent. of formalin.

A BIOLOGICAL INCUBATOR

"I AM proposing to make a small incubator from a biscuit tin for use in biological work at school, and wish to incorporate some device for keeping the temperature constant. I believe there is such a thing as a thermostatic capsule, but have no details of it beyond its name. Can you supply any suggestions for above?" J. B. (Kettering).

YOU do not state whether you wish to make or to purchase a suitable thermostat for your biological incubator, and also you do not mention whether the incubator is to be gas or electrically heated.

It is not an easy task to make a thermostat which will operate effectively over a definite temperature range, and we would advise you to purchase one suitable for your needs.

Both gas-operated and electric thermostats can be obtained from Messrs. Philip Harris & Co., Ltd., laboratory furnishers, Birmingham; and we believe that electrically operated ones can frequently be obtained from Electradix Radios, Ltd., 214 Upper Thames Street, London, E.C.

In making inquiries for a thermostat, you should not omit to mention whether a gas-operated or an electrical one is required, and also the temperature range at which it is to operate.

There is an article on "Thermostats and Their Uses" in the issue of "Practical Mechanics" for May. 1937.

MAKING A REFRIGERATOR

"CAN you please inform me how to construct a refrigerator or cold box without having to use ice, and what material is best for packing between the two shells assuming the box would consist of a container with an inner lining. I have heard there is a compound to which water is added that creates the necessary action." C. B. (London, N.4).

YOU refer to a cold box cooled by a so-called "freezing mixture." Such a device is certainly expensive to operate on account of the cost of the chemicals needed, and it is doubtful whether it is as satisfactory as an ordinary ice box.

However, a "chemical" cold box may be made by constructing an ordinary wooden box of suitable dimensions. Inside the box is placed another smaller box (which should be of metal), the dimensions of the inner box being such that a space of about 1½ inches is left between it and the outer box. This space is packed with curled hair, dried seaweed, fibre or other heat-insulating material, and it would be advantageous also if the inner walls of the outer box were lined with thin sheet asbestos.

A lid, lined with sheet asbestos, is provided, care being taken to see that it is a tightly fitting one.

Within the inner metal box is placed the container carrying the articles which it is desired to refrigerate, and around this central container is packed the freezing mixture.

WATCH REPAIRING AND ADJUSTMENT

(Continued from page 588)

daily rate" forms the basis for deciding the consistency of daily rate.

To obtain an "A" certificate the change of daily rate with change of temperature must be less than 0.3 second per 1 degree Fahrenheit; the mean daily rate must not be more than 10 seconds; the mean variation of daily rate must not be more than 2 seconds in any of the eight periods; pendant-up and dial-up positions must not vary by more than 5 seconds, 10 seconds for pendant-up and any other position. To obtain full 100 marks (20 marks for temperature compensation, 40 marks for position adjustment, and 40 marks for consistency of daily rate) a watch would have no temperature error, its rate would be constant and unaffected by change of position.

The formula used to determine the marks is :—

$$40\left(1-\frac{a}{2}\right)+40\left(1-\frac{b}{10}\right)+20\left(1-\frac{10c}{3}\right)$$

a = mean variation of the daily rate for the whole eight periods.

b = the mean variation with change of position (six periods only).

c = the mean change of the daily rate for 1 degree Fahrenheit.

The first part of the formula will be considered as an example, viz., the consistency of daily rate $40\left(1-\frac{a}{2}\right)$, the average of all the results shown in column 7, Fig. 4, is 0.070. Substituting this result for "a" gives

$$40\left(1-\frac{0.070}{2}\right)=40\ (1-0.035)=40\ (0.965)$$
$$=38.6$$

38.6 marks out of a possible 40. By similar methods, the values of the other quantities "b" and "c" can be found. A watch with 80 or more marks is endorsed "especially good."

BUY, EXCHANGE OR SELL

TOOLS—*Continued*

GRAYSON'S Glass-boring Outfits and Tube. Cutters avoid risk.—Below.

DRILLS, Taps, Dies, Files, Chisels and Punches. Best quality at keenest prices.—Grayson & Company, 300 Campo Lane, Sheffield.

120 Combined Engineers & Woodworkers Vices, a most useful tool in any workshop, 6″ Jaws, opens 4½″. Clearance price, **4/9** each; honestly worth double, —Below.

500 Woodworkers Vices, 4″ Jaws, clear **2/9** each.—Below.

85 Machine Vices for Drilling or Milling Machine. Robust design, Width of Jaws 2¾″, opens 3¾″, very cheap to clear, 3/3 each, below.

150 S.A.E. Split Dies, 2″ Diam. cutting ⅝″; ¾″; 1″, clear **2/-** each.—Below.

48 Split Dies, 2″ & 2¼″ Diam., ¼″ to 1″ Whit & B.S.F., **2/9** each, subject unsold.

1″ Round Dies, Screwing ¼″; 5/16″; ⅜″; 7/16″; ½″; Whit., B.S.F.; or Brass 26 Threads; or American Fine. S.A.E. for Yankee Cars, Set of Five Dies **2/9**; Four Sets **10/-**; Best Quality 1″ Die-Stocks, all Steel unbreakable with Hardened adjusting Screws, **1/9** each.—Below.

4,000 Taps, same sizes and threads as Dies, **2/9** set, four sets **10/-**.—Below.

Vee Blocks and Clamps, Starret pattern, accurate, first-class finish, 4/- pair.—Below.

Fine Emery Wheels, 1/16″ to ⅜″ thick, ¾″ hole; 2½″ to 4″ diam., extremely useful for Grinding Drills, Small Tools. Special selection, 2/6 per doz.—Below.

250 Gross Genuine Tungsten Hack-Saw Blades, 8″, 9″, 10″, 12″, 14″ to 32″ teeth; ½″ wide; a few gross 12″ ⅝″ wide. These are very slightly stock soiled, but guaranteed serviceable, **8/6** gross. Three gross lots, **22/6**. Power Blades, 12″ by 1″, **2/6**; 14″, **3/6** doz., subject unsold.—Below.

J. BURKE, 30 TRIPPET LANE, SHEFFIELD, 1

TOOLS—*Continued*

Special Clearance guaranteed quality Small Taps and Dies, 13/16″ Circular Split Dies, British and American make only. Usual price 10d. to 1/3 each. Sizes: ⅛″; 5/32″; 3/16″; 7/32″; ¼″; 9/32″; 5/16″. Whitworth, B.S.F. also Model Engineer 40 Threads in all above sizes; also 0, 1, 2, 3, 4. 5, 6 B.A. Clear **6d.** each, 5/6 doz. —Below.

Small Taps in all above sizes. Taper; Second or Plugs, ⅛″ to ¼″, Whit., B.S.F. Also 0 to 6 B.A. **4d.** each; 3/- doz.; 9/32″ and 5/16″ **6d.** each. Please note we have no stock of M.E. 40 Thread Taps.—Below.

Die-Stocks for above Dies, steel throughout, hardened adjusting screws, **9d.** each; Tap Wrenches, 0 to ¼″ Adjustable, all steel, **9d.** each.

700 Cutting Off Grinding Wheels, approx. 7½″ diam. ⅛″ thick, ¾″ hole, 2/6 each; ditto, approx. 6″ diam. **1/9** each.—Below.

Hexagon Die-Nuts, invaluable to all repair shops, Genuine clearance prices: Whit., B.S.F., S.A.E., sizes ¼″, 5/16″, ⅜″, 7/16″, ½″. Usual price, 7/6 set; outstanding value, **2/9** set. Also ⅝″, ¾″, ⅞″. 1″, in same threads, **4/-** set of four.—Below.

1,200 Best Quality Taps, Tapers, 2nds, Plugs. ⅝″, **9d.**; ¾″, **1/-**; ⅞″, **1/3**; 1″, **1/6**, Whit., B.S.F. Also in gas thread, ⅛″, **6d.**; ¼″, **9d.**; ⅜″, **10d.**; ½″, **1/-**; ⅝″, **1/3**; ¾″, **1/6**; ⅞″, **1/9**; 1″, **2/-**.—Below.

2/9 any lot. Eight lots £1.—Below.

⅜″ **Toolholder** with four H.S. Tools.

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½″ **Drill Chuck,** taper or straight shank.

1/16″ to 5/16″ **Silver Steel,** 13 pieces. 13″ long.

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500 Ass. Brass and Steel Screws, etc.

100 Steel Hex. Bolts and Nuts, ⅛″ to ¼″.

16 H.S. Drills, 1/32″ to 5/32″.

12 Drills, 1/16″ to ⅜″. Carbon.

Set 1″ Dies, ¼″, 5/16″, ⅜″, 7/16″, ½″, Whit.

Ditto, B.S.F. 26 threads of S.A.E.

Set ¼″ to ½″ **Taps,** same as Dies. T.S. or P.

Slitting Saws, five 1/32″ to ⅛″ thick, 1″ hole.

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TOOLS—*Continued*

Two dozen Fine and Odd Thread Taps to ⅜″.

Three dozen Tungsten Hack-Saws to 12″.

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Three H.S. Tap Fluting Cutters, 1¼″ diam.

One dozen Ass. Files, 4″ to 12″.

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Dozen Toolmaker's Needle Files, indispensable.

Best Carborundum Wheel, 7″ by ½″ by ¾″ hole.

200 Springs to approx. 6″ long.

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High-Speed End Mills, ½″, **2/9**; Straight Shank, ⅜″ carbon ditto, **1/9**.

£1 Orders Carriage Paid, except abroad. Money refunded if not satisfied with any of the above bargains.

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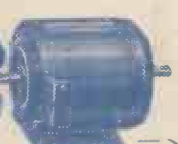

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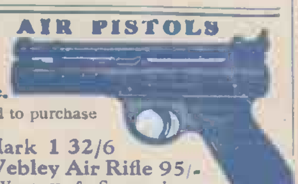

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