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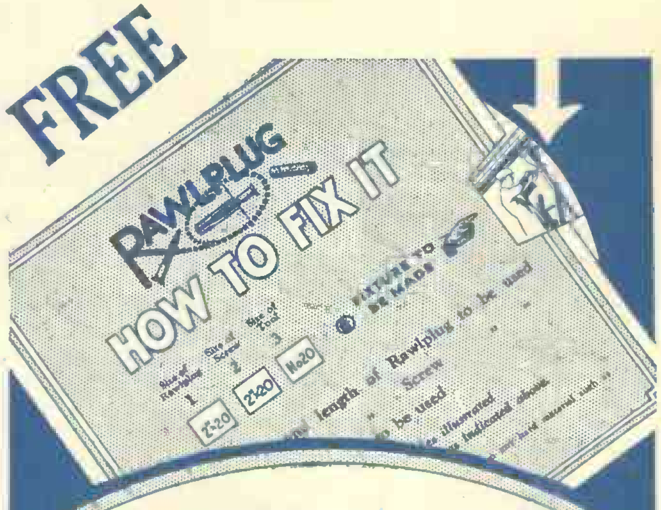

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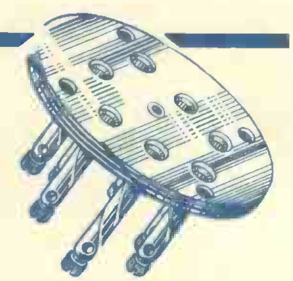

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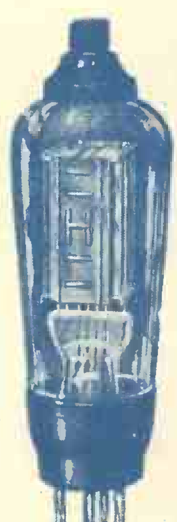

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Notes, News and Views

New Dutch Diesel-Electric Train

THE first of the forty triple-articulated Diesel-electric trains for the Netherlands Railways has just been put into regular service. The train consists of three coaches, the two Diesel-electric units being arranged side by side in the centre compartment. The train is designed to carry 192 passengers, and is capable of travelling at a maximum speed of over 90 miles per hour, although the service speed is limited to about 60 miles per hour. The engines, which have twelve cylinders, each develop 410 b.h.p. at 1,700 r.p.m. A feature of the body construction is its lightness, all the parts being welded. Weight-saving has also been carried out in connection with the wheels, and light alloys have been used for the doors, parcel racks, fuel tanks, etc. Electric lighting is used throughout the train, and the heating is carried out by a special warm-air system, the heat being extracted from the engine-cooling water in cold weather. The braking system is operated by compressed air.

New High Altitude Flight Record

ON May 11th a new world's altitude record for an aeroplane fitted with a heavy-oil compression-ignition engine was made by a Westland Wapiti machine, having a Bristol-Phœnix engine, when an altitude of approximately 28,000 ft. was attained. The engine behaved perfectly throughout the flight, and at the greatest height reached there was little sign of any sudden failure to burn the fuel, although at the high altitude a temperature of 40° C. was recorded. Special precautions were taken to avoid undue cooling of the oil by covering the tank with felt, and lagging all external pipes. An oxygen system was, of course, installed for the pilot.

A 15,000 Miles Submarine Voyage

TWO Italian submarines, *Sciesa* and *Toti*, have recently completed a five-and-a-half months' voyage, covering 15,000 miles and completely encircling Africa. The submarines are equipped with two Fiat engines of 2,200 b.h.p. running at 380 r.p.m., and it is stated that the machinery operated extremely satisfactorily, such repairs as were required being carried out on board. The officers and crew lived on board continuously during the five-and-a-half months. The submarines both have a displacement of 1,400 tons.

A Mammoth Motor-driven Tanker

THE new Norwegian 12,500-ton oil-carrying vessel *Solheim*, which has just completed her trials, has an overall length of no less than 477 ft., a breadth of 59 ft. 6 in., and a depth of 34 ft. Designed for a speed of 11½ knots, this huge craft is driven by two single-acting four-stroke 2,000 h.p. Diesel engines which run at a speed of 145 r.p.m. Two smaller Diesel engines of 100 h.p. drive the electric generators. The cargo pumps are steam driven, and two oil-fired steam boilers are installed which supply steam to the winches and windlass, and the heating coils. The capacity of the oil cargo tanks is 16,300 cubic metres, and the two duplex pumps installed are capable of delivering 325 tons of oil per hour.

Large Electric Welding Machine

A LARGE butt-welding machine has recently been put into use by Imperial Chemical Industries Ltd., in connection with a special plant in which a large number of joints had to be made in heavy alloy-steel tubing having a section area of 30 sq. in. The machine is 15 ft. 6 in. in length, 8 ft. 3 in. in width, and 8 ft. 6 in. in height, while the transformer which supplies the welding current has a capacity of 600 kw. After the tubes to be joined have been clamped in position, the machine is fully automatic in action. The upsetting pressure is applied by hydraulic rams, and may be varied from 10 to 50 tons.

The World's First Air Train

A FEW weeks ago a flight of 450 miles was made by a Soviet aerial train composed of an aeroplane towing three gliders. The train took off from Moscow and landed at Kharkov in the Ukraine, the average speed being 100 miles an hour. Each of the gliders was manned by a pilot, and a further test flight is planned to demonstrate that individual gliders can drop out of the train at different points without the aeroplane landing.

A New Fibre

ACCORDING to a recent report a new fibre has been evolved which may become a rival to Egyptian cotton. It has been given the trade name of "Fibro," and is produced from wood pulp. It can be cut into short lengths and mixed with any kind of cotton. It is stated that many spinners are already using it as a mixture with cotton, and existing cotton-spinning machinery can be adapted without great difficulty to use the new fibre.

How Lenses are made

WITH reference to our article on "How Lenses are Made," which appeared on page 327 of our issue dated April 1934, we should like to point out that the illustrations for this article were prepared by Messrs. Dallmeyer, Ltd., the well-known manufacturers of lenses and prisms, at their works at 31, Mortimer Street, Oxford Street, London, W.1. This old-established firm of lens experts can supply lenses of all types and for all purposes.

Streamlined

The importance of Stream-
Saver is becoming recognised
which move through the Air,

A rear view of the German Zeppelin train.

FROM the very dawn of civilisation the innate desire of man has been to explore areas beyond his immediate vision, but his peregrinations necessarily had to be performed on foot. This restricted his activities, and his world was circumscribed by the distance he could travel by that means. The world indeed must have been an extremely small place in which to live, but it was not long before chariots were introduced by some unknown genius, who probably used as the crude forerunner of the wheel sections of a large tree trunk. The wheel indeed is probably the greatest invention of all times. It is the giant's boots with which everyone can equip himself. In the earliest days, however, time was of no importance, and distance was the only important factor to be taken into consideration when wishing to travel from one place to another. It was soon realised, however, that travelling could be speeded up by using a team of horses instead of one, and we thus see the genesis of time being considered in conjunction with distance. A moment's thought will show that all travel has been developed to shorten the time taken for a given journey, which is equivalent, of course, to shortening the distance, if we think of distance in terms of time.

An Increase in Power and Size

Towards this end the tendency has been to produce engines or prime movers of more and more power, a system which has limitations as well as many disadvantages. There must, for example, be a limiting size in ships, aircraft and motor vehicles, for obvious reasons, but even if there were not there are economic reasons which would limit the size of vehicles. For example, suppose a regular motor coach service is in existence serving two points A and B, and that the motor coaches are always filled to capacity and are equipped with the most up-to-date engines and are capable of travelling at a speed equivalent to the record. Further, suppose that it is desired to speed up that service. The only means of doing would be to lighten the load of each vehicle so that it could travel faster, or, alternatively, to equip it with additional engine power to gain speed. This could only be a commercial success provided that passengers would be agreeable to paying the increased cost if we presumed, as we have done, that no further passengers were available to equalise the cost. It is a somewhat surprising circumstance that, notwithstanding the lessons which have existed around us since the world began, it is only since the birth of the aeroplane that we have realised the importance of the streamline or ichthyoid form in increasing the speed of a body moving in a fluid.

Eddystone and the Square Lighthouse

The earliest constructors of moving bodies signally failed to appreciate the lesson of a tree trunk or the form of a bird's body. The builders of lighthouses did not realise that a stationary body with a fluid-moving past it was governed by the same principles as a moving body in a comparatively stationary fluid. Everyone knows that it was Eddystone who first perceived that a square lighthouse was bound to meet with continued disaster. No one up to his time had succeeded in building a lighthouse which could withstand the heavy ocean swells. His lighthouse of circular section immediately solved all of the problems. The builders of the first aircraft similarly failed to make their structures of such a form that they offered a minimum of resistance to the air. Failure to fly was attributed to lack of power, and it was some time later before it was appreciated that by reducing the resistance to movement the same effect was obtained as by increasing the power. Ship designers even to-day are only just beginning to make use of the results of experiments on streamline forms. The shape of the moving body has everything to do with speed; even the minutest parts respond to an alteration in their shape. The early aeroplanes were usually braced with 16-gauge piano wire; this is of round cross-section, and one would think that little could be gained by altering its section to streamline form. Yet such is the case, for the alteration was responsible for increasing the speed for a given power by as much as 20 m.p.h. on a machine whose top speed was only 80 m.p.h. Let us take this point a little further so that we can appreciate what wind (or head) resistance really means. The scientific law which sums up the situation says that resistance increases as the square of the velocity. Suppose, therefore, that at 100 m.p.h. the resistance is 10 lb. per square inch. If we double the speed the resistance is 40 lb. to the square inch. We at once see the importance of so shaping the body and its associated exposed parts that it moves through the air with a minimum of resistance—in other words, so that it leaves the air in as undisturbed state as possible. Any part of it which sets up eddies or partial vacua at its trailing edge is absorbing power which could be more usefully employed in imparting speed.

A Simple Experiment

Hence the modern tendency of streamlining our aeroplanes, our road vehicles, our ships, and all contrivances, whether stationary or moving, which could absorb power by virtue of their resistance. A simple experiment will demonstrate the value of

Trains

By F. J. CAMM

lining as a Time and Power by designers of Vehicles the Water and on the Land.

"The Burlington Zephyr," which is capable of a speed of 125 m.p.h.

streamlining. Try swishing a piece of ½-in. square wood in a bath of water. Considerable resistance to its movement will be felt. Now round off the front edge of it and repeat the experiment, when it will be noted that the resistance is considerably less. Finally, sharpen off the rear edges so that in section the piece of wood has the same form approximately as the plan view of a ship. The resistance of movement to the water can now scarcely be felt.

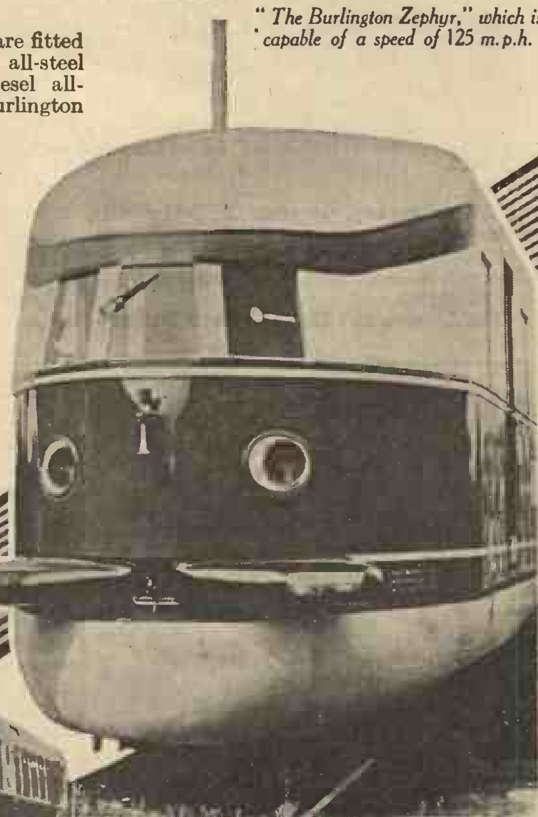
The art of streamlining is now being applied to the iron horse. From the time of Stephenson's first locomotive trains have been solidly built without any consideration for the theoretical perfection of their shape. A bluff, almost flat front to the locomotive, excrescences which offer considerable resistance to the air, wrongly shaped carriages, and unstreamlined under-carriages have always been their main characteristics. Experiments in every country of importance are now being carried out with streamline trains, as is indicated by the illustrations to this article. In every case a great improvement in speed has resulted. Some designers are even building locomotives whose tractive effort is not applied to the wheels at all but through an airscrew as fitted to aircraft.

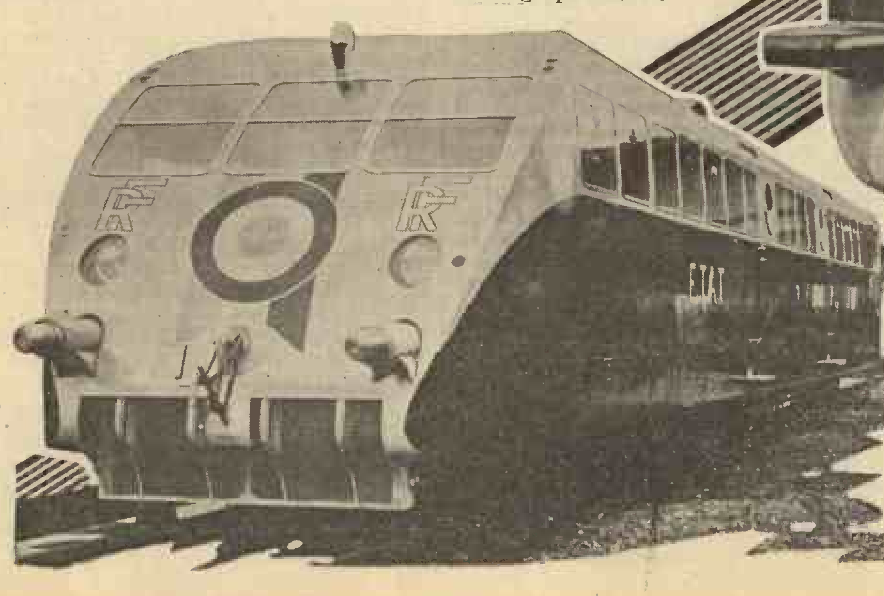
"The Burlington Zephyr"

Many of these streamline trains are fitted with Diesel engines and are of all-steel construction. America's first Diesel all-steel streamline train, "The Burlington Zephyr," recently made its first official test on the tracks of the Reading railroad twenty-five miles above Trenton, Philadelphia. Its speed officially timed was 104 m.p.h., and it is stated to be capable of 125 m.p.h. The German Federal Railroad have built "A Lightning Train" which has been tested on the Berlin–Hamburg route. This new type is built on similar lines to the "Rail Zeppelin." Under test it travelled at an average speed of 93 miles.

In France a streamlined car of the road-rail type travelled a distance of 230 miles at an average speed of 76·5 m.p.h. This was produced by the well-known Bugatti firm.

The British streamlined locomotive illustrated is the longest and heaviest locomotive in Great Britain. The engine and tender weigh 170 tons, the boiler is constructed to the extreme limits of the railway gauge to gain streamlined effect,



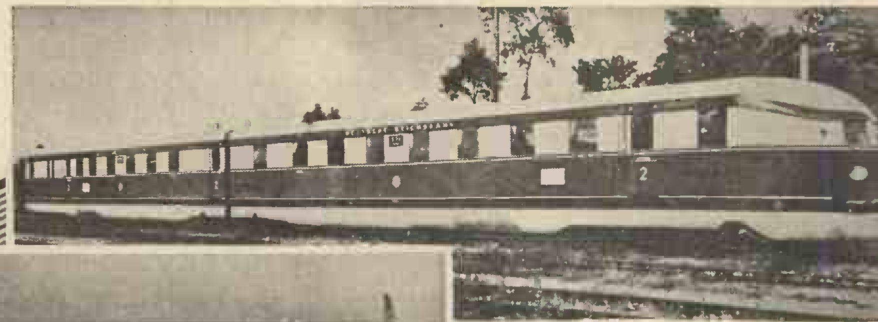


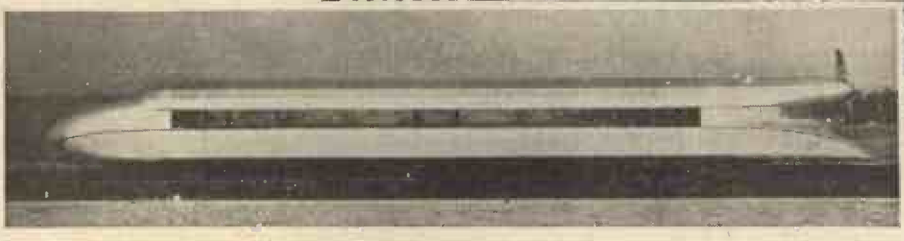
(Left) The road-rail car, which is stated to have travelled a distance of 230 miles at an average speed of 76 miles per hour. (Above) A front view of the new "Rail Zeppelin," which is appropriately named the "lightning train" and travels at an average speed of 93 m.p.h.

and the chimney has been sunk within the casing plates to lessen resistance. The boiler has the unusually high working pressure of 450 lb. to the square inch.

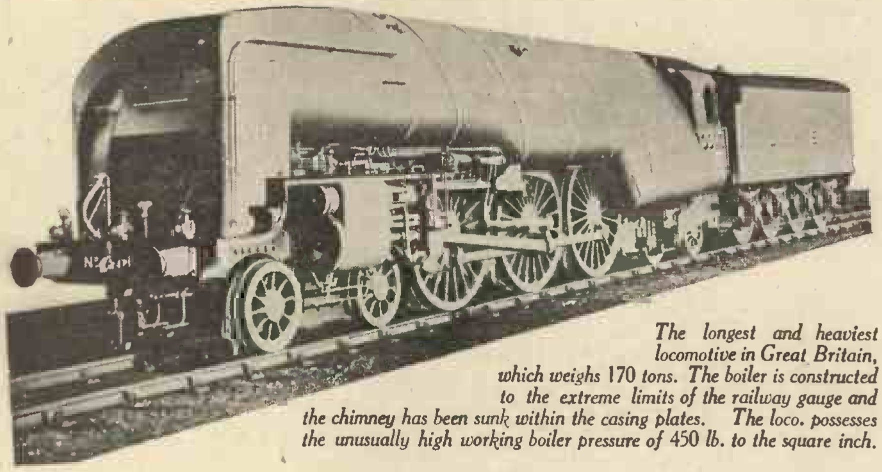
The Zeppelin Propeller Railway Car

This was produced a year or so ago under a full load of passengers and achieved the amazing speed of 99·4 m.p.h. Designed by H. Kruckenberg, it was built by the Gesellschaft für Verkehrstechnik. It is equipped with an engine of only 200 h.p. The car is 95 ft. long, and is driven by a petrol engine.





(Left) The "lightning express" of the future—a sensational German invention and (above) a view of the new streamlined "lightning train," which is capable of a great speed.



The longest and heaviest locomotive in Great Britain, which weighs 170 tons. The boiler is constructed to the extreme limits of the railway gauge and the chimney has been sunk within the casing plates. The loco. possesses the unusually high working boiler pressure of 450 lb. to the square inch.

The London and North-Eastern Railway a few months ago tested their streamlined Diesel-electric railbus at Newcastle-on-Tyne. The unit was designed and built by Armstrong-Whitworth, and seats from fifty-six to seventy passengers and travels at a speed up to 70 m.p.h. The Great Northern Railway have installed a semi-streamlined car on the Belfast–Dundalk service. A few weeks ago the first pneumatic-tyred train made a trial run from Betchley to Stoke-on-Trent with a load of twenty-four passengers, and travelled at an average speed of 60 m.p.h.

A streamlined railcar is already in operation on the Great Western Railway between Reading and Slough; driven by 130-h.p. heavy-oil engine, it has a maximum speed of 60 m.p.h.

Those readers who visit King's Cross will have noticed the tendency towards streamlining on the L.N.E.R. giant locomotive, the "Cock of the North," No. 2001.

Other experimenters are reviving the monorail idea in combination with streamline construction. One such system is the Bennie railplane, which it is suggested could be built over the existing railways. The passengers' cars, which are self-propelled, are driven by airscrews fore and aft, and are suspended from a steel girder.

Sufficient has been said in this article to indicate the extreme importance of streamlining, and we may expect during the next few years that transport will rapidly develop along these lines.

"HEAVY WATER"

LATELY, much publicity has been given by the Press to a substance termed "Heavy Water," and although the term and the discovery convey little to the man in the street, the attention of the scientific world is focussed expectantly in its direction. In customary style many newspaper accounts were of a grossly exaggerated nature, and it is the purpose of this short article to give readers a clearer idea of the nature of "Heavy Water." It is more convenient, perhaps, to first give consideration to "Heavy Hydrogen" or "Diplogen"—a name suggested by Rutherford—and an appreciation of this new kind of hydrogen involves a little knowledge of

Isotopes

Isotopes are elements having almost identical chemical and physical properties, but differing slightly in atomic weight, and a knowledge of their existence is due to investigations made on radio-active matter. A notable example of isotopism is found in metallic lead which, associated in its origin with uranium, has an atomic weight of 206, when with thorium 208, but when occurring free from either of these elements its weight is 207·2—evidently a mean value and conceived to be a mixture of the previous two. This kind of variation is found to be present when other elements are examined, indeed, where an atomic table of weights shows an element to have a fractional value (chlorine, for instance, at 35·5) it can almost be taken for granted that this figure represents a mean value given by slightly differing, *integral* atomic weights. This gives weight to Prout's long-shelved theory that hydrogen is the fundamental atom. In 1929 an examination of the absorption spectrum of atmospheric oxygen revealed the presence of an oxygen isotope of mass 18, the proportion present being about 1 in 650. The figure given in text-books of chemistry, ascertained by earlier workers and clumsier, less accurate methods than are available to-day, is given as 16. This figure must represent a mean value, and it is apparent therefore that another oxygen isotope must exist having a value less than 16.

Ratio between Oxygen and Hydrogen

This discovery upset for the moment all preconceived ideas of the ratio between the oxygen and hydrogen until it was suggested that this ratio would still remain unaltered if it could be accepted that a hydrogen isotope of mass 2 should exist in about 4,500 parts of ordinary hydrogen. The accuracy of this hypothesis was subsequently established by a close examination of the atomic spectrum of hydrogen, wherein a fine line was perceived which grew in intensity when liquid hydrogen was evaporated and the heavier isotope thereby concentrated. From this to the production of "Heavy Water" was but a short step. Minute quantities have been discovered in various parts of the world, while it has recently been stated that the barren nature of the ground immediately beneath the weeping willow is due to the exudation of this substance by the tree. A laboratory method of preparing "Heavy Water" is to subject sodium hydroxide solution to continued electrolysis.

Able to destroy Life

This brings about concentration of heavy water in the solution. Pure heavy water exhibits properties markedly different to those of ordinary water, as will be seen on glancing at the following table of some of its physical constants:

Density . . .	1·105
Freezing point . .	3·80° C.
Boiling point . .	101·42° C.
Temperature of maximum density . .	11·60° C.

Experiments made on living organisms with this remarkable liquid show that as its concentration increases, metabolism decreases. It is more than probable that life would be destroyed by a 100 per cent. concentration.

The MECHANICS of SIDESHOW GAMES

It was P. T. Barnum who made the somewhat sweeping statement that there is a fool born every minute, nor is the great showman's axiom any less true to-day than it was during his lifetime, for, despite the spread of knowledge, free education, cheap printing and a thousand other boons of modern life, there is still that glamour about a fair-ground or "amusement arcade" which conjures the pennies out of the pockets of visitors who, in other surroundings, pride themselves on their common sense and perspicacity.

THE fair-ground, of course, gives excellent value for money in terms of thrills, excitement and noise, nor is there any question of swindling on the part of the various spectacular "rides," "shows" and vendors of goods, but the side-shows known as "games joints" are by no means above suspicion in every instance. It is with a view to showing how utterly impossible it may be to win on these games when the operator is not above "faking" that this article has been written, in fact a good alternative title might be "Science for Fools."

Even when these games of alleged skill are conducted fairly, as many of them indubitably are, the player has a very remote chance of winning, for the law of average is always against him, and many showmen, who conduct their business on a strictly fair and square basis, make quite a good living out of this fact. Unfortunately there are black sheep in every fold, and the unscrupulous games operator takes care that any player who is determined to get a particular "prize" pays far more than its intrinsic worth before he is allowed to carry it off—if indeed he does so at all. So common is this "faking" of games that a glance at any periodical which lists second-hand fair-ground equipment for sale will prove the fact. Fair-ground and carnival workers have a jargon of their own, and much information may be conveyed in a few words. For instance, an advertisement stating that the vendor wishes to sell a "two-way fish-pond with good flash" conveys, to the initiated, that the game in question is a "fish-pond" which is adapted to be worked either honestly or crookedly (two-way) and has an attractive decorated front to the stall (flash). Another term is "strong," and "may be worked strong" implies that the game may be run dishonestly if desired.

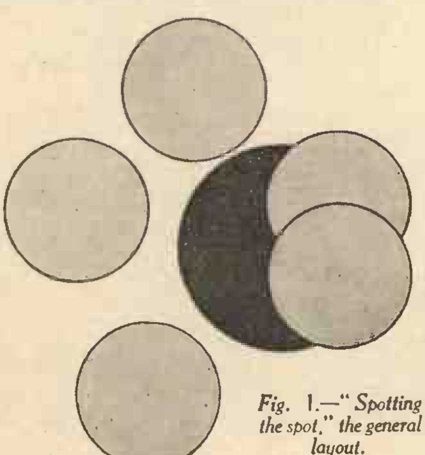


Fig. 1.—"Spotting the spot," the general layout.

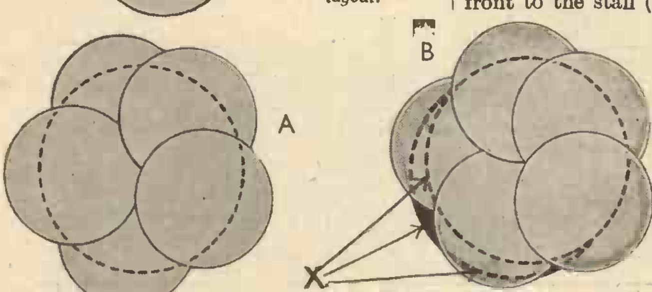


Fig. 2.—(A) The spot totally covered as demonstrated by the operator, and (B) why the player loses. The circle is now an ellipse. X is the "gaff."

Fig. 3.—The rings must be flat on the board to win.

Fair-ground Slang

Before proceeding to the why and wherefore of swindles in games of "skill" it may be interesting to note a few of the terms peculiar to fair-grounds and their *habitués.* "Bunce" is earnings or profit. "Gazumped" means swindled, while a "bloomer" is a bad financial day, and "swag" or "slum" is the slang term for the cheap prizes offered in games or hawked for sale by vendors (teddy-bears, woollen monkeys, squeakers and crockery "seconds" are examples of "swag"). A "gaff" is the device which enables the proprietor to run the game as he desires so that, when a wheel is faked in such a way that the operator can stop it at any desired number, it is said to be "gaffed." It is from this that the expression "blowing the gaff" comes, meaning literally "exposing the swindle."

There are innumerable words of equally occult meaning which would give any etymologist a headache to try and trace, but we must get on to the actual "gaffed" games themselves.

When the Player is "On the Spot"

One of the oldest fair-ground games, and one which every reader must have seen at one time or another, is "Spotting the Spot." In this game the operator has, in the front of his stall, a plank or table which is covered with white oilcloth on which is painted a large red spot or circle about 5 in. diameter. Lying loose on the cloth are five metal discs each about 3in. diameter (see Fig. 1). The game consists in dropping these discs, one after another, so that they overlap each other and completely obscure the red spot; not a single vestige of red must show either in the middle or at the edges. To demonstrate the simplicity of the game the operator drops the discs swiftly and easily, completely obliterating the spot, as shown in Fig. 2A. The player then pays the fee demanded and essays to copy the example shown, feeling sure he can emulate the demonstrator and capture one of the prizes offered. Alas! however careful he may be and however much he may spend, there is always an

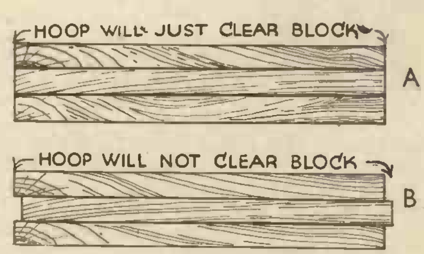


Fig. 4.—The supporting block with cloth removed to show the "gaff."

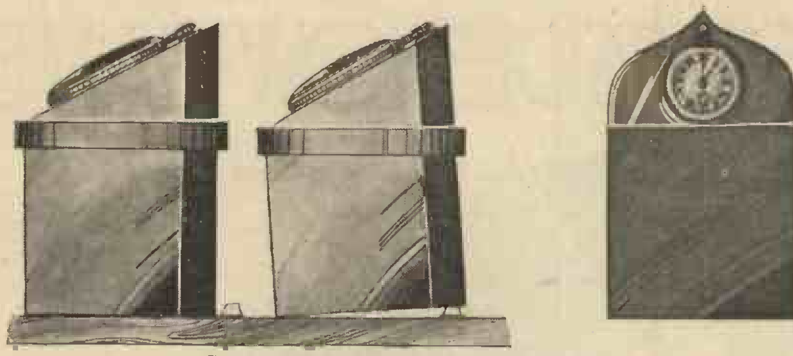


Fig. 5.—" Watch-la," a variation of Hoop-la.

aggravating edge of the hated red visible! Fig. 2B shows why the player cannot win unless the operator so chooses. A little pressure on the far edge of the table causes the cloth on which the spot is painted to stretch slightly, converting the red disc into an ellipse, and, as the discs will only just cover the spot while it is a perfect circle, they cannot possibly cover the stretched area. A simple " gaff " indeed, yet a real money-spinner and quite safe from detection because, immediately the tension is released, the rubberised cloth resumes its normal size.

Hoop-La

This is, perhaps, the most popular fair-ground game, and there are few of us who have not, at some time, thrown a ring which slipped neatly over the coveted prize but stopped at the little black block which supported it (Fig. 3). Remonstrance is, of course, useless, for the rule of the game is that all rings must lie flat on the board, and if one has the temerity to question the relative sizes of block and ring, the showman most obligingly passes the ring over the whole thing, thus proving it can be done. Fair enough to all seeming, but things are not always what they seem at a fair. Fig. 4 shows the " gaff " in this case. It will be noted that the blocks which support the prizes are always covered with most genteel black cloth or velvet. Possibly the proprietors of hoop-la " joints " have a passion for black, but the real reason for the cloth is to hide the working of a simple yet ingenious " gazump." The block consists of three or more flat pieces of wood piled one on the other. When level on all edges they form a block over which the ring will just pass, as shown in Fig. 4A. If, however, the middle piece is pressed out at one side even a trifle as shown at Fig. 4B the ring will most assuredly *not* pass over and the funereal drapery makes it impossible to detect the little edge which protrudes.

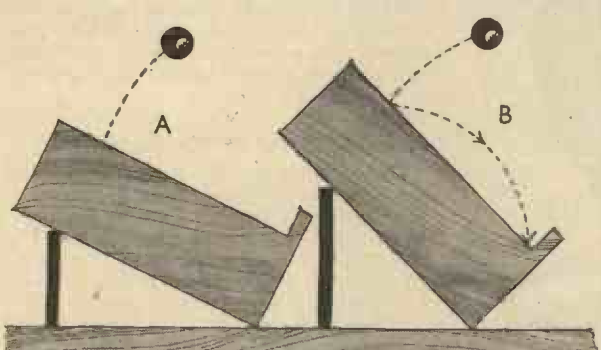


Fig. 7.—Why the ball bounces out of the rack. (A) *Rack at low angle so that ball has a fair chance of staying in.* (B) *Rack at high angle, ball almost certain to bounce out again.*

Watch-La

A variation of the profitable hoop-la is known as " watch-la," and is run on very similar lines. A table is covered at intervals by very small upright plinths (also in mourning) which have sloping tops on each of which rests a most desirable watch. Time and time again the ring very nearly goes over and the operator is always willing to show that the feat is really possible. The " gaff " in this case is somewhat different and is dependent on the shape of the plinths as shown in Fig. 5. When the plinths stand upright, the sloping tops with their tapering peak stop the rings as shown at Fig. 5, but, if tilted very slightly forward, by the little stud or ridge at the back (and under the ubiquitous black cloth), the ring will just slip over; again vindicating in public the honest integrity of the proprietor and shaming the player who has dared to question it! It is easy for the operator, when retrieving the player's last ring, to make the very slight movement necessary and the tilt is imperceptible from the front.

The Bounce makes the " Bunce "

Fig. 6 represents another very old game known as the Ball-rack and which is, like all such games, deceptively simple. A large wood box is divided into compartments as shown, each having a value indicated, with the higher values in the upper rows. Each compartment will easily accommodate one of the wooden balls used and the game consists in trying to toss the three balls provided into sections which will give an aggregate score of, say, 15. At Fig. 7A the rack is shown in a position wherein a really skilful player stands a fair chance of winning if careful. The proprietor has, however, had a couple of " bloomers " and feels that he cannot afford to let anyone win, so he simply alters the angle of the rack as shown at Fig. 7B. Now let the player be as skilled and as cautious as you please, the ball, even if landed fairly and squarely in a compartment, will inevitably bounce out again and down to a division of lower value, if not out of play altogether.

Another form of " bouncer " is the ball and bucket or " pop 'em in," as it is sometimes called, and this is figured at diagram No. 8. The bucket is tilted so that the opening faces the player at an angle much as the rack did in the last game. A soft ball is used and, with a rigid-bottomed bucket, it is well nigh impossible to make the ball stay inside. The " gaff " shown here is not to throw the ball out, but to enable the operator to demonstrate that the task *can* be accomplished, thus putting the players on their mettle. When the solid bottom is dropped the operator tosses a ball and the resilient false bottom " gives " sufficiently to let it stop in if cautiously thrown. When the pedal is again depressed the bottom becomes rigid once more and the bouncing proceeds merrily.

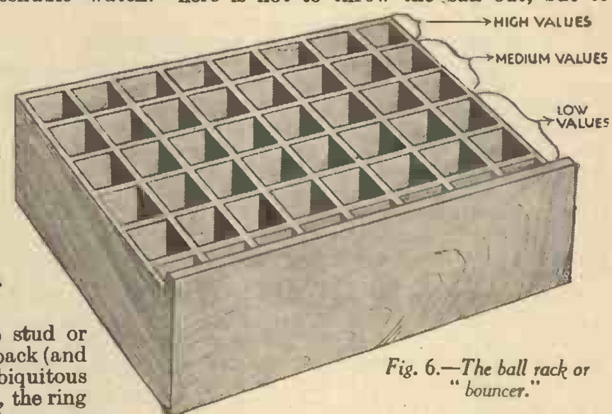


Fig. 6.—The ball rack or " bouncer."

Fastest Civil Plane

THE fastest private light plane produced in this country was demonstrated at Heston recently. This remarkable machine, which was designed by Mr. E. W. Percival, has a top speed of 200 miles an hour, and flies at a cost comparable with that of a medium-powered car. It is a low-winged monoplane with a wing span of only 24 ft. and a length of 18 ft. 3 in., and is fitted with a Napier " Javelin " engine of 160 h.p.

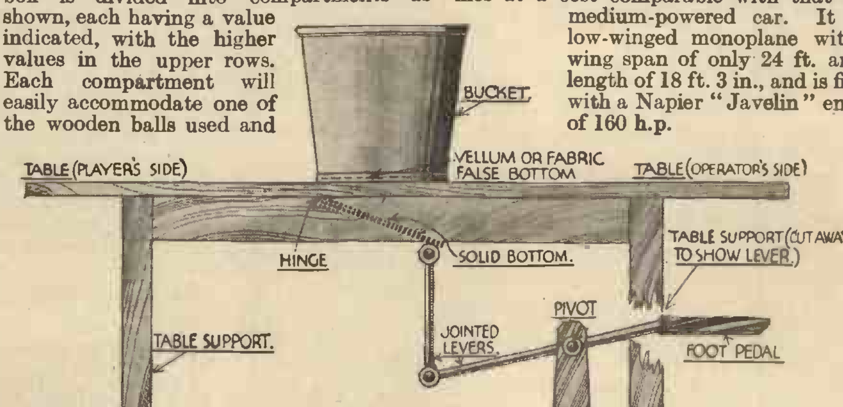
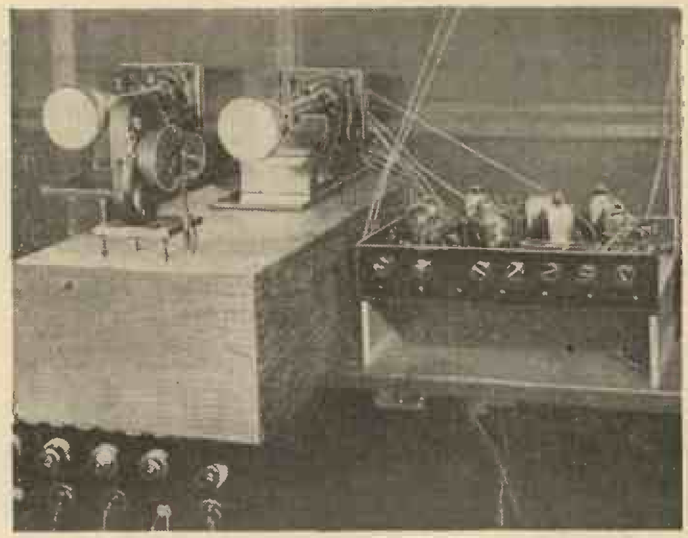


Fig. 8.—The Bucket Bouncer. The table is shown horizontal, but in actual use the players' side is lowered so that the bucket faces outwards.

TELEVISION—
THE POSITION REVIEWED

The appointment of a television committee by the P.M.G. has brought to the fore the enormous progress made in the art. The position is clarified in this thoughtful review.



The experimental Cossor receiver with its cathode-ray tube ; a film camera is set up to record the images.

DEVELOPMENTS in the world of television are taking place with such rapidity that the present moment is an opportune one to review briefly the position as far as this country is concerned. That this course is a justifiable one is strengthened by the recent action of the Postmaster-General in appointing a committee to inquire into the whole television situation. The terms of reference are: "To consider the development of television and to advise the Postmaster-General on the relative merits of the various systems and on the conditions under which any public service of television should be provided."

The *personnel* of the committee chosen seems to indicate that the major proportion of its work will be concerned with technical and scientific questions, for the names are as follows: Lord Selsdon, Chairman; Sir John Cadman, Vice-Chairman; Col. A. S. Angwin (G.P.O.); Mr. N. Ashbridge (B.B.C.); Mr. O. F. Brown (D.S.I.R.); Vice-Admiral Sir C. Carpendale (B.B.C.); Mr. F. W. Phillips (G.P.O.); with Mr. J. Varley Roberts (G.P.O.) as Secretary.

Known Facts

It has been accepted generally that there are four systems which merit consideration, namely, Baird's, Cossor's, E.M.I.'s and Scophony's. These are given in alphabetical order and, taking each in turn quite impartially, it can be stated that the Baird system first came before the public as far back as 1925. Coupled with the advantage of this long start over its competitors, there is the close co-operation with the B.B.C. which has existed since 1929 when the first experimental thirty-line signals were radiated from the Brookman's Park station.

The actual television transmitter was situated in the Baird Company's laboratories at Long Acre, but in August, 1932, the B.B.C. took over the responsibility for the whole of the programme and transmitting side, a special mirror drum transmitting machine being designed and installed by the television company at Broadcasting House for this purpose. The apparatus has now been removed to Portland Place, but during the whole of the period that the transmissions have been available for the public to look-in, enormous improvements in "low definition" (thirty-line) technique and the images have taken place.

New Experimental Facilities

It is admitted on all sides that although the programmes which can be radiated are limited in scope, there is definite entertainment value. Unfortunately, all efforts to compute the number of individuals who take advantage of this television service have failed for one reason or another, and the estimated figures have been as widely divergent as 500 and 20,000. The broadcast time-table is now only two half-hour transmissions per week, a service which definitely is wholly inadequate to meet the needs of the many amateur constructors who are anxious to become initiated into the science of television.

It has now been announced that this Company has signed a contract with Sir Henry Buckland, Manager of the Crystal Palace, whereby additional facilities are granted for experimental transmission and reception research work. This includes the renting of 30,000 square feet of the Crystal Palace floor space, and the use of the whole of the South Tower. Up-to-date laboratories, studios, dressing-rooms and offices are to be erected, and a new ultra-short-wave radio transmitter will be installed within a few weeks. This will be capable of supplying 12,000,000 people in and around London with regular experimental television programmes. The contract, subject to certain options, is a long-term one, and should give this company unrivalled facilities for developing television as a public entertainment.

The Cossor System

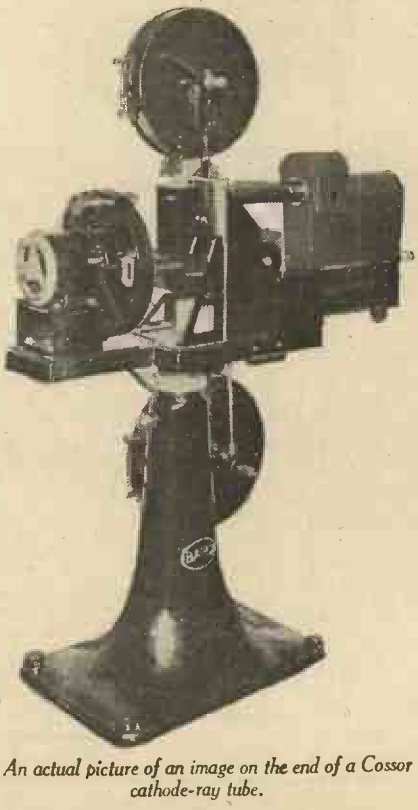
The Cossor system is based on the methods developed by von Ardenne from the original principles established by Thun, using what is termed velocity modulation. In addition, however, they incorporate intensity modulation and claim to take account of the advantages of both. Briefly stated, we have intensity modulation brought about by controlling the number of electrons which form the cathode ray beam impinging on the fluorescent screen, the velocity being kept constant. On the other hand, with velocity modulation the number of electrons is kept constant, but the velocity is varied.

A Merger

No details concerning the high definition system of Electrical and Musical Industries Ltd. (E.M.I.) are available at the moment, but it is known that they have been developing cathode ray tube reception of 150-line television images using cinema films as the transmitted subject. The headquarters for this research work and the location of the experimental radio transmitter employed is at Hayes, Middlesex. A merger of special significance was announced quite recently when it was made known that a new company had been formed—the Marconi E.M.I. Television Company—the shares of which are held equally by the Marconi Company and E.M.I. Ltd. Naturally, this new company represents a powerful combine, and the results of the collaboration of interests will at least expedite the day when television is as popular as aural broadcasting.

Scophony

Finally, we come to Scophony Ltd., a company engaged in the developments of the inventions of G. W. Walton. This research worker has been investigating television problems for many years now, and while the system developed has not been demonstrated generally to the Press or the public, it is known to differ completely in almost all particulars from the other television methods. It incorporates an elaborate but very ingenious echelon prism arrangement whereby a three-dimensional subject for transmission is converted into a two-dimensional one for transmission purposes. It is claimed that all the moving members are extremely light in weight, and hence easily synchronised at the receiving end. Furthermore, it has been stated that the original optical arrangements which are the foundation of the system can be used to transmit television on any broadcast wavelength without interference with other transmission systems at present in use.



An actual picture of an image on the end of a Cossor cathode-ray tube.

THE AUTOMATIC—

A good deal has been heard recently about of this remarkable device which played so flight to Cape Town last year have been

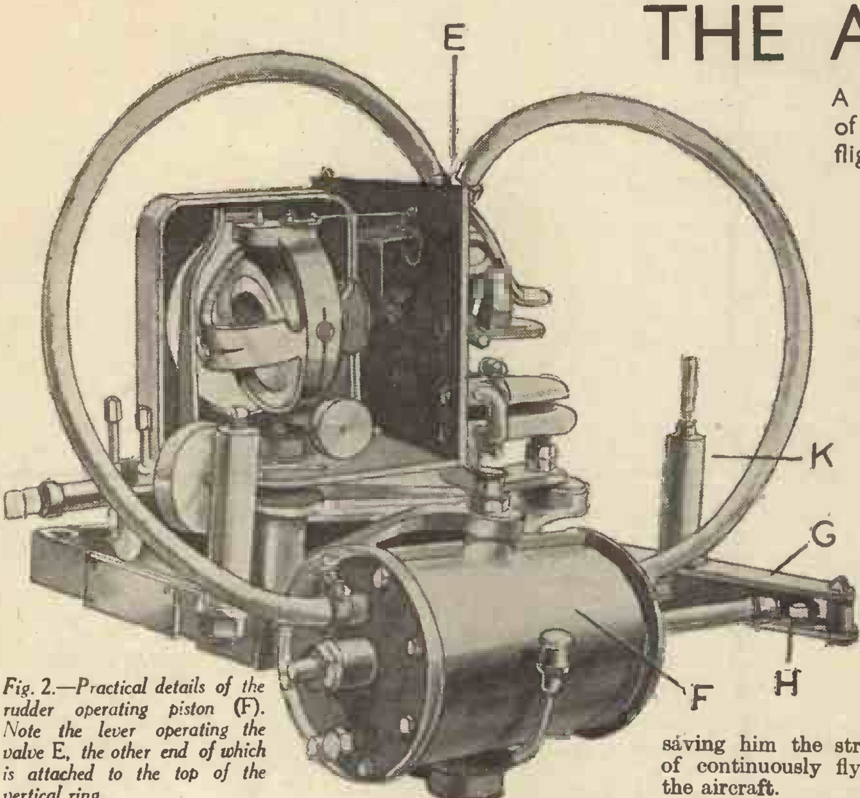


Fig. 2.—Practical details of the rudder operating piston (F). Note the lever operating the valve E, the other end of which is attached to the top of the vertical ring.

THE "robot," or more strictly "automatic," aeroplane pilot is a device which takes entire charge of the aeroplane and flies it steadily on a given course without human aid of any kind. During long tests over the North Sea the pilots were able to read a book while this uncanny device, now released from the secret list and marketed by Smith's Aircraft Instruments, a branch of S. Smith & Sons (M.A.), the well-known motor-car clock and instrument makers, flew the aircraft for them.

What the Robot Pilot has to do

Two main controls have to be operated by the pilot of any aircraft even when flying on a straight course—the rudder and the tail elevator. While it is possible to "trim" an aeroplane so that it will fly practically level without movement of the "stick" either backwards or forwards, no aircraft yet designed can be "trimmed" to fly without losing or gaining height for indefinite periods. This is equally true of the rudder, especially in multi-engine machines.

Without the robot pilot, therefore, however carefully "trimmed" the aircraft is, constant small adjustments have to be made by the pilot throughout a flight. The robot pilot, however, does this for the pilot, leaving him free to make observations, consult his maps and write up his log or take photographs as he wishes, apart from saving him the strain of continuously flying the aircraft.

The main parts of the robot pilot are firstly the gyroscope, which is the heart of the device, a compressed air piston controlling the rudder bar and another compressed air piston or "servo motor" which operates the elevator control normally worked by the pilot's "stick." Fig. 1 gives practical details of the gyro unit.

How the Gyro is driven

The actual rotor of the gyro is shown at A, and it will be seen that it has on its surface small bucket-like projections cut round its circumference. Compressed air is pumped by an air-screw-driven air compressor up through the hollow spindle through pipes in the vertical ring C, from whence it emerges and strikes the bucket-like projections, thus driving the gyro round.

The gyro itself, although driven by air from the inner edge of the vertical ring, is actually pivoted in a horizontal ring which is in turn pivoted to the vertical ring.

How the Rudder is controlled

The gyro rotor, by reason of its gyroscopic properties, once set revolving by the compressed air jets takes up a given position and stays there; if, however, the aircraft swings to the left or right, the frame of the robot pilot will move with it, but the gyro will prevent the vertical ring moving round, so that there will be angular movement between the vertical ring and the frame of the robot pilot which is fixed to the aircraft.

It is this movement which is made use of to control the compressed air piston operating the rudder bar of the aircraft by a valve shown at E in Fig. 2.

Extending towards the left of the frame will be seen a lever which is attached to the top of the vertical ring. The movement of this lever in or out of the valve E deflects air into one end or other of the piston F to which is attached the rudder bar.

Fig. 3 shows the plan of the arrangement when the aircraft is on course. The rudder bar is square with the fore and aft line of the aircraft, which is in turn exactly pointing along the course.

In Fig. 4 the aircraft has turned to the left of the course, but the gyro has kept the vertical ring in the same position; in this case the frame, which is fixed to the aircraft, has swung away from the vertical ring so that the little lever has been pulled further away from the valve, letting more air into the left-hand end of the piston, forcing out the piston rod and pushing the rudder over to the right.

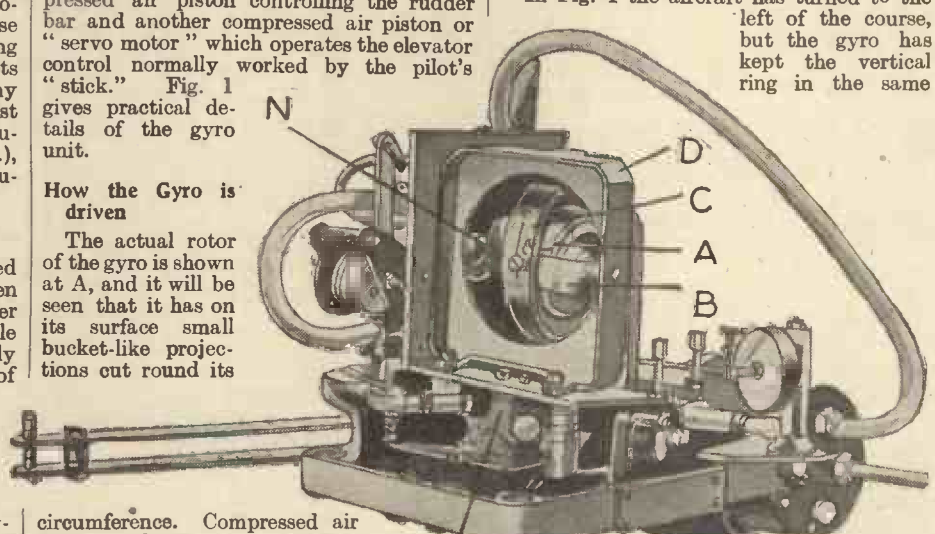


Fig. 1.—Practical details of the device (A), frame (D), vertical ring (C), horizontal ring (B). Note the bucket blades on the gyro rotor.

In Fig. 5 the aircraft is off course to the right and the frame with the valve on it has moved towards the vertical ring, thus pushing the lever further into the valve and allowing more air into the right-hand end of the piston, withdrawing the piston rod and putting on left rudder.

Details of the Elevator Mechanism

Referring back to Fig. 1, a thin rod will be seen extending downwards from the end

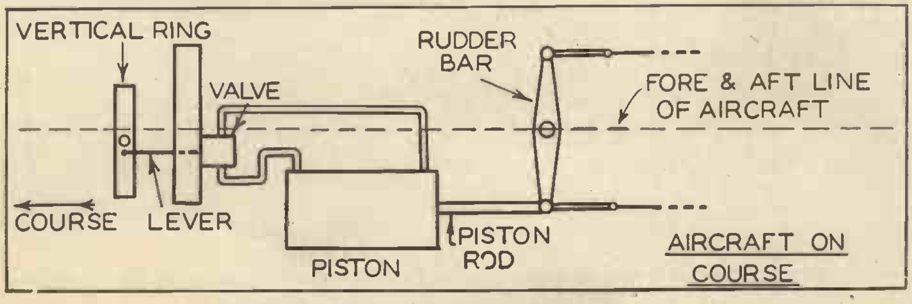


Fig. 3.—The Robot rudder controls in the central position.

—AIRCRAFT PILOT

the "Robot" Pilot, but few practical details important a part in the long-distance record vouchsafed to the public.

of the horizontal ring B. This rod, one end of which is fixed to the horizontal ring, which, like the vertical ring, is prevented from being affected by the "trim" of the aircraft, slides in and out of a second valve M, which, like the rudder valve E, moves with the frame of the aircraft if the nose is tilted up or down; the action is exactly similar to the rudder valve E, with the exception that the valve M admits air into either end of a piston which is linked to the fore and aft movement of the "joy stick."

Cutting the Robot Pilot "In" or "Out"

A very ingenious device is used to turn over to the "human" pilot; N in Fig. 1 is a plate (seen also in Fig. 2) which is held by a spring against the horizontal ring of the gyro, thus locking the gyro rigidly to the frame. The plate is attached to the piston rod of a valve shown at O in Fig. 6.

If air is admitted to valve O by the starting cock, it pulls the locking plate away from the gyro ring, thus giving it free movement and at the same time admitting air on to the rotor blades and starting the gyro revolving. The movement of the piston of valve O also opens up the air pipes to the pistons operating the rudder and elevator, so that the

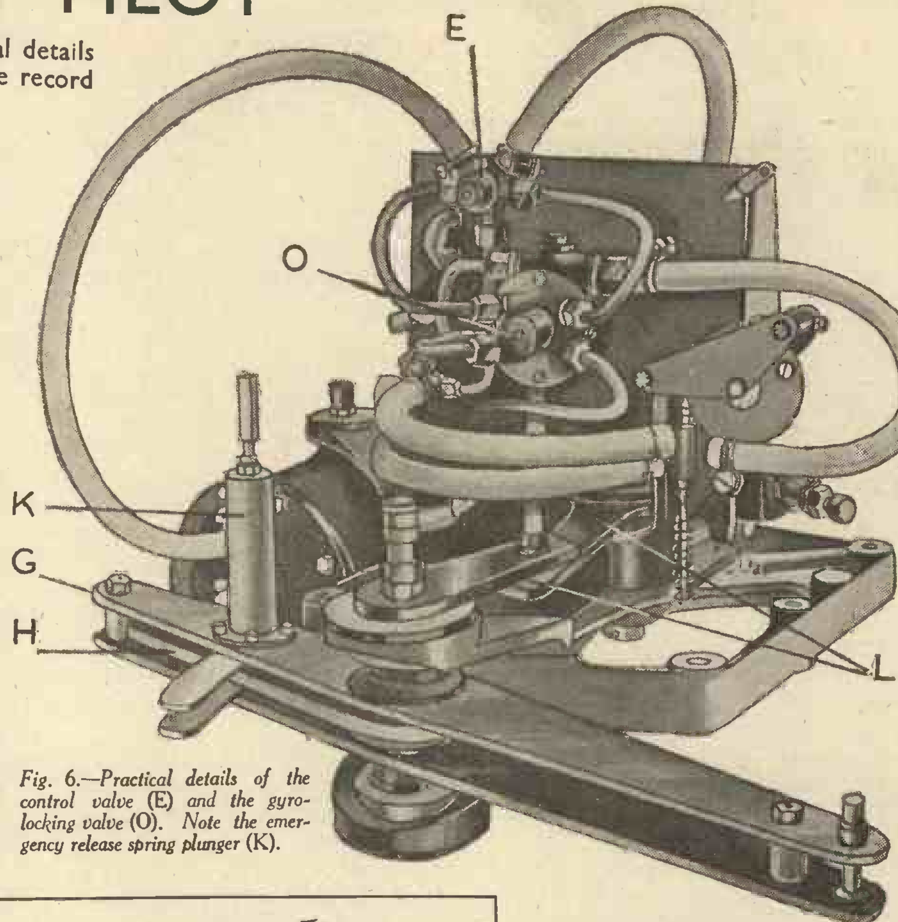


Fig. 6.—Practical details of the control valve (E) *and the gyro-locking valve* (O). *Note the emergency release spring plunger* (K).

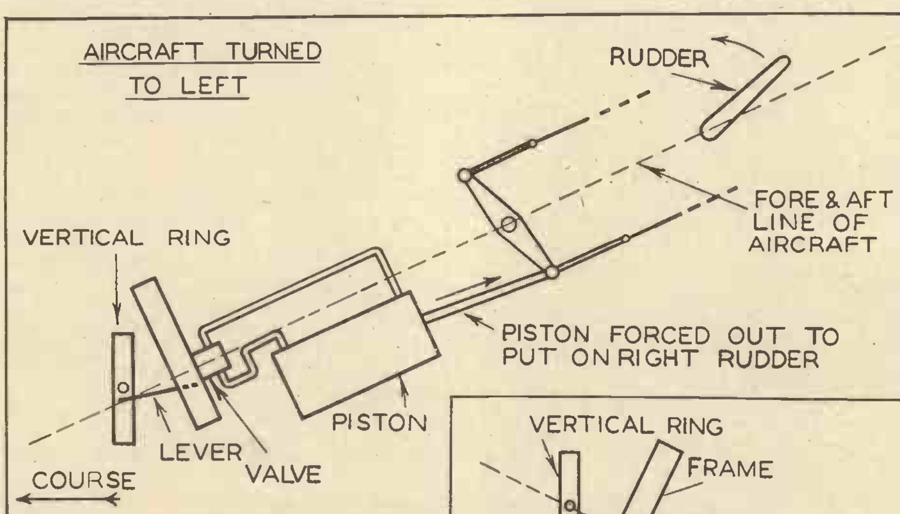


Fig. 4.—The aircraft has turned to the left but the Robot has put on right rudder to counteract the turn.

whole system is ready to operate. If the starting cock is turned off the spring allows the locking plates to re-engage the gyro.

The Emergency Release

Both the elevator and rudder piston rods are connected to their respective levers through spring-loaded plungers, which lock the pistons to the aircraft controls. In the event of anything going wrong with the robot mechanism, all the pilot has to do is to pull these spring-loaded pins out by a Bowden wire cable and the robot mechanism is instantaneously released mechanically and can be kept out of engagement by ratchets on the spring plungers.

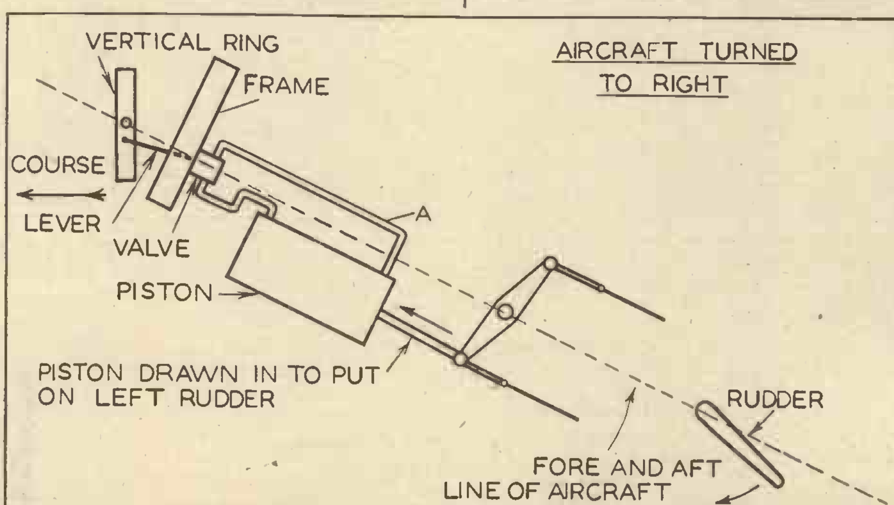


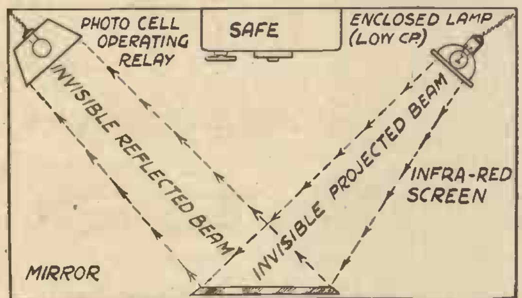
Fig. 5.—The Robot is putting on left rudder to correct the aircraft position to the right of the course by admitting air into pipe A *and drawing the piston rod in.*

With the increasing perfection of wireless-ray control it seems to be quite possible that apparatus could be arranged in an aeroplane to make the various adjustments necessary to enable the aeroplane to be completely "controlled" from the ground. The robot would carry out all the necessary adjustments as described in the above details, whilst the necessary changes of direction, height, etc., could be carried out through the medium of transmitted impulses, so that a machine could be directed from the ground to a distant aerodrome, a safe landing being easily accomplished. The utility of this device needs no stressing.

INTERESTING FACTS ABOUT RAYS

A practical article dealing with the discovery of various rays and how they may be utilised to aid commerce.

MANY years ago the eminent scientist Herschel, investigating the coloured rays of visible light as shown in the spectrum, was amazed to discover that the sensitive thermometer he was using registered a distinct change of temperature at positions where no visible colour could be seen. The positions in question were, immediately following the violet at one end, and preceding the red at the other. Thus were we first introduced to the now commonplace terms "Infra-red" and "Ultra-violet" to designate light rays beyond the scope of the human retina. Day by day rays are playing an increasingly important part in the march of science, the alleviation of suffering, and the minimising of physical effort. Nor are they confined to sober fact, for they have proved a veritable godsend to the writers of sensational fiction, who glibly introduce amazingly destructive "rays" to aid the airman hero and compass the villain's doom.



Infra-red ray as a burglar alarm.

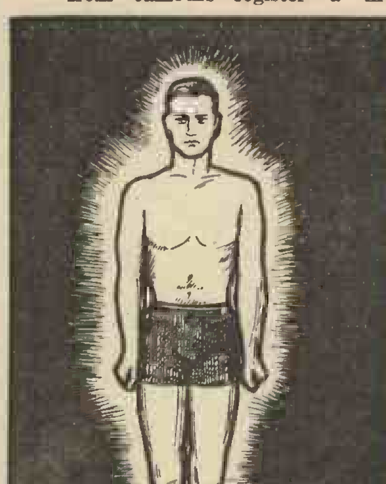
The Ultra-violet Ray

The ultra-violet ray has restored health and vitality to thousands of sufferers, and quite recently found a novel use in a large hospital near Philadelphia, where new-born infants were "branded" with index numbers done in the sun-tan of the beneficial rays through the medium of an ordinary stencil. The judgment of Solomon would surely be superfluous in Philadelphia. Vitamin D, which plays so important a part in the promotion of bone growth and blood content, may well be termed "the sunshine vitamin," as its production in food is due to these beneficial rays derived from Old Sol.

Infra-red rays, on the other hand (and from the other end of the spectrum), have proven of vast assistance to photographers, enabling photographs to be taken through hazy atmospheric conditions which would render detail quite invisible under ordinary circumstances. The value of this, especially in aerial photography, needs no emphasis. Burglars too look like having a thin time, for safes, strong-rooms, and the like have a never-sleeping sentry in the infra-red ray. All that is necessary to foil Mr. Sykes is a lamp whose light is "obscured" by an infra-red filter, a mirror, and a photo-electric cell. The invisible beam from the lamp is projected on the mirror, which in turn reflects it across the room on to the photo-electric cell. The room is thus spanned by two quite invisible rays, and no one could even approach the safe without interrupting one of these. Such interruption instantly starts a most clamorous alarum, and another Raffles becomes His Majesty's guest!

The X-ray

The work and inestimable benefits of the X-ray—discovered by that brilliant genius Röntgen—are known to every schoolboy; but how many of the witch-finders and amulet hawkers of the mediæval days who spoke so glibly of the evil-eye realised that science would one day find definite proof of its existence? Yet such is the case, for each of us radiates a definite sheaf of invisible rays which flicker and fluctuate according to the mentality and feelings of the owner. These rays constitute an "aura," and the emanation is known as odyle. They can be detected by a photo-electric cell, but are also visible to the naked eye if this organ is prepared by gazing at a bright light through a solution of dicyanin for a few seconds and then observing the subject. The aura will be seen as a lambent flame-like sheath extending out from the body for some inches and very reminiscent of a saint's "halo," though the saintliness had better not be taken too much for granted. A curious fact in connection with this aura is that persons suffering from tumours register a much stronger radiation than those in good health, and this would seem to indicate that the radiation is due to the steady regeneration of the cells in living tissue. By living tissue, however, we do not confine ourselves to mammalian tissue, for as far back as 1926 the Russian scientist Gurwitsch proved that radiations emanated from such widely diverse subjects as onion roots, tadpoles, and yeast. As far as can be ascertained, the wavelength of these rays is about 0·00034 mm., which brings them very close to the ultra-violet.


The odyllic emanation or "aura" as seen by the aid of a dicyanin screen.

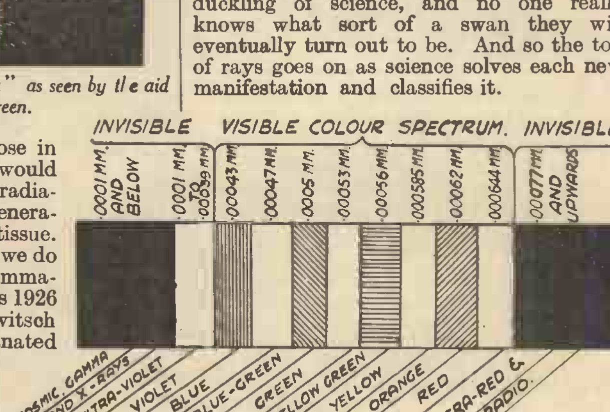
Cosmic Ray

Recently much has been heard of cosmic rays, and the sensational balloon ascent of Professor Piccard last summer contributed much to our knowledge of these rays, about whose existence scientific controversy has raged. Even now scientists are not quite agreed among themselves as to the nature and origin of the rays, but the fact that they exist is now beyond dispute, while that they appear to come from somewhere out beyond our atmosphere in the illimitable realms of space seems certain. Whether they owe their origin to that source of mysterious power—the sun—or to electrical energy produced by the breaking down of the atoms of certain elements of space, is a question which can be left to science, but that the wavelength of these rays is shorter than that of any other and their penetrative power far greater than the X-rays has been settled beyond doubt. So penetrative, indeed, are they that they will pass through solid lead many feet in thickness, and have been detected at great depths in the ocean.

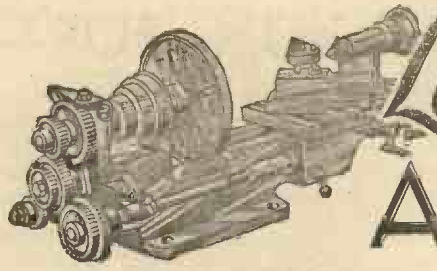
As these were proved to reach the earth from all directions at once, it was thought that the atmosphere must act as a filter and that the higher one ascended the greater would be the strength of the radiation. When Professor Piccard ascended over 53,000 ft. into the statosphere he took recording instruments and was very surprised to find that this expectation was not realised. His own view is that the atmosphere changes the nature of the rays altogether, acting as a sort of transformer, and if the time comes when measurements can be taken in the void of space, we may find something totally different from any, thing guessed at.

Electro-magnetic Rays from the Sun

It is known that heat cannot be transferred through a vacuum, and that a vacuum exists in space. Yet the sun's heat reaches us because the cold electro-magnetic rays from the sun are transformed into heat when they strike the atmosphere enveloping the earth; just as the current travelling along a cold metal cable is transformed into heat and light in the electric lamp-bulb. It will be seen that the cosmic rays are at present the ugly duckling of science, and no one really knows what sort of a swan they will eventually turn out to be. And so the toll of rays goes on as science solves each new manifestation and classifies it.



The visible and invisible spectrum, with types of rays and approximate wavelengths in m.m.



Lathe Work FOR AMATEURS

SECOND OPERATIONS

Much second-operation work can be avoided by the careful study of jobs which are not of a straightforward nature. By W. H. DELLER

A LOT of machining time can be saved by tackling a job the right way round. Even a plain shouldered bush is produced quicker by having sufficient material to stand out of the chuck completely to machine and part off, than by having a casting equal in length to the required bush, boring the hole, afterwards finishing the outside on a mandrel between the centres. This is merely a simple illustration, and more complicated work is worthy of some thought beforehand as to what will be the next move when the opposite side of the job has to be machined perfectly true in relation to that first turned. However careful one is in planning machine work of the "one off" variety, certain jobs will have to be done, which although they do not appear on the finished article, are necessary in order to make a good job.

Holding Work on Pegs

A common form of holder for second operations is by means of a turned peg or plug. This can be employed for holding work, having a cleanly machined hole of reasonable size in it, and about which the remaining portion of the turning must be true. A piece of round bar material, either steel or brass, is firmly gripped in the chuck, leaving sufficient projection, on which a plug is turned to suit the hole in the job. The diameter at the back must be made slightly larger than at the nose. All turning marks must be removed with a very fine file and the surface of the pin polished. The fit of the plug must be such that the hole in the job "wrings" on to it, care being taken to oil the surface before the job is tried on or seizure between the contacting surfaces may result.

Too much taper will cause the work to wobble, and when on the plug it must, in order to be properly driven without the likelihood of slipping under cut, be clear of the shoulder formed by the turning. Particular care should be taken when fitting a job having a blind hole in it to a peg, and a small flat must be filed along the peg to allow the air to escape from the hole. Holes that are too shallow to provide sufficient drive, such as a ball race housing, may be held on to the peg with a nut and washer, screwed over a stud turned on, or tapped into, the end of the peg.

For work of a light character requiring a peg of large diameter boxwood may be used in place of metal for the peg.

Use for a Pipe Centre

It is frequently necessary to bolt work on to the faceplate to do some further machining true with an existing machined hole. A lot can be done to place the work in such a position that it will, when bolted up, run almost true, by using a pipe-centre held in the tailstock and engaging with the edge of the hole, to hold the job on the faceplate while being bolted or clamped on to it. A pipe centre is of large diameter and is turned to an angle of 90 degrees inclusive.

Mandrels

As distinct from the pegs described mandrels are used for holding second operation work between the centres. That shown in Fig. 1 is a solid mandrel. These are obtainable from ¼ in. diameter and upwards in standard sizes. The centres are in recesses so as to protect them from damage, and the mandrels are hardened and ground. The ground portion is slightly tapered, the largest end being usually that on which the size is marked. Flats are provided at each end for carrier hold.

A type of adjustable mandrel is seen in Fig. 2; the body of the mandrel is fairly steeply tapered. On to this fit a series of sleeves. These are bored out taper to suit the mandrel and a row of equally spaced holes are drilled close to each end, the holes on one end being staggered to come between those on the opposite end. Cuts are made with a saw into each hole from the far end of the sleeve, allowing the sleeve to expand when pushed on to the mandrel. In use, the sleeve nearest in diameter to the hole in the job is selected, and the sleeve expanded until the work pushes on. Further expansion is obtained by bumping the large end of the mandrel on a wooden block.

Another type of expanding mandrel is that shown in Fig. 3. This is made in a range of sizes, one being specially made to suit the needs of amateurs. The body of the mandrel is screwed for most of its length. Three slots are cut from end to end, these being spaced at 120 degrees apart; the slots are parallel in their width, but the bottoms taper in relation to the axis. Into these slots strips are fitted, the tops of which are machined concentric with the centres. Projections on the ends of the strips fit into a recess in the screwed collar which pulls them along the mandrel. The screwed portion is turned away on the front to permit small diameter work being held. This type of mandrel is not particularly suitable for holding thin work owing to the lack of support between the strips. For heavier work it provides a means of holding a very wide range of sizes.

Tube Mandrels

Very thin tube is best held on a solid type of mandrel. A positive drive without fear of distortion can be obtained by warming the mandrel and lightly coating with beeswax; the tube is also warmed before it is put in position. Work can be commenced when the wax has set. It is, of course, necessary to re-warm before removing.

An adjustable cone mandrel for heavier tube is shown in Fig. 4. The work is held between the faces of two cones; one cone is made integral with the body of the mandrel, which is screwed for the greater part of its length. A tapped hole in the other cone fits this thread closely and flats (or a hexagon for a spanner) form the means of adjustment. It may be as well to mention that before being mounted on a mandrel of this description the ends of the tube should be faced.

Mandrels to fit into Head

Useful items that can be made as an addition to the equipment of the lathe are the mandrels shown in Figs. 5 and 6. They are made with a taper shank to fit into the nose of the lathe. The first one is split and is expanded by means of a taper-

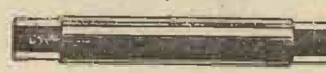


Fig. 1.—A solid mandrel.

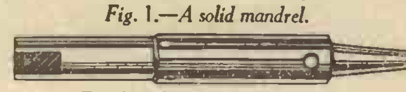


Fig. 2.—An adjustable mandrel.

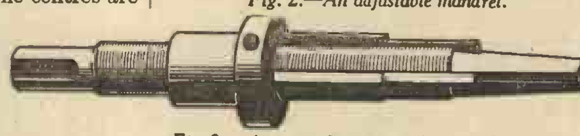


Fig. 3.—An expanding mandrel.

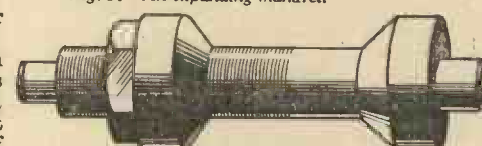


Fig. 4.—An adjustable mandrel for tubes.

Fig. 5.—A split mandrel expanded by means of a taper screw.

Fig. 6.—A mandrel for turning discs or wheels.

headed screw. Where the lathe has a hollow spindle and the design of the thrust arrangement will permit) the taper plug may be attached to a drawbar passing through the spindle.

After turning the shank to suit the nose of the lathe the remainder of the turning is done in position; the angle of the taper for expansion purposes should not be too steep. These mandrels can be made in a range of useful sizes or one of, say, ⅜ in. diameter made with split sleeves to take the larger sizes.

The one shown in Fig. 6 is for turning discs or wheels. A stud is turned on the front of the shank, having a plain portion slightly larger than the thread. A range of true bushes is made to fit over the stud.

The work is clamped between the washer and the shoulder, which must be faced perfectly flat. In making and before removing these mandrels from the lathe for the first time mark them to correspond with the mark on the nose of the lathe, so that each time they are inserted in the same position when required on a future occasion.

ROCKET PROPULSION FOR—

A number of experiments are now being carried out by where liquid fuel is being used in place of the

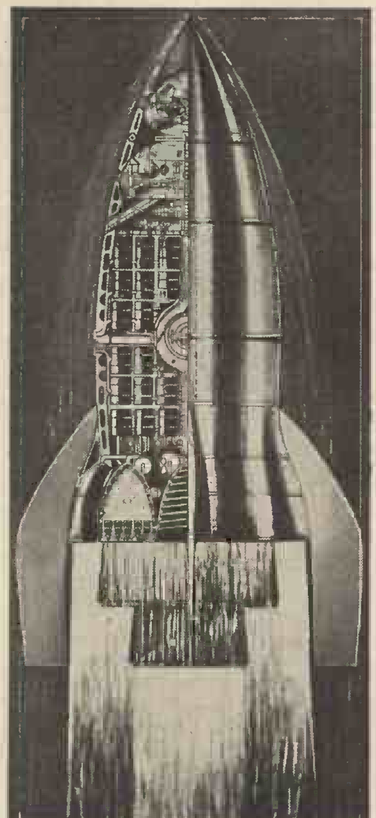
In case of danger the observation-room of the vessel can be detached from the collapsible nose of the hull, by means of a parachute. To-day in America there are already huge parachutes capable of carrying whole flying machines.

THERE has of late been an unmistakable spurt in technical progress in rocket flying, especially so far as the development of the flying machine is concerned, and the increase of its speed and power. The recent introduction of the Diesel engine into air transport has resulted in a fundamental improvement in the propelling of the machine which has introduced a new era in flying. Things have calmed down a little in the sphere of rocket flying since the intensive efforts of Valier, Opel and others.

In America, Russia, France, England and Germany there is a feverish activity in the further development of the rocket engine with liquid fuel. Indeed, we are standing to-day on the threshold of a great development. It is about 300 years since the famous English scientist, Isaac Newton, reached the conclusion that it must be possible, by means of the rocket type of machine, to travel in the stratosphere, because rockets get their impetus from backward pressure which results from the expulsion of the combustible gas. We have such a machine in miniature in the firework rocket, which, in its fundamental form, was already known to the ancient Chinese. The expanding gas produced by explosion is expelled backwards, and produces a great deal of energy, which shoots the rocket up into the sky in a shower of glowing sparks. The future flying machine for the stratosphere would also work on this principle, as it represents a giant-size rocket. However, it is a long way from the imaginary structure of theory to the vessel ready for practical use.

Rocket Planes and Cars

Attempts are continually being made with rocket planes, particularly rocket cars, where liquid fuel is used in place of the gunpowder rockets formerly in use. Later on, these high-power rockets will also be installed in aeroplanes, in order to reduce the taking-off distance as much as possible, even where the planes are carrying exceptionally heavy freights. These so-called starting rockets might acquire a special significance when used for ocean and endurance flights.



Section of a rocket-flying ship. Top, the parachute-room, navigation-centre, and quarters for the crew. Centre, the steering-gyroscope and fuel-tanks, and, below, the cold-water pipes and rocket.

The successful attempts with a Junkers seaplane of the "Bremen" type should be mentioned as an example. Here, rockets were used formerly with the object of making a rapid start, and it was commonly agreed that with a normal motor plane it would have been impossible to raise the overloaded machine from the water.

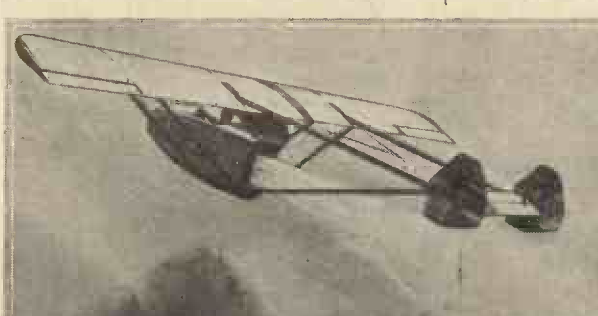
Then of equal importance with the starting rocket will be the brake rocket, whose function it is to bring the plane quickly to a standstill in the event of a forced landing.

Once the efficiency of auxiliary rockets has been proved in propeller planes, the transition will gradually be made to the exclusive use of rocket power for aeroplanes. This has been successful in the case of light sports planes and gliders, and it can well be said that the rocket plane has a great future, if it can attain to achievements of far-reaching importance. Then, indeed, there is a special rise of activity for the rocket plane, at great heights in the stratosphere, for only there would it be possible to attain the desired speed, which cannot be reached in the dense layers of the atmosphere.

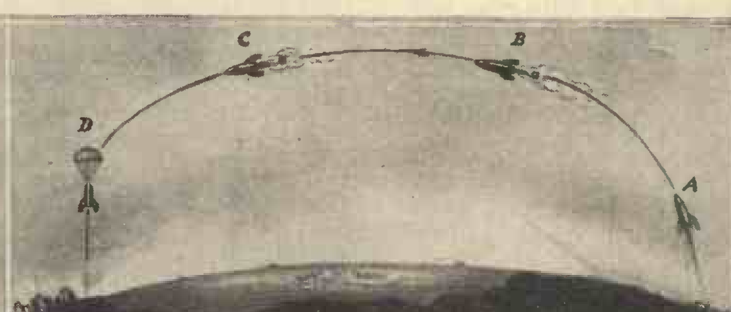
A Height of Twenty-five Miles

The first earthly body to penetrate to these higher strata was the projectile shot by the large long-distance German gun which fired towards Paris near the end of the war. The projectile reached a height of twenty-five miles in the course of its flight, and only the practical suspension of air resistance made the colossal shooting distance of eighty miles possible. The initial speed of the projectile was 5,850 feet per second, and its average speed 2,340 feet per second. The long-distance projectile, however, probably represents the limit of what can be reached. Substantial increase in the achievements of such shooting can only be expected from air torpedoes propelled by rockets.

In America the War Department has already started experiments of this kind in connection with the work of Professor Goddard. The object is to construct rocket projectiles which will travel 375 miles. Conceivable enough, the results so far achieved are being kept strictly secret. In Europe, interest in the rocket problem



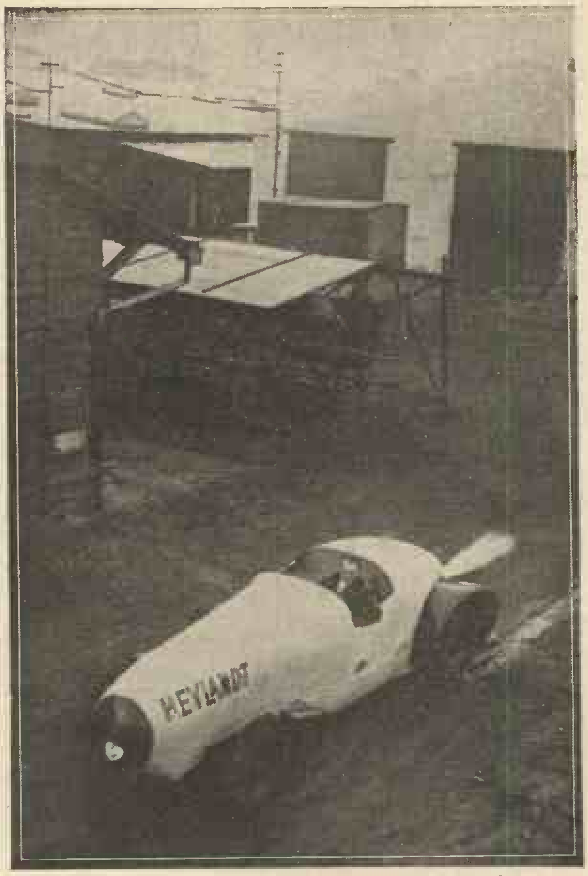
The notable rocket start of Fritz von Opels at Frankfurt, with the single-decker monoplane, which was equipped with Sander rockets.



Proposed Rocket-mail: London–New York. Calculated duration of flight, 28 minutes. A—Start of the rocket. B and C—Automatic casting-off of the first and second burnt-out hulls. D—Landing by means of a parachute.

AIRCRAFT & MOTOR CARS

eminent scientists with rocket planes, rocket cars, etc., ordinary gunpowder rockets formerly in use.



Showing a rocket car during a trial run. Note the white smoke at the back of the car issuing from the rocket.

is centred more in purely scientific circles—for meteorological purposes, in the investigation of the higher air strata and also for geographical purposes and for research in other abstruse subjects. In the former case, the unmanned exploring rockets would be equipped with automatically registering instruments, while in the latter automatic film cameras would be included. The landing of the burnt-out rockets would be made by means of a parachute. Similar parachute landings have already been made with small trial rockets, and have been most successful.

Mail Rockets

A further step in the development will be mail rockets. The idea of such a mail express from one continent to another is strongly supported by Professor Oberth and other rocket experts.

Such a rocket, for example, could carry 1 cwt. of letters from London to New York in less than half an hour, and, moreover, the cost of transport would be astonishingly small.

The rocket mail express service might therefore be not only a valuable innovation, but would also work very economically and provide an excellent source of revenue for the countries concerned.

Whether it will be possible within any reasonable space of time to leave the sphere hemming in the earth, and rush onward to another heavenly body, by earthly expedients, cannot yet be determined. At all events, further attempts with liquid fuel must first lay the technical foundation for the further development of the stratosphere rocket.

In the literature on this subject expansive calculations and plans for future stratosphere airships have already been made. These would be composed of several large liquid fuel rockets, and would have to attain a speed of seven miles per second in order to penetrate the heavy sphere round the earth.

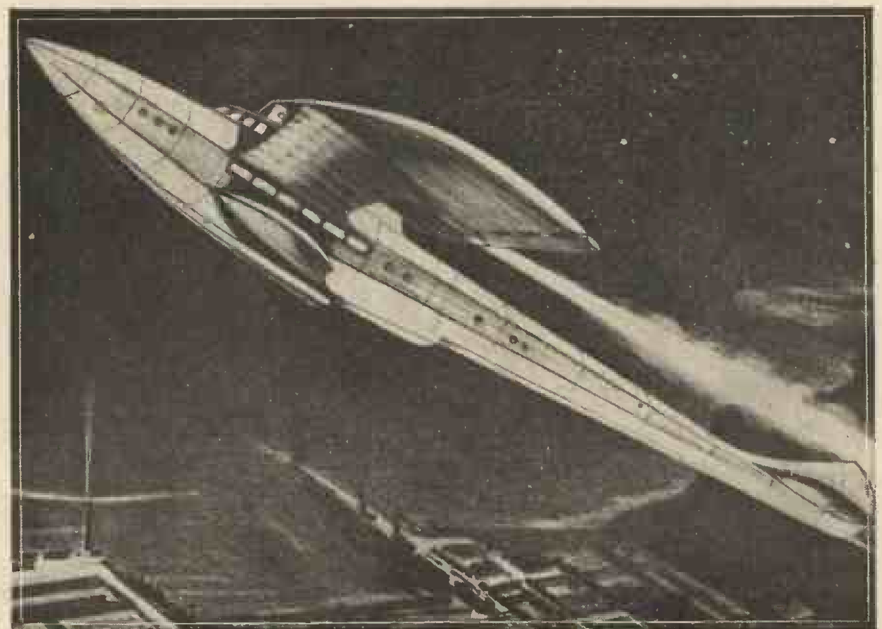
Thus we see that the problem of travelling in the stratosphere is mainly a question of speed. And this is a question of the fuel, and the rocket motor which converts it into energy.

Successful Experiments

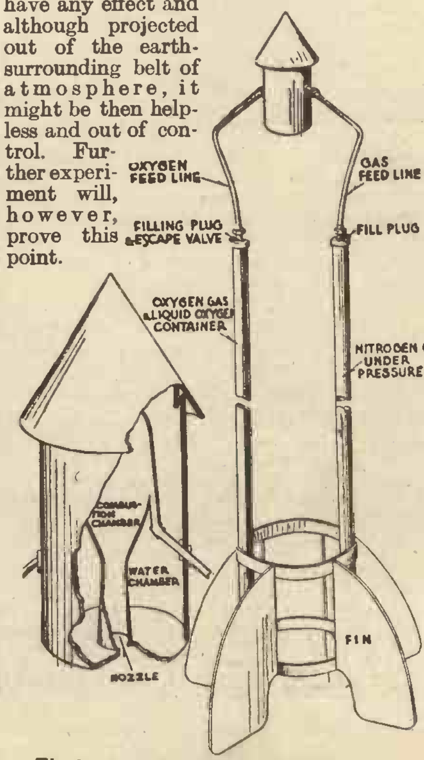
A few months ago a successful attempt was made with a flying rocket in Germany. The inventor started three of his aluminium rockets from a Berlin airport with satisfactory results. Each rocket was approximately 9 ft. high and the wings on the rocket had a span of 12 ft. The rockets started very slowly and gradually reached a high speed. At the highest point (which depends on the quantity of the explosives) the wings unfolded and the rocket descended in a spiral flight and landed near the starting point. Another development in rocket propulsion is a 200-h.p. "vest pocket" motor car. The 200-h.p. motor which only weighs 14 lb., has been invented by a German expert on liquid gases. It is claimed to be one of the most powerful liquid-oxygen motors in the world. The inventor states that the speed of the car is so great that it could reach any place in Europe in a few minutes.

Stratosphere Travel

There still remains, of course, the problem of the effect of the expelled gases on the "atmosphere" which exists in the stratosphere, and although the maximum effect is experienced when near the surface of the earth—owing to the density of the air—it is even yet conceivable that in the outermost space the rocket would fail to have any effect and although projected out of the earth-surrounding belt of atmosphere, it might be then helpless and out of control. Further experiment will, however, prove this point.



Sketch for a long-distance rocket flying machine, for the propelling of which a liquid fuel rocket-motor would have to be used. The long-drawn-out shape of the flying machine is reminiscent of fast-swimming deep-sea fishes.



The details of a liquid fuel rocket which is stated to be the first rocket to fly one mile.

Modern Fitments for the Home

Cupboards for gramophone records and shelves for books are integral with the design of the fireplace in the sitting-room. The illustration shows one side of the fireplace.

How built-in cupboards and clocks, novel lighting arrangements and radio in every room can be installed at low cost.

WHEN, at this time of the year, the question of redecoration arises, the majority of people have this done in a similar manner, the usual procedure being to refresh the walls with paint, paper or distemper, and perhaps invest in a few new curtains. But with a little imagination and a few extra pounds it is possible to change the whole character of a house. Many of the ideas incorporated in a new house of the author's are likely to be of interest to readers who are considering the establishment of a new home or the redecoration of the one they already occupy. As this house was purchased when completed, except for the general decoration and installation of fireplaces, it will be appreciated that no major constructional alterations were made.

All the doors were of the usual panel type, but they have a much neater appearance and are easier to keep clean if they are perfectly plain—that is, flush-faced. Ordinary doors can be altered quite simply with sheets of plywood, nailed on, after which they can be painted or stained.

Built-in Cupboards

When this house was purchased it was decided that as much cupboard accommodation as possible should be provided, and that, wherever practicable, they should be built-in.

In the hall the fireplace recess was across one corner, but as there was also a radiator in the hall a fire was really superfluous. A cupboard, 18 in. deep, was therefore built in this corner for overcoats, hats, umbrellas, etc. The sides and top were plastered, the cornice extended round the top, and the exterior finished in the same way as the hall. The effect obtained is just that of another door in the wall.

The same idea was adopted in a room originally intended by the builder to be a small study. It was decided to use this room, which was rather narrow for its length, as a bedroom by night and an additional reception room by day. Space for a fireplace was provided in one of the narrow walls. This recess was lined with plaster, and rods were placed across for accommodating shoes. Three cupboards were built across this end of the room, additional cornice and plaster being used to give the "built-in" effect. Heating for the room was provided by an electric fire set flush in one of the other walls.

Incorporating Shelves and a Writing Bureau

A rather more ingenious method was employed for built-in cupboards and a writing bureau in another bedroom. Here there was the conventional chimney-breast, protruding from one of the walls. In the space between one side of this and the nearest wall, five shelves were mounted at right angles, extending to nearly the whole length of the available space. The spaces at the side and above and below the shelves were filled in flush with the chimney-breast, a new length of cornice being added across the top. Two doors, mounted horizontally, were provided to cover the upper two shelves (which are intended for clothes, additional box shelves on the insides of the doors being provided for socks and shirts) and two drop-down flaps were made to cover the fronts of the remaining shelves. The larger flap is held, when lowered, by strong stays, and is used as a writing bureau. The lowest shelf is used for shoes.

In the sitting-room capacious cupboards for gramophone records and shelves for books are integral with the design of the fireplace. By dispensing with a picture rail, making the cupboards low, and bringing the walls and ceiling together by a simple curve, an effect of height was obtained.

Throughout the house all the paintwork

From left to right: The built-in shelves and bureau open showing the trays mounted on the doors. Shoes are kept on the lowest shelf. Built-in shelves and bureau in the bedroom. Note the flush electric clock and neat design of fire—both inexpensive. One of the flush fitting electric light boxes with the frosted glass removed. The glass reflectors are mounted round the side.

and wallpaper is washable, but before this kind of decoration is put in hand it should be made sure that all the electric light and power arrangements are quite satisfactory.

Electric Clocks

The wise housewife will want a point for the vacuum cleaner or floor polisher in each room and on each landing, also points for electric clocks on each mantelpiece. These ingenious timekeepers are comparatively cheap to buy, consume a negligible amount of electricity, never require attention, and once set always keep the correct time. Electric clocks can be actually built into the walls or mantelpieces; or in an oak-panelled room the clock may be mounted behind one of the panels with just the hands and numerals visible.

Radio in Every Room

In the author's house provision is made for music from a single H.M.V. radio-gramophone to be heard in nearly every room. The instrument is situated in the sitting room, and the wires for the aerial and earth have been led through the wall to a neat gilt plate which is set flush in the skirting; there is also a socket for the extension wires for the loud speakers, these wires being run to each room either between the walls or ceilings. In the bedrooms the loud speakers are built into the tops of the cupboards, whilst in the bathroom all that is seen is a square of white oiled silk in one of the walls (the loud speaker is in the linen cupboard behind, a small section of the intervening wall having been removed). There is even a loud speaker in the garage, in case the car owner requires some entertainment whilst he is making adjustments to his vehicle. A watertight socket is also mounted on one of the garden fences in order that tea in the summer may be accompanied by incidental music. Each loudspeaker is controlled by a switch in the main switch panel of the appropriate room.

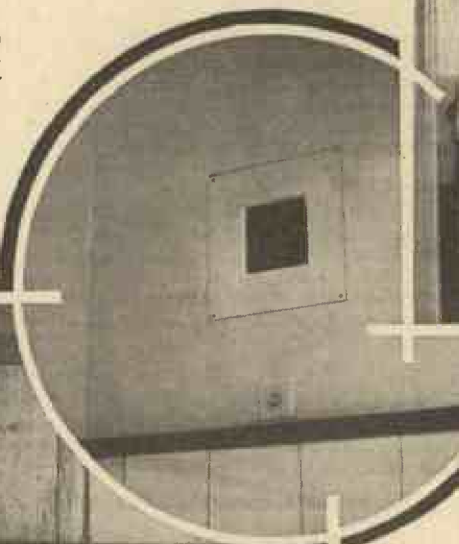
Ceiling Box-Lights

The general scheme of lighting in the principal rooms and on landings is rather novel and inexpensive. In the centre of each ceiling is a small sheet of frosted glass set practically flush. Ordinary pearl lamps are mounted in a metal box, which is secured to the floor joists of the room above. These boxes were made specially and cost between £2 and £4 10*s*., according to size. This system of lighting gives an adequate but soft illumination and avoids the necessity for the constant cleaning of fittings. It certainly requires the use of more lamps than usual, but if the cost per unit of electricity is low the difference will be hardly noticeable.

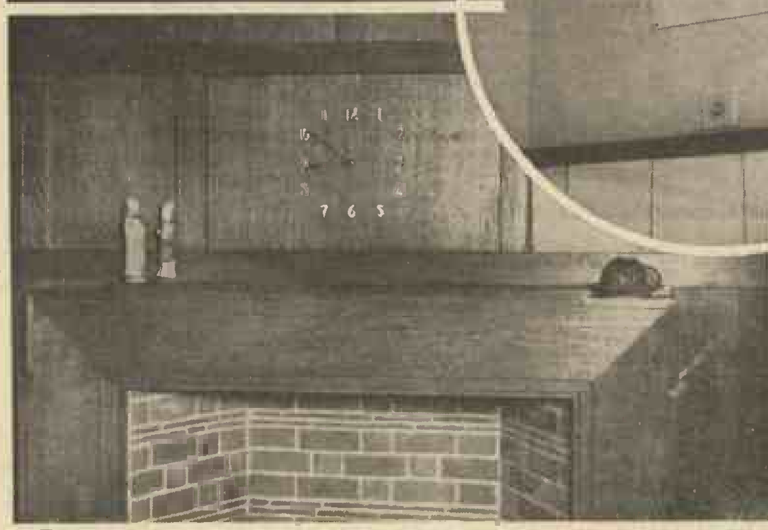
In the bedrooms additional illumination above the beds and wash-basins is provided by tubular lamps. Where the basins are in cupboards, the lights are automatically switched on and off by the opening and closing of the cupboard doors.

As all the ideas described have been put into practice and found to be most successful, the householder need not have any qualms about adopting them.—R. ARBIB.

A built-in cupboard for the lavatory basin. The tubular lamp is automatically illuminated as the door is opened. Note the mirror on the inside of the door.



(Above) The loud speaker in the bathroom is set behind a square of white oiled silk in one of the walls.



The movement for the electric clock is mounted behind a hinged panel in the dining room.

A FREAK CIRCULAR WINGED MONOPLANE

IN our article last month on "Aircraft of the Future," we showed a photograph on page 400 of an aeroplane of unusual design. On top of the machine was a large revolving disc in place of the ordinary wings, which was filled with non-inflammable gas, and the plane had fourteen aeroplane propellers. We have recently received details of a similar type of 'plane designed by Stephen Paul Nemeth, a Chicago aeronautical engineer. This machine, designed chiefly for the sportsman pilot, has a low landing speed, high cruising speed, maximum stability at all speeds, and the utmost all-round safety. It is said that the aeroplane will land and take off within a 50-ft. circle, and the machine has received the apt name of the "Backyard" Flyer. The machine has an Argo fuselage that the designer lengthened to 17 ft. Duralumin tubing is used throughout, and the landing gear is of the conventional type, and airwheles are installed. It has a normal tail assembly with the exception of an inverted horizontal stabiliser, which has the curvature on the underside instead of the top. This is believed to counteract an inherent nose-heaviness. The designer originally fitted the plane with a 90-h.p. Lambert engine, but the plane was found to be underpowered, so a 125-h.p. Warner engine has been installed. With this new engine the "Backyard" Flyer has a top speed of between 110 and 120 miles per hour, cruises at 95 to 100, and has a rated landing speed of from 20 to 25 miles per hour. The circular wing fitted to the top is constructed of wooden spars, and a special wing curve designed by Mr. Nemeth has been used. The wing is 16 feet in diameter, and the entire structure is extremely well braced. A speed-arresting flap, 5 ft. long and 2 ft. wide is built into the trailing edge of the unusual wing, and is lowered by the pilot to reduce the forward speed when making a landing. Conventional ailerons are used, and are of such a size that according to the designer the machine is quite sensitive to their use. Test flights are now being flown, and, to date, the aeroplane has given very satisfactory results.

"The New Infra-Red Photography"

With reference to our article on this subject appearing in last month's issue, we should like to take this opportunity of thanking Messrs. Ilford Ltd., the well-known manufacturers of photographic materials, for their kindly co-operation in providing us with the illustrations which appeared in this article, and which so aptly demonstrated the remarkable progress which has been made in this modern form of photography.

MARKING-OUT TOOLS & METHODS

SOME SOUND ADVICE ON THE CORRECT METHODS OF USING TOOLS.

THE most necessary tools required for marking out as applied to light engineering are a scriber, a pair of dividers, a centre punch, a square (a plate square is also handy) and a steel rule.

These are illustrated in Figs. 1 and 2. The scriber is one of the pocket variety; the dividers a pair of 5-in., finely pointed;

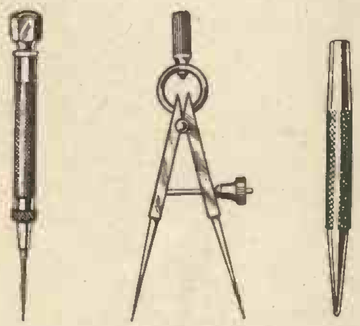


Fig. 2.—A group of essential marking-out tools.

the centre punch is small, that is, at the pointed end; the square has a blade that is movable on the beam and is also rule marked. The small 4-in. plate square needs no comment, and, if a square such as that illustrated is used, a flexible steel rule will be best, but otherwise a stiffer rule will be necessary.

Marking out with a Blue Print Guide

In its simplest form marking-out takes the form of laying a blue print on a baseboard and pricking the necessary holes off with a scriber. Where a blue print can be relied upon for accuracy, this method has the advantage of being direct, but where the scale of drawing is, say, half size, all dimensions will have to be doubled; that is, of course, where the distances are being picked off the drawing. In such cases the dividers are adjusted to suit the various hole centres and measured with a rule, and the

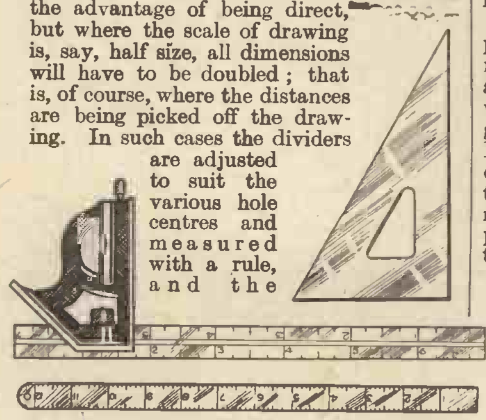


Fig. 1.—Adjustable square, steel rule and set square.

measurement increased by the number of times that the scale of the drawing is under full size, or, where practical, the increase can be made as in Fig. 3. Thus, if the drawing was one-third full size, the length between the divider points would be plotted three times.

Just a word about keeping the points of dividers in trim. They must be kept sharp and fine, and require oil-stoning from time to time, but in doing so see that the points do not gradually become stubby; also see that the points are level when the dividers are shut. This condition is important when marking small circles.

Marking out squares or rectangles for baseboards or panels is carried out as follows. Either one edge of the material is prepared with a perfectly straight edge as a line to work off, or the steel rule is laid on to the material for this purpose. In the first case the blade of the square is set to the vertical height required and one end line is marked, also a line is made against the top of the blade of the square to indicate the height. The square is moved to the other end of the job and the process repeated, the distance between the lines being controlled by the rule held at the first line, leaving the required amount over-lapping as a gauge (see Fig. 4). Where the other method is adopted the set square is called into use, the rule being used as guide for the base of the square, and also an indication is at once obtainable as to length by setting the right-angled portion of the square against the appropriate markings on the rule (Fig. 5).

Marking out Panels

When marking out panels for drilling, a very similar procedure can be adopted. All vertical heights can be made by adjusting the blade of the square so that only the correct amount of rule is projecting beyond the square face of the beam. All distances

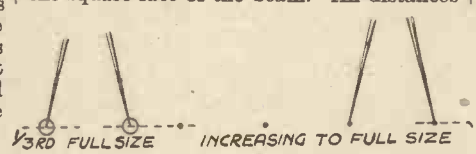


Fig. 3.—How to square off with the dividers.

in the opposite direction are measured with the rule either off one edge or from a previously marked centre line. If properly carried out, a very accurate marking will result.

It remains to centre-punch each hole position. The best way to do this is to make a hole with the point of the scriber at the point of intersection of two lines where a hole is located. This will make a guide for the point of the centre punch. By the way, panels, particularly if they are of copper, or will otherwise be visible on the completed piece of work, should be marked off on the inside or invisible portion when the work is assembled. For this reason it should be remembered that markings will have to be made in reverse, *i.e.*, right hand when viewed from the front becomes left hand on the back side. Large holes that can be drilled direct should have an indicating circle scribed round the centre dot to act as a check on drilling after the centre dot has been removed by the point of the drill.

Large holes, such as cannot be conveniently drilled in the ordinary manner, are cut out by drilling a chain of holes. Thus, for a large circular hole, a circle of required diameter is first scribed with the dividers. Inside this a further circle is made (Fig. 6).

The best known type of drill is that of the twist or spiral flute type, but there are several other types, notably the straight flute, such as are included and contained in the hollow handle of some of the better makes of hand drills, and flat harpoon drills. For general purposes the twist drill is the best, as it permits being reground until worn out, has a constant cutting rake during its life, maintains its size, and is self-clearing. Straight flute drills are handy, particularly for drilling brass and aluminium. Flat drills are useful for drilling small holes in fairly thin material, but for hand work are liable to run when drilling deep holes. Standard twist drills are commercially obtainable in fractional sizes, ranging from $\frac{1}{64}$ in. diameter to 1 in. diameter by increments of $\frac{1}{64}$ in., in wire sizes from No. 80 (·0135 in. diameter) to No. 1 (·2280 in. diameter)—80 different sizes in all, and in Letter sizes from Letter A (·2340 in. diameter) to Letter Z (·4130 in. diameter).

These drills may be purchased separately, or are made up in sets and mounted in wood or aluminium stands provided with holes to suit the drill shanks. Each hole is distinctly marked with its respective drill size, so the task of selecting a correct drill is made easy.

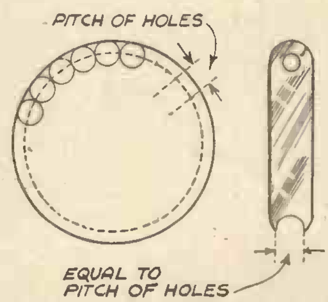
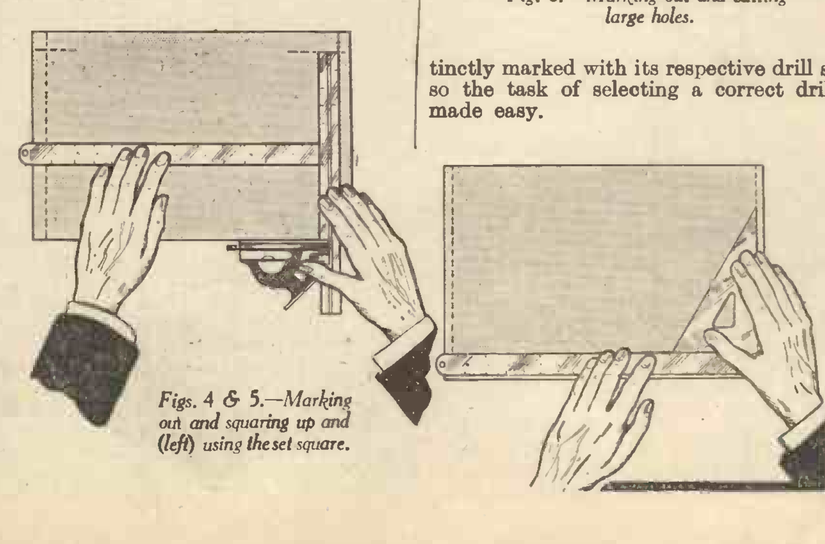


Fig. 6. Marking-out and cutting large holes.



Figs. 4 & 5.—Marking out and squaring up and (left) using the set square.

LEVITATION MYSTERIES EXPLAINED

By V. E. JOHNSON, M.A.

This article deals with a number of amazing tricks whereby the law of gravity is apparently defied, and describes in simple language how they are made possible by means of mechanical devices.

THAT bodies if unsupported fall to the ground is one of the very earliest facts impressed on our minds. That birds fly, expending energy in so doing, that balloons rise up into the air, that aeroplanes, by the exertion of considerable energy, can overcome (so long as this energy is exerted) the force of gravity is well known, and causes us no surprise. We have all of us seen light balls at shooting galleries supported on a thin stream of water or more mysteriously on one of air—but the ball does not remain quite stationary; it is also rotating and obviously held up by something.

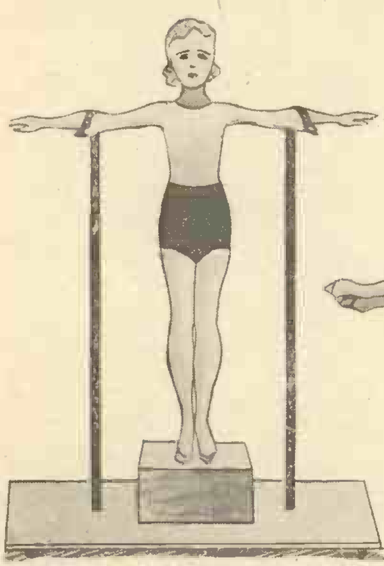


Fig. 1.—(Left) the original position and (right) the final position of the person levitated.

But all these are more or less everyday occurrences—no matter how much they may excite our interest and admiration. But to see (say) a human body rise from a table or divan slowly into the air, remaining perfectly rigid all the time, in a trance as it were, apparently under the magnetic will of the magician, arouses or at any rate is capable of arousing quite different feelings. We may believe it to be something supernatural or superhuman, or we may simply admire the mechanical skill with which it is brought about, knowing all the time that it is simply a trick, being fully aware that gravity never has been and never will be, under present physical laws, defied or set at naught.

First of all, let us take quite an old but very ingenious and clever mechanical levitation mystery and see how it was worked.

A Mystery explained

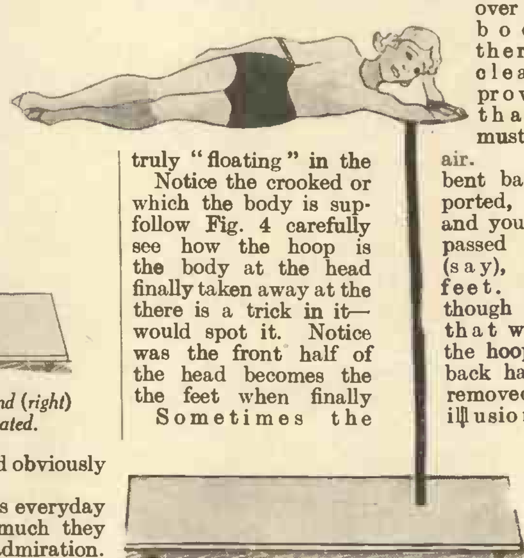
Fig. 1 shows the original and final position of the person levitated, and in the second position he or she was supposed to be able to remain so owing to his or her hypnotic or trance-like state.

This was possible owing to the " harness " worn, shown in Fig. 2.

KHG is a strong rod working on a hinge—capable of being locked or made rigid when the rod assumes a horizontal position, and the rod runs down one side of the " subject's " body. At M is a strap for the arm; CC is a shoulder strap; BAA a strap going round the body; and EEED and I are leg straps. Shown first of all in a vertical position (Fig. 1), the subject is raised by the feet or ankles into a horizontal position across the two upright rods. The subject is then hypnotised or put into a mesmeric sleep or trance and the upright left rod is removed, and the subject " sleeps " quite calmly and peacefully in the second position shown in Fig. 1.

An Effective Illusion

Figs. 3 and 4 show a greatly improved form of illusion, because a hoop is passed over the body, thereby clearly proving that it must be truly " floating " in the air.



Notice the crooked or bent bar by which the body is supported, and follow Fig. 4 carefully and you will see how the hoop is passed over the body at the head (say), and finally taken away at the feet. But there is a trick in it—though few would spot it. Notice that what was the front half of the hoop at the head becomes the back half at the feet when finally removed. Sometimes the illusionist stood behind the figure, to hide the upright supporting bar when the illusion was worked from beneath the stage. In this, as in all illusions, much depended on the personality of the performer.

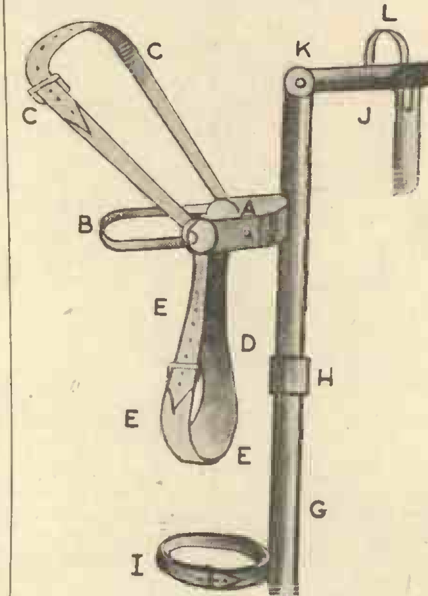


Fig. 2.—The illusion in Fig. 1 is made possible by the person wearing the harness shown here.

Two Further Illusions

A little girl is brought or comes on to the stage, and after the usual procedure is placed on a divan as shown in Fig. 3, or any other suitable device. A cloth is placed over her, somewhat deeper than that shown in Fig. 3. The illusionist puts her to sleep, and under his hypnotic or mesmeric influence she rises into the air. The divan, etc., is removed, he walks backwards and forwards with his arm fully extended once over the figure and once under it. He then leans right over the figure and sweeps his arms in a semicircle over and around the figure, and then walks completely round it.

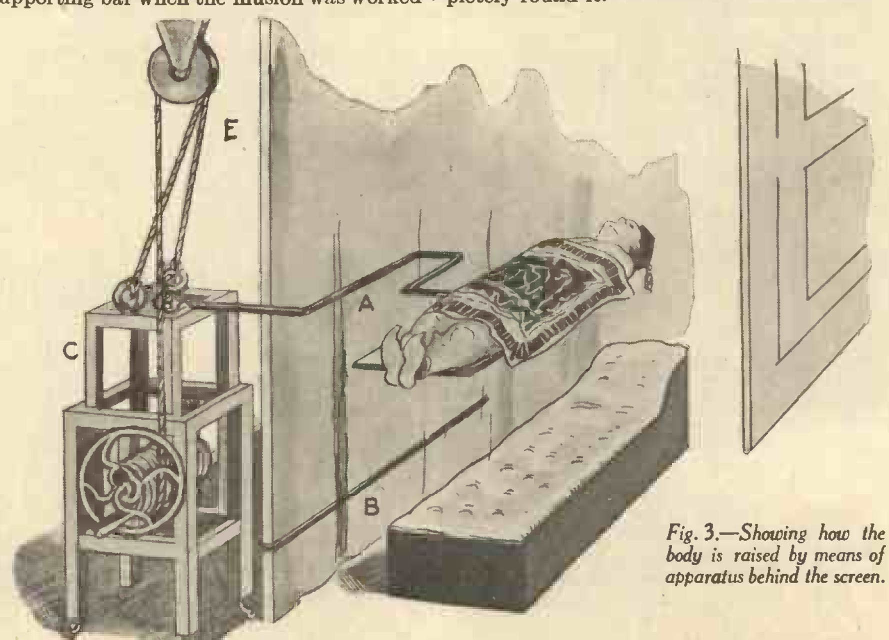


Fig. 3.—Showing how the body is raised by means of apparatus behind the screen.

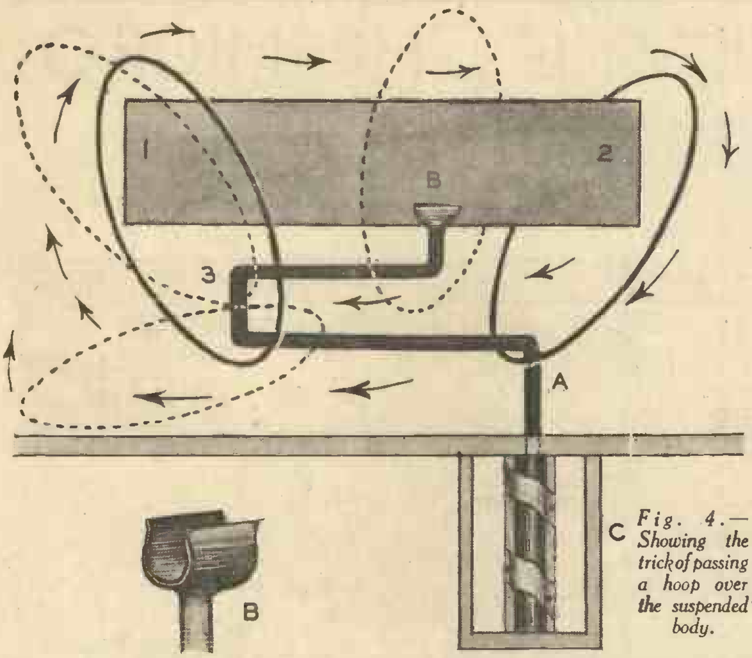


Fig. 4.—Showing the trick of passing a hoop over the suspended body.

The Explanation

A balance weight and a dozen *very* fine steel wires painted a dull black are required—such wires are absolutely invisible even at so short a distance as 12 or 15 ft., under proper conditions of lighting and background which can be variegated in colour. The same applies to the magician's dress when he walks round the figure. In Fig. 5 let us suppose we are looking down on the apparatus from above. ABCD is the board on which the little girl lies down quite flat with her arms folded. So as to prevent any swaying the balance weight was in a somewhat lower horizontal plane than the board. This and the connecting rod and board were all concealed by the cloth placed over the girl. Had the connecting rod been given the shape shown in Fig. 4, the hoop effect could have been shown.

The best method of raising and lowering the body is a well-greased accurately running rack and pinion, which must be worked from above. It must be worked very steadily and evenly, and there must not be a vestige of swaying or the illusion becomes imperfect.

The Aerial Swing

A swing—white seated—supported by thick white ropes, to which a few steps lead up, is seen against a black background. The illusionist enters and introduces a little girl, suitably attired in white or some gaily coloured costume. The girl climbs the steps, seats herself on the swing, the steps are removed, and the illusionist assists her in swinging. One rope is first removed and falls—causing the seat to drop and swing to one side and then the other rope is removed and the entire swing falls to the ground, but the little girl goes on swinging just the same. The performer then brings forward a hoop, which he bounces on the stage to show its genuineness, or it can be examined. He then passes the hoop completely over the swinging girl—over her head, under her and away at her feet—without any movement on her part, thereby proving that her swing must be truly aerial. No half turn is given to the hoop—what the audience see is actually what is done. Considerable practice on the part of the performer and his assistant behind the scene is necessary, and everything must be timed to a nicety for it to work smoothly. There is nothing optical about this illusion; the little girl is really where she appears to be all the time.

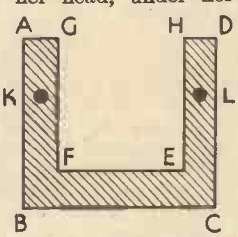


Fig. 7.—Details of the seat for the swing.

How it is performed

First as to the mechanical principles involved. (1) It is obvious that the performer is never at any time supported by the swing, *i.e.*, the ropes and white seat. (2) In order that the hoop can be passed completely over her as described above, she must be held up by what is known as the method of "alternate support," *i.e.*, she must be supported differently at different times whilst the hoop is passed over, and this change must be made as smoothly as possible. In Fig. 6 the reader must imagine he is viewing the apparatus direct from the side, and that it is a vertical section of same. XYPQ we can regard as a stool on which the little girl sits, which has a white top; all the rest is a dull black. The seat which falls fits round its front and sides (see Fig. 7), the top of the stool occupying the space GHFE, and the white ropes are attached to KG and L. The stool has a top and vertical ends or sides, but no cross-pieces.

A suitable hinged flap, sliding panel or roller curtain fills up the space GHEF as it falls.

ABCD is a lever, fulcrum C, on which the stool rests, and the swinging is really done by the assistant behind the curtain grasping the handle D with one hand. FCH is another lever, whose handle H is also grasped by the other hand of the assistant. The first lever ABCD is shown only in one position, but the other lever, which is capable of sliding backwards through C, is shown in another position F'CH', and it is kept in this position. The stool and girl are supported by the lever ABCD *until the hoop has passed the level of FCH*, then this lever is thrust forward under the *top* of the stool, the handle D of the other lever raised and the weight passed on to the lever FCH, and AB being now lowered, the hoop is free to be taken away, underneath PQ and forward in the direction QP.

The assistant behind, who is in darkness, can see through the thin black curtain and knows exactly when to make the change; it is best made when swinging forward.

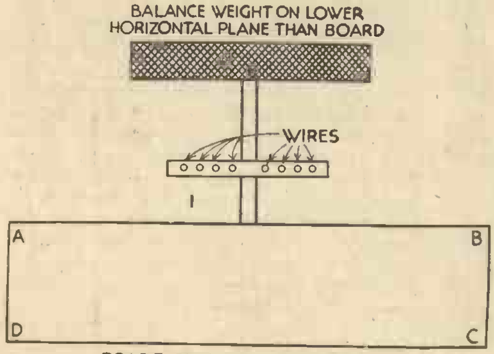
Suitable lighting and a dull black render the mechanism absolutely invisible to the audience.

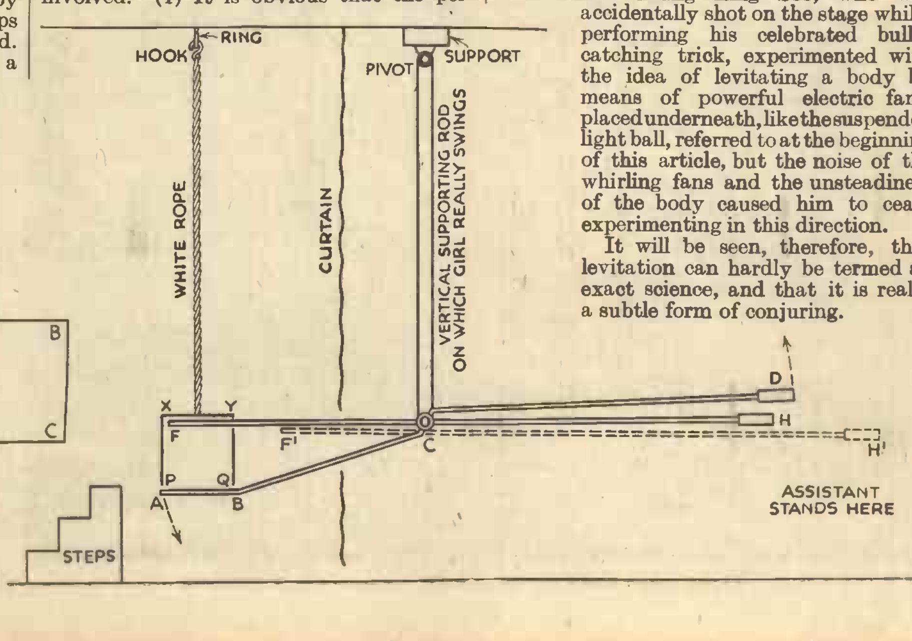
Since the pivot on which the swing works or swings is not the same as that of the ropes, there would be a tendency for the ropes to slack during the swing. This is obviated by springs attached to the seatings of the supporting rings or by making the ropes themselves elastic.

The Late Chung Ling Soo

The late Chung Ling Soo, who was accidentally shot on the stage whilst performing his celebrated bullet catching trick, experimented with the idea of levitating a body by means of powerful electric fans, placed underneath, like the suspended light ball, referred to at the beginning of this article, but the noise of the whirling fans and the unsteadiness of the body caused him to cease experimenting in this direction.

It will be seen, therefore, that levitation can hardly be termed an exact science, and that it is really a subtle form of conjuring.





Figs. 5 and 6—(left) The apparatus for performing a trick similar to that shown in Fig. 3, and (right) the framework used in performing the aerial swing illusion.

READING AND USING THE MICRO-METER AND VERNIER

Apart from gauges of the fixed type the tools used in the workshop for making accurate measurements involve either the micrometer or vernier principle.

Fig. 1.—The line along the barrel of a micrometer is engraved so that when it is held as shown it is in the direct vision of the operator.

THE most common type of micrometer is that used for external measurements. Such a micrometer is seen in use in Fig. 1, where the diameter of a pin is being taken. This actual tool is what is known as a 1-in. micrometer, and it will deal with measurements of a similar nature from zero up to an inch. Briefly, it consists of the following parts: A flat, bow-shaped, stiff frame into the inside of which at the top is fitted a hardened gauging face. Exactly opposite to this face and on the outside of the bow is arranged a stout machined tube. The tube is tapped inside with a thread, into which fits a threaded spindle faced and hardened on the inner end to form an adjustable gauging face. Attached to the outer end of the spindle is a tube that is large enough in the bore to slide over the outside of the tapped tube. Thus, by turning the outer tube, the end of the screw will advance or recede in relation to the fixed gauging face. It is quite obvious, therefore, that providing the pitch of the screw is accurate, if the gauging faces are in contact and the spindle is then unscrewed for one complete turn, the distance between the gauging faces will be exactly equal to the pitch of the thread. In order that the turns of the screw need not be counted, a line is engraved along the outside of the tapped tube, this being subdivided by short vertical lines spaced equal to the pitch of the thread. The edge of the outer tube is chamfered and engraved with equally spaced lines so that the thread can be moved by complete turns or exact parts of a turn.

The fixed gauging face is called the anvil, the movable gauge face the spindle, while the tapped tube is known as the barrel and the outer tube the thimble.

Reading a Micrometer

On a micrometer reading in inches the spindle is threaded forty threads per inch. The line along the barrel is engraved so that when the micrometer is held as shown in Fig. 1 it is in the direct vision of the operator. This line is along its lower edge divided into forty parts, every fourth line commencing from the frame being marked with a numeral from 1 to 10. The end of the thimble is graduated into twenty-five equal parts. When the gauging faces are touching, one of these lines exactly coincides with the long line on the barrel and the feather edge of the thimble is in line with the first vertical line. This line on the thimble is marked 0, and every fifth line is marked with a number; thus, 5, 10, 15, 20. This means that the divisions along the barrel represent fortieths of an inch, and the distance between the numbered lines four-fortieths or one-tenth of an inch. The divisions on the thimble, then, represent one twenty-fifth of one-fortieth, or one-thousandth of an inch. It will be seen that the reading is in decimal fractions. Thus $\frac{1}{2}$ in. becomes 0·5 in., and to set the micrometer to this size the thimble is unscrewed until the zero mark on it corresponds with the line marked 5 on the barrel, that is $\frac{5}{10}$ in. To give another example of setting we will take the decimal equivalent of $\frac{3}{16}$ in. which is 0·1875 in. or one-tenth eight-hundredths and seven and a half thousandths. Set the zero mark on the thimble to number 1 on the barrel; three further complete turns to the spindle adds seventy-five thousandths; this leaves twelve and a half thousandths or twelve and a half divisions on the thimble to be added.

Some 1-in. micrometers have the decimal equivalent of from $\frac{1}{64}$ in. to $\frac{63}{64}$ in. in sixty-fourths engraved on the frame, which, by the way, is a very convenient arrangement.

Micrometers reading in tenths-of-thousandths are obtainable. These are read in the ordinary way to three places of decimals, but the fourth place is read on a vernier. Above the datum line on the barrel is another line parallel to it. This line corresponds with the fifth line on the thimble with the zero mark set at the datum line. At a distance away from the second line equal to nine divisions on the thimble is another line, the space between these lines being divided into ten equal parts. The number of tenths-of-thousandths are added as follows: Say it is necessary to add 4; take the line marked 4 on the vernier and bring the line on the thimble that is nearest, alongside, keeping the thimble moving in a direction to unscrew the spindle, of course.

Fig. 2.—The micrometer shown in the bottom left-hand corner has a ratchet stop fitted.

Holding a Micrometer

Reference to Fig. 1 again will show the correct way to hold a small micrometer; as will be seen, the frame lies in the palm of the hand with the thimble between the thumb and finger. This leaves the other hand free to manipulate the work being measured. In using the micrometer a certain amount of "feel" must be cultivated, the thimble being adjusted so that the gauging faces are only lightly contacting with the surface of the work. Some thimbles are fitted with a device, namely, a ratchet stop to ensure that the spindle is adjusted on to the work each time with the same degree of pressure. This arrangement is fitted on to the end of the thimble

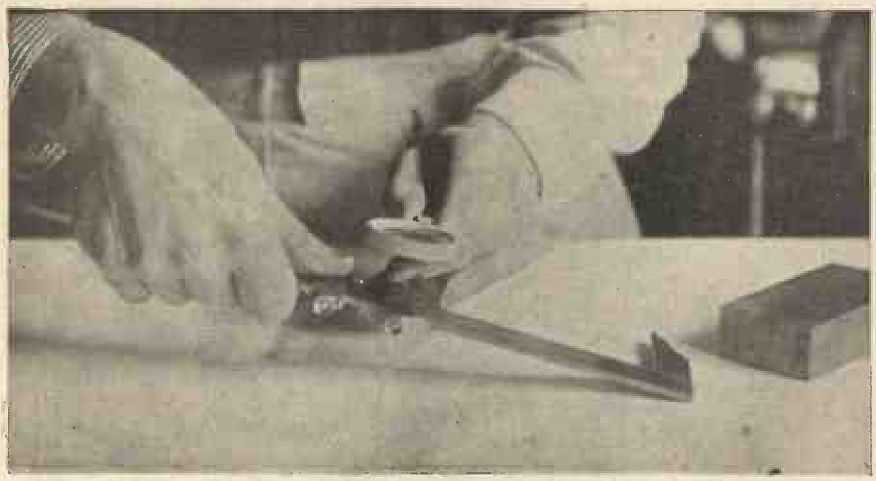


Fig. 3.—To ensure that the lines of the vernier calliper coincide when adjusting it for a job, view them through a magnifying glass as shown.

with a screw upon which it is free to rotate. It is prevented from doing so by a spring-loaded pawl in the end of the thimble engaging in ratchet teeth cut in the end of the stop. The final adjustment is made to the spindle by turning the knurled portion of the ratchet stop; as soon as the end of the spindle is in contact with the work hard enough to overcome the pressure of the pawl, the ratchet teeth which are cut in a direction to override the pawl do so. The micrometer in the bottom left-hand corner of Fig. 2 has a ratchet stop fitted. When it is necessary to set the micrometer to size for use as a gap gauge, a means of locking the spindle is provided. Usually this is in the form of a locking ring on the frame at the point where the spindle emerges. The ring tightens on to a collet through which the spindle passes.

Adjusting

In common with other things micrometers are subject to wear. Compensation for wear on the gauging faces is provided by making either the anvil adjustable or by making the position of the datum line movable. This is acomplished by fitting a friction-tight sleeve over the barrel. On the sleeve is engraved the markings that are normally on the barrel. By means of a special spanner the sleeve is rotated slightly to bring the datum line against the zero line on the thimble, being done, of course, with the spindle shut against the anvil.

After a fair amount of use the threaded spindle may become so slack a fit in the nut that backlash is created. The end of the barrel that is reduced in diameter is taper-threaded and split by saw-cuts down to the shoulder, a circular nut fitting over the end of the thread. To take up the wear unscrew the thimble past the end of the barrel to reveal the circular nut. A pin on the special cee spanner supplied with the micrometer fits into a hole drilled in the nut. As this nut is tightened on to the tapered thread it closes in the end of the spindle nut. This should be done very gradually, and in order to make sure that the screw will not bind. Wind it into the nut for the full distance of travel between each tentative movement of the adjuster.

Types

Micrometers are manufactured in a range of sizes covering from 0 to 1 in., 1 to 2 in., and so on. Those larger than the first are supplied complete with a standard test-piece to facilitate checking and adjustment. A 1–2-in. micrometer and 1-in. standard are seen in the right-hand corner of Fig. 1. Apart from these types a range of 0–2 in. is covered by micrometers having either a sliding anvil or an inch extension that can be clamped on to the anvil. Other types, not in common use, are those in which the head is carried on a member sliding on a beam like a vernier calliper.

For inside measurements a special type of micrometer is required. Such a tool is illustrated in Fig. 2. It will immediately be seen that the range of sizes that can be covered is governed by the overall length of the micrometer when closed. This is seldom less than 2 in. A hardened gauging face is fitted to one end of the thimble and a removable face on the end of the barrel.

Fig. 4.—The vernier calliper in use.

The overall length of the gauge can be increased by adjustment of the thimble by ½ in. beyond this; the range can be increased by means of a combination of distance rods and sleeves fitting into the end opposite to the thimble. Other methods employ distance rods that are ringed with a groove at intervals of ½ in. which engage with a lip formed inside a collet-like holder. A similar tool using a distance rod of the kind is the micrometer depth gauge.

All types of micrometers are to be had in either English or metric readings. The pitch of the screw in a metric micrometer is ½ mm., the reading being $\frac{1}{100}$ mm.

The Vernier Calliper

A vernier calliper such as is shown in Fig. 3 will make measurements within the restriction of the graduated beam. These tools are chiefly used for measurements of length, as the largest diameter that can be covered is controlled by the depth of the jaws. As will be seen, the graduated bar carries a fixed gauging face on one end and a sliding face working along the beam. For English measurement the beam is graduated in the same way as the barrel of a micrometer, namely, in fortieths of an inch. In an opening cut in the sliding jaw is a plate which is also graduated. The total length occupied by these markings is equal to twenty-four fortieths on the beam, but the space between the lines is divided into twenty-five parts. Thus the vernier will read in one-thousandths of an inch.

To make for easy setting the beam is numbered off in inches, and every fourth fortieth in each inch is marked from 1 to 9 as a micrometer.

To set the gauge to, say, 4·619 in. the sliding head is moved along the beam until the zero mark on the scale passes the fourth inch marking; now it is taken to the sixth tenth of an inch marking past the 4 in., the reading now being 4·6 in. The locking screw on the fine adjustment, that is, the screw at the top of the part by the operator's right hand, is tightened and the jaws opened to the required extra nineteen thousandths by means of the fine adjustment under the operator's thumb. To add the 0·019 in. bring the line at the end of the nineteenths division on the scale in line with the next fortieth line on the beam. To ensure that these lines coincide exactly they are viewed through a magnifying glass as in Fig. 3. The vernier is shown in use in Fig. 4. It will be noticed that the lower end of the jaws are stepped. This is for the purpose of making inside measurements such as the diameter of a hole. In reading, or setting for, such measurements the total width over the stepped portions of the jaws must be allowed for. So that if the vernier reads 2·110 in. and the width of the stepped portion is 0·300 in. the size of the hole is 2·110 + 0·300 in., or 2·410 in., but to set to a certain size the width of the jaws is "knocked off" first; thus to set for an internal size of 3·750 in. the reading

(Continued on page 479.)

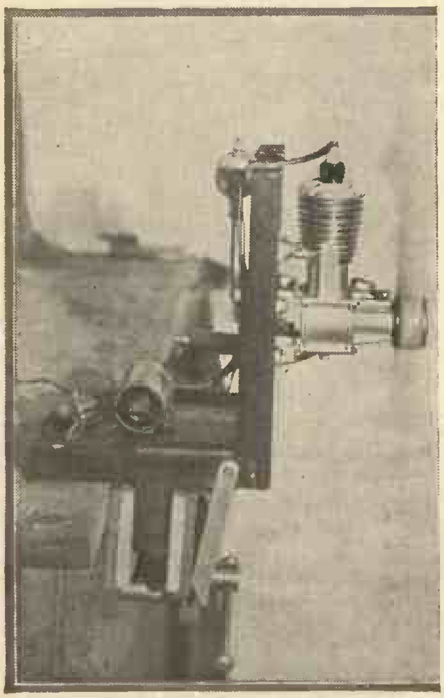
MODEL AERO TOPICS

By F. J. C.

Mr. F. J. Camm testing Mr. A. E. Jones' Improved Atom Minor 14·5 c.c. two-stroke aeroplane engine.

The A. E. Jones' Improved Atom Minor

BY courtesy of my friend Mr. A. E. Jones, the well-known manufacturer of everything for model aeroplanes, I was recently afforded an opportunity of testing one of his remarkable little 14·5 c.c. two-stroke petrol engines which he markets in two types, one for model boats, and the other for model aeroplanes. As readers know, he supplies these engines complete and ready to run, or as sets of castings complete with blue print. An engine was selected from stock and placed on the test bench in the PRACTICAL MECHANICS' laboratory. Without any special tuning or warming up of plugs, doping, etc., the engine started from cold at the first swing. Thinking this might be a purely fortuitous coincidence, the engine was left alone for half an hour to get cold, but it again started at the first swing. This test was repeated at regular intervals for two days, and it was only very occasionally that a second or third swing became necessary in order to start it. Under test, the engine two-stroked perfectly, even when throttled down to low crankshaft speed. It immediately answers to the throttle, its maximum speed being in the neighbourhood of 3,500 r.p.m. At the end of two days' continuous testing, there was no sign of wear, and the compression, if anything, had improved.



The A. E. Jones' Improved Atom Minor running at 3,200 r.p.m. in the "Practical Mechanics" Laboratory. Note the complete absence of vibration.

The engine is solidly, yet lightly designed. The crankshaft runs on double ball races and the make and break mechanism is operated by means of a cam and tappet. This showed no trace of the usual dither (and consequently erratic timing) which the usual trembler blade contact possesses. I like the design throughout, which has evidently been very carefully thought out. The castings themselves are extremely clean and true and require a minimum amount of machining. Convenient chucking lugs are provided throughout, although where the amateur experiences difficulty in making a particular part, Mr. A. E. Jones undertakes to supply finished parts at a nominal cost.

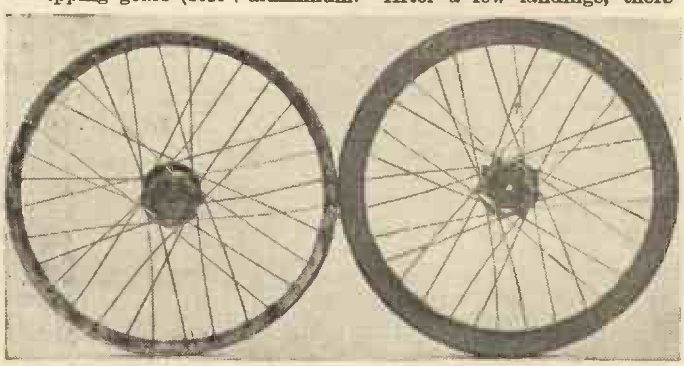
I am making up one of these engines myself and will report upon its performance in due course.

Miniature Transmission Gear for Rubber Motors

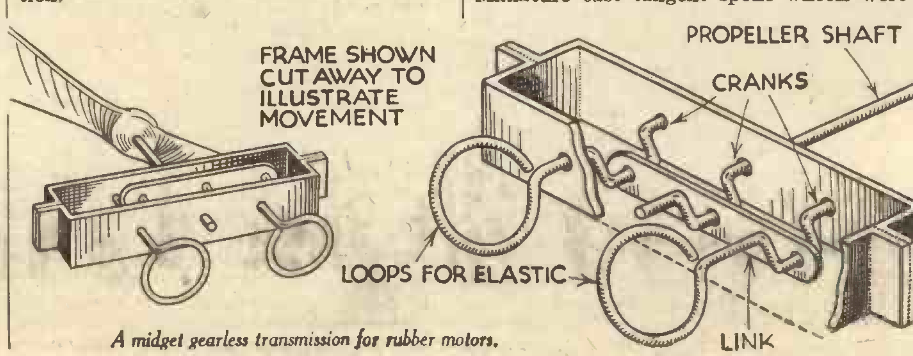
An American firm has recently marketed a gearless motor for multi-skein elastic drives. It is illustrated at the foot of this page. It will be seen that three cranks are coupled by a link, and whilst the arrangement certainly gives a silent motor and gets rid of the difficulty of slipping gears (soft soldering of gears to shafts is never satisfactory; silver soldering should be employed), it loses one of the main advantages of gears, namely, that of balancing the torque from the skein. It will be seen that both skeins of elastic must revolve in the same direction — a decided disadvantage. Its main object, I take it, is to permit of a compact motor in flying scale models where scale proportions do not admit of a full length motor. Readers may have the address of the manufacturer upon application.

Making Tangent Spoke Wheels

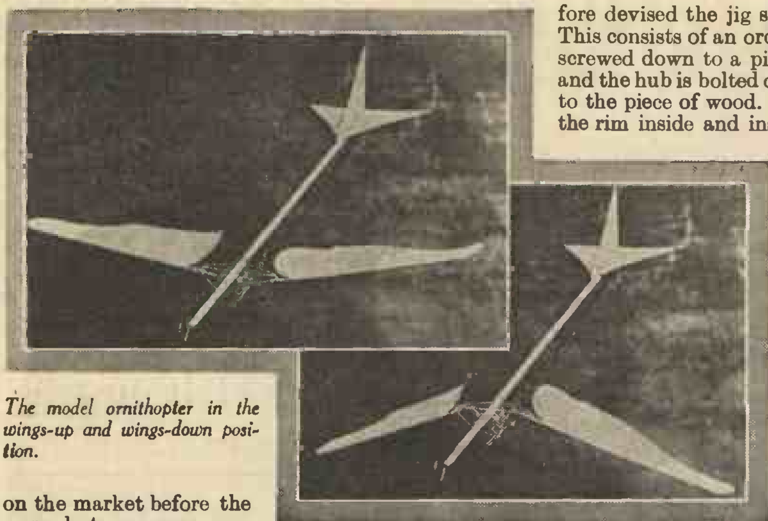
Model aeroplane wheels are not usually very satisfactory accessories. Few makers market a reasonably designed wheel which will stand up to continued use. The usual wheel supplied consists of two aluminium discs spun together with a brass boss between the two. This boss is naturally loose, as it is not possible to solder brass to aluminium. After a few landings, therefore, the hole in the aluminium becomes enlarged, so that the wheels do not stand vertical when the model is on the ground. Miniature cast tangent spoke wheels were



A pair of tangent-spoked wheels, made according to instructions given in this article.

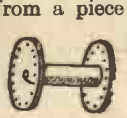


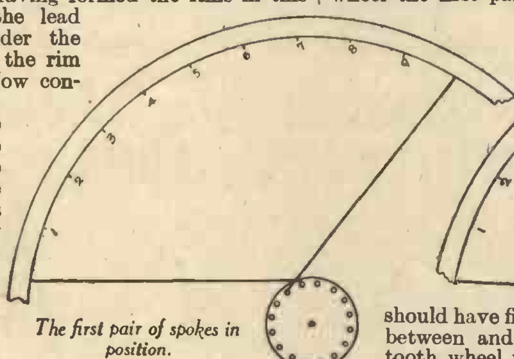
A midget gearless transmission for rubber motors.



The model ornithopter in the wings-up and wings-down position.

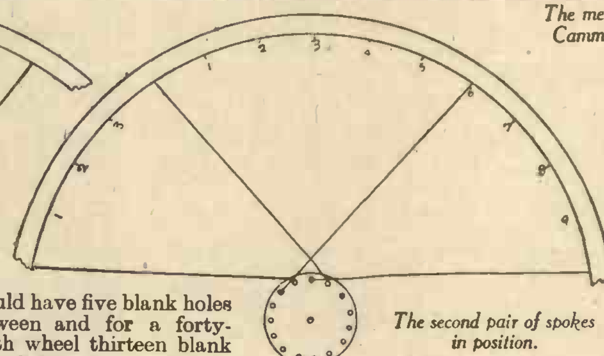
on the market before the war, but no one now supplies them. It is not a difficult matter, however, to make them, and I set about it in the manner described later. The pair of 3-in. tangent spoked wheels (one with tyre and one without) shown in the photograph weigh less than ½ oz. each, yet they are enormously strong. One side of the wheel is spoked at a time, and when this is completed the wheel is turned over and the second side is spoked. As for all ordinary model purposes, a wheel having thirty-two spokes will be found satisfactory, this article details the construction of such wheels. The rim can be improvised from the rim of a blacking tin or anything else which can be tyred. On p. 465 is shown a pair of bicycle rims which I made from some half-round section lead-filled brass beading. Having formed the rims in this way, melt the lead out and solder the two ends of the rim together. Now concerning the hubs. These have a flange at each side and may be built up as shown below from a piece





The first pair of spokes in position.

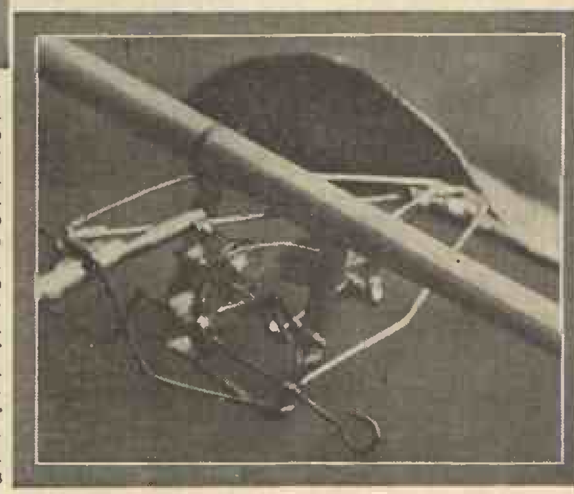
of shouldered brass tube with a washer soldered on each end, or they may be turned from the solid as shown below; each flange must have sixteen equally spaced holes round the circumference. It would be almost impossible to spoke such a wheel truly without some sort of a jig, and I therefore devised the jig shown below. This consists of an ordinary tin lid screwed down to a piece of wood, and the hub is bolted centrally also to the piece of wood. Now spring the rim inside and insert the first two spokes. The sketch shows these in place. Notice that they cross each other at the hub and that nine clear spoke-holes are allowed between them. No. 26 gauge piano wire should be used, and a little hook needs to be formed on each end so that each spoke springs into place. Three clear spoke-holes are allowed between the first spoke and the third spoke. Having placed this into position, allow a further nine holes between it and the fourth spoke. Continue until one side is completely spoked, and remove from the jig. There is then a blank hole between every pair of spokes, and the wheel should now be reversed (after soldering the spokes into their holes) and the process repeated. For a twenty-tooth wheel the first pair of spokes should have five blank holes between and for a forty-tooth wheel thirteen blank holes between.



The second pair of spokes in position.

Model Ornithopters

Very little experiment seems to have been done with flapping wing models. It is quite easy to make one fly, as the photographs on this page show. I obtained a duration of fifteen seconds with the model shown, which flaps its way along like some prehistoric bird. It is a popular idea that no one has ever succeeded in making these models fly. Laurence Hargreaves, the Australian experimenter, made several successful ornithopters driven by compressed air engines, and there are one or two successful American commercial models.



The mechanism of Mr. F. J. Camm's model ornithopter.

Model Aircraft Gala Day

One of the brightest and most interesting social events of the model flying season takes place, by kind permission of C. R. Fairey, Esq., at the Fairey Aviation Company's Great West Road Aerodrome, Heathrow, near West Drayton, on Sunday, July 8th, 1934, 11 a.m. until late in evening.

Mr. Fairey is presenting a handsome Challenge Cup for an Inter-club Team Contest, and Mr. Percival Marshall is presenting a Trophy for a Figure of Eight Steering Contest. Other prizes are offered by A. E. Jones, Esq., Model Aircraft Supplies Ltd., F. J. Camm, Esq., and The Northern Heights Model Flying Club, who, for the second year, are organising the event. At least 300 models of many kinds are expected, and clubs from various parts of the country have promised to compete. The Brighton Club have already booked forty tickets, and are entering for all the contests on the list. Birmingham also is giving *very* active support.

An open duration contest will take place, in addition to the published programme, in response to many requests. As the aerodrome is private, admission is by ticket only, which takes the form of a coat lapel label, and can be obtained post free 2½*d.* from C. A. Rippon, 70 Hampden Way, Southgate, N.14.

Last year's event was a huge success, and given equally fine weather, this year's event should be a bumper show. Full particulars will be sent on receipt of 1½*d.* in stamps.—The Northern Heights Model Flying Club, C. A. Rippon, 70 Hampden Way, Southgate, N.14.

This illustration shows a rim (made from half-round brass beading), the hub, and the assembly jig.

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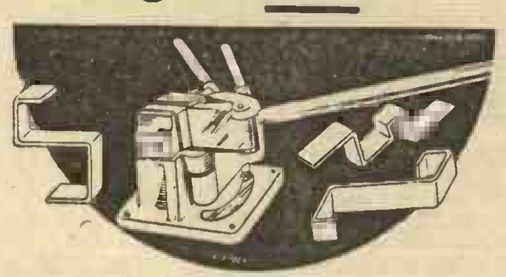

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" " " "	1 in. × ½ in.	2 in. × ½ in.
" " (warm) "	3 in. × ⅜ in.	4 in. × ⅝ in.
" " " "	2½ in. × ½ in.	3 in. × ⅞ in.
" " " "	1½ in. × ¾ in	2½ in. × 1 in.
Rd. or Sq. Iron (cold) "	9/16 in.	¾ in.
" " " " (warm) "	1 in.	1½ in.
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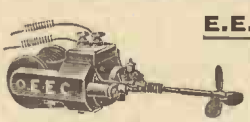

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THE PILOT CLASS B FOUR

An excellent Four-Valve Battery Receiver which provides ample Output combined with Long Range

THIS month we are departing slightly from our usual custom of describing the construction of a receiver designed in our own laboratories by dealing with a high-grade battery receiver which has been designed by Messrs. Peto-Scott, who are so well known as suppliers of complete kits of parts. We recently took the opportunity of testing the set very carefully, and soon came to the conclusion that it was an instrument of which PRACTICAL MECHANICS readers should be made aware.

The Kit of Parts

The "Pilot" Class B Four is extremely easy to build, it employs a modern circuit and an up-to-date form of construction, whilst it is particularly inexpensive. A complete kit of guaranteed parts can be obtained from Messrs. Peto-Scott, and by wiring these according to the large-size wiring plan given on a following page, the reader will experience no difficulty whatever. In this particular instance we are not giving a theoretical circuit diagram, because we feel that the set will appeal most strongly to those constructors who work from a practical plan only. Those who are more technically inclined, however, will observe from the plan that the circuit is on fairly conventional lines, although it has been designed with care, and with a view to keeping down the total cost without in any way sacrificing efficiency or appearance.

Foolproof Circuit

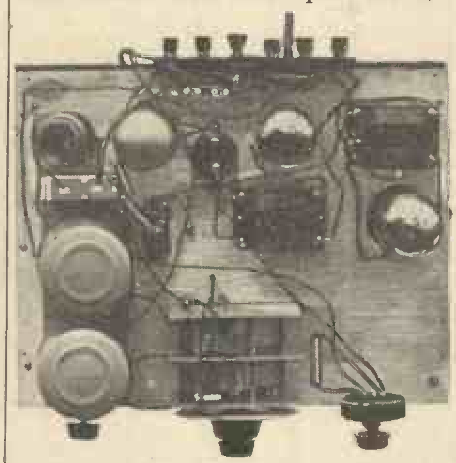
The first valve is a variable-mu, and this functions in conjunction with a volume control potentiometer which serves to vary the bias applied to its grid. A leaky-grid detector follows, this being transformed coupled to the driver valve, which is in turn coupled to the Class B output by means of a special driver transformer. Tuning is by means of two Colvern screened coils, these being the popular KGO and KGR types, which give a remarkable degree of selectivity. The KGO has a transfer aerial tapping, so that selectivity is practically uniform on both wavebands instead of, as is usual, being good on medium waves and only moderate on the long-wave band.

Ganged Tuning

Both coils are tuned by means of a special British Radiogram two-gang air-dielectric condenser, on one section of which is fitted a neat trimmer. Both sections are operated by means of a single large knob, and a smaller concentric knob is provided for reaction control. The reaction condenser is one of the bakelite dielectric type and forms a part of the complete condenser assembly. This arrangement makes for simplicity of control and also for neatness of layout, besides reducing the cost of components.

Mounting the Components

It will also be seen from the drawings and photographs that the two coils are mounted on a single aluminium baseplate and their self-contained wave-change switches are ganged together and operated by means of a single knob. As a matter of fact, there are only three controls on the front of the set, these being the wave-change switch combined tuning reaction control, and the knob of the volume control potentiometer.



A top view of the receiver showing the neat and compact layout of the components.

The on-off switch is mounted on a terminal strip at the rear of the chassis; it is sufficiently accessible considering that it only has to be operated at comparatively rare intervals, and its disposition assists in maintaining a simple and uniform layout on the front of the cabinet.

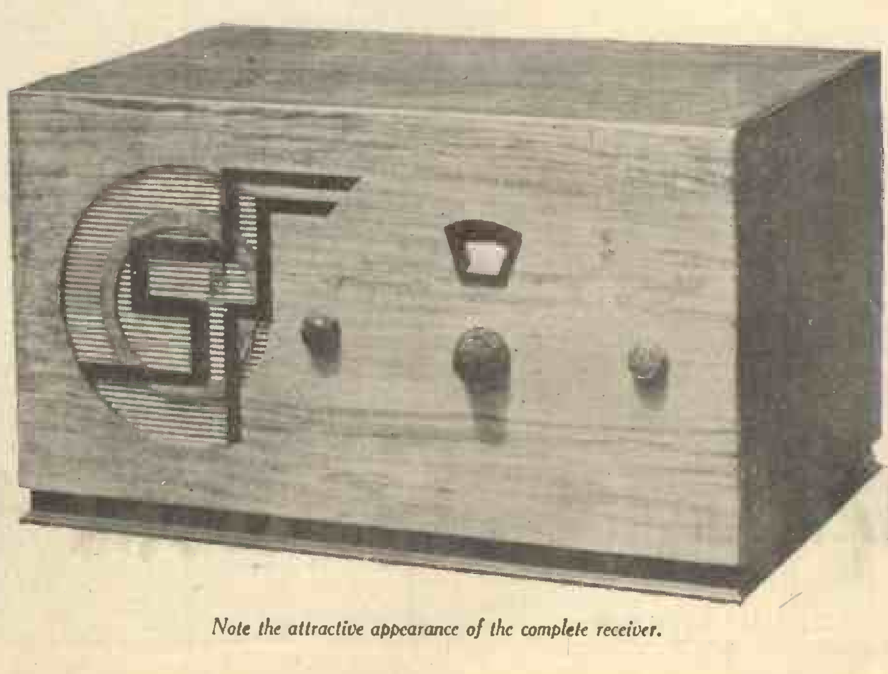
There is no panel in the ordinary sense, but all the knobs project through the front of the attractive horizontal cabinet. The potentiometer is actually mounted on the cabinet, but the other controls are supported by their corresponding components which are attached directly to the metallised chassis.

The cabinet is of the modern type and contains, in addition to the set itself, the moving-coil loud speaker unit and all the batteries. It is finished walnut and is highly polished, with a result that it will harmonise with almost any kind of furniture.

Simple Construction

It need scarcely be stressed that the constructional work is extremely straightforward and has been planned out to assist the amateur who does not possess any workshop facilities. Nevertheless, the finished set presents a very workmanlike appearance. The parts have been so placed that there is very little waste space, and yet there is ample room for making the necessary connections and carrying out the wiring in a minimum of time. All the parts, including the cabinet and terminal strip, can be bought ready for use, all necessary holes being drilled so that they can be assembled by using nothing more than a screwdriver and a pair of pliers. Those who prefer soldered joints can, of course, use them, but there is no necessity for this, because all the components are provided with terminals of good size.

The first thing is to drill the metallised chassis with four holes for the valve-holders; three of these are 1 in. diameter, and the fourth, which is for the Class B valve-holder, is 1¼ in. diameter. When the



Note the attractive appearance of the complete receiver.

holes have been made the valve-holders can be mounted in position by passing two ⅜-in. screws through the holes in each. The method of dealing with the other components calls for no special mention, since they are simply attached to the chassis by means of ½-in. screws, these being provided with the kit of parts, if ordered from Messrs. Peto-Scott. If the parts are bought separately from a local dealer, about 2 dozen ½-in. and 1 dozen ⅜-in. round-headed brass screws should be obtained.

The Dial Light

It will be apparent that the tubular fixed condensers and also the Varley "Electronic" grid leak are not fixed to the chassis in any way, but are supported by their own connecting wires which are joined to the appropriate terminals on the other components. In wiring-up it will be seen that two leads are taken to the flash-lamp bulb-holder on the front of the gang condenser; this serves as a dial light, the light showing through the celluloid scale and escutcheon when the set is switched on. We have not specified a bulb for the dial light, since this is optional; in any case, an ordinary 2·5-volt bulb, which can be bought for a few coppers, will serve the purpose, and can be used if desired.

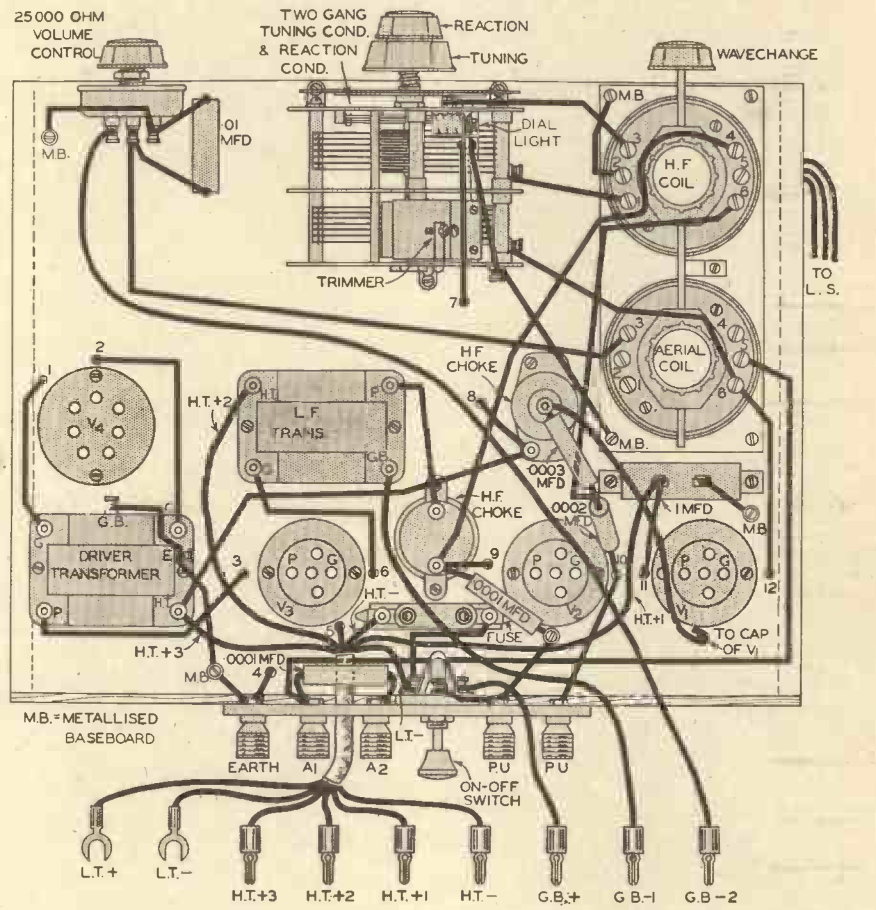
Battery Connections

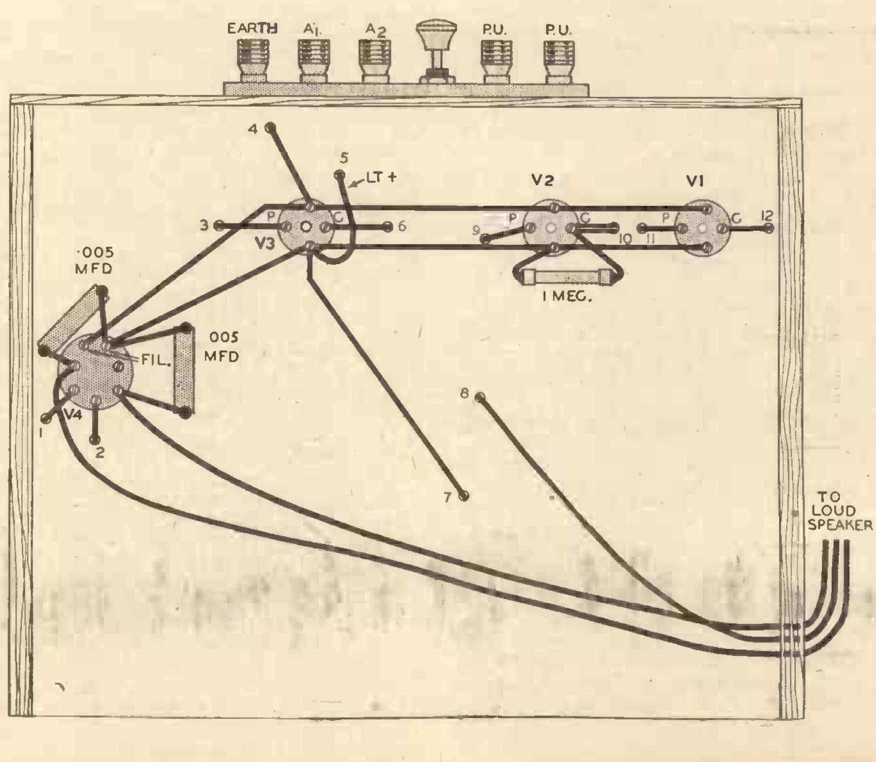
Most of the wiring is carried out in insulated connecting wire, but the leads to the batteries and to the loud-speaker unit consist of flex. The H.T. and L.T. leads are combined in a six-way battery cord, but separate lengths of rubber-covered flex are employed for the G.N. connections and for the speaker leads. All these flexible-lead connections can be made by looping the ends of the wire and gripping the loops under the terminal nuts, or they can be soldered if desired.

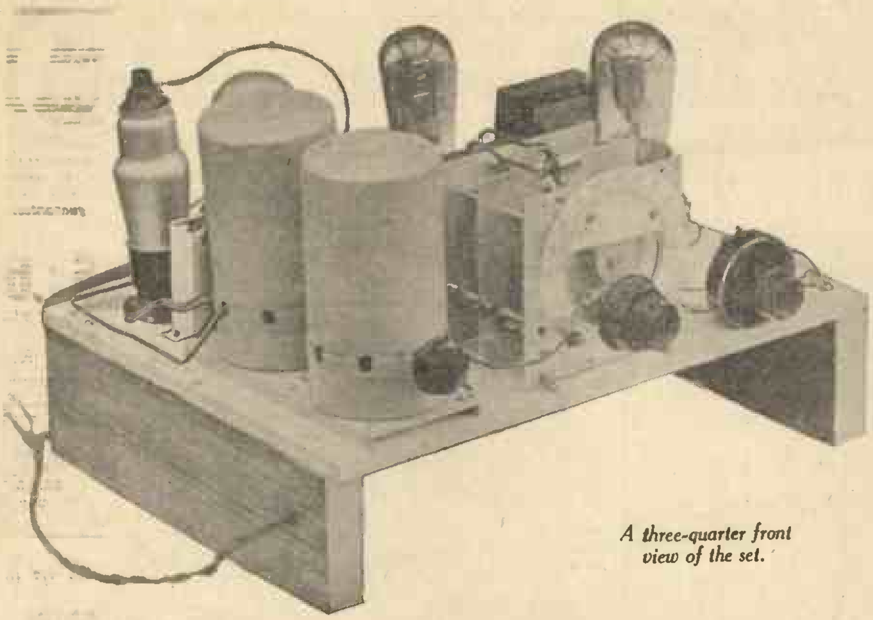
LIST OF COMPONENTS

One Peto-Scott Metaplex Chassis, 13 × 10 in., with 2¾-in. runners; one B.R.G. 2-gang tuning condenser, Type 15; two Colvern coils, type K.G.O. and K.G.R. on baseplate; three Clix 4-pin chassis mounting valve holders; one Clix 7-pin chassis mounting valve holder; one B.R.G. H.F. type H.F. choke; one B.R.G. Midget reaction H.F. choke, type 46; one Burne-Jones magnum 25,000-ohm potentiometer; one B.R.G. 3 : 1 L.F. transformer; one B.R.G. Class B driver transformer; one Varley 1 meg. grid leak; one T.M.C. ·0003 mfd. tubular condenser; one T.M.C. ·0002 mfd. tubular condenser; two T.M.C. ·0001 mfd. tubular condensers; two T.M.C. ·005 mfd. tubular condensers; one T.M.C. ·01 mfd. tubular condenser; one T.M.C. 1 mfd. condenser, type 25; one ebonite terminal strip, 6 × 1½ in.; one B.R.G. 3-pt. on-off switch; five Clix terminals marked A1, A2, E. PU, PU; one Belling-Lee 6-way battery cord with L.T. + and − terminals and H.T. −, H.T. + 1, H.T. + 2, and H.T. + 3 wander plugs; three Clix wander plugs, marked G.B. +, G.B. − 1, and G.B. − 2; length of flex, connecting wire, screws, etc.; one Microfuse; one Peto-Scott cabinet; one Amplion "Sonette" moving-coil speaker unit; one Drydex 120-volt H.T. battery; one Drydex 9-volt G.B. battery; one Exide 2-volt accumulator D.R.G.; four Hivac valves, V.S.210, D.210, L.220, B.220.

COMPLETE WIRING PLANS AND LAYOUT OF COMPONENTS FOR THE PILOT CLASS B FOUR







A three-quarter front view of the set.

After the construction of the set has been completed the speaker should be mounted in the cabinet, directly behind the fret. It can be attached by means of small screws, but it is better to employ a five-ply baffle which should be fixed in the cabinet, the speaker then being screwed to this. The baffle can be obtained, if desired, along with the cabinet, a slight extra charge being made for it.

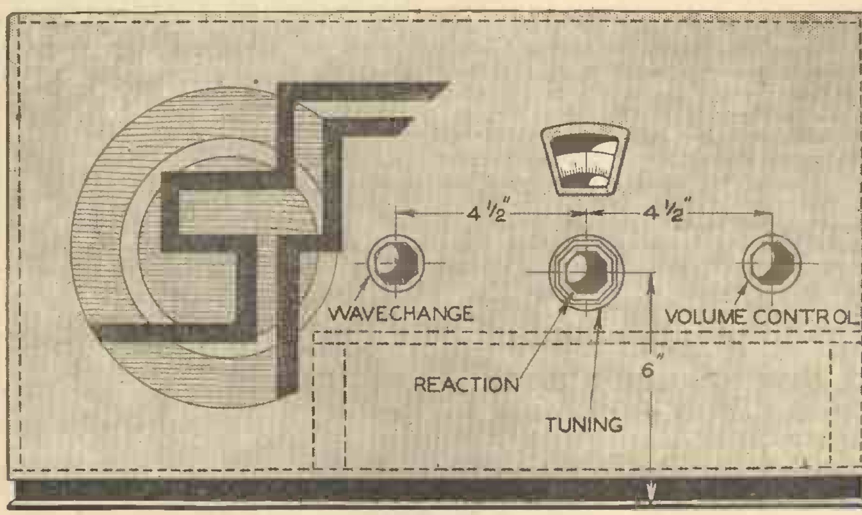
Testing Out

Next connect up the batteries, speaker, aerial and earth in readiness for giving the set its preliminary trial. There are two aerial terminals provided, and these serve as a means of obtaining different degrees of selectivity. That marked "Aerial 1" is least selective, but gives maximum signal strength; but that simply marked "A" will generally be used, since it provides an ample margin of selectivity with only a very slight reduction in volume on more distant stations. Of the H.T. positive leads, marked 1, 2 and 3, the first is for the screening grid of the first valve and should be plugged into the 72-volt socket on the battery; the second is for the detector valve anode and should be taken to about the 60-volt socket, whilst the last feeds the anodes of the first, third and fourth valves, and should receive the full voltage of the battery.

Pick-up Connections

The G.B.-1 wander plug is for the driver valve and should receive about 3 volts negative, and the G.B.-2 plug goes to the variable-mu potentiometer control and so should receive the full 9 volts from the G.B. battery. Pick-up terminals are provided, but no bias is applied to the detector when these are in use, this having been found to be unnecessary. With some pick-ups, however, especially those which provide a high voltage output, it might be desirable to apply a little bias to the detector, and in that case a flexible lead (with wander plug) should be attached to the left-hand pick-up terminal, the present wire being removed. In doing this it will also be necessary to connect the top terminal on the three-point on-off switch to the filament terminal on the second valve-holder.

Of the three loud-speaker leads, that which goes to one side of the larger H.F. choke should be joined to the centre terminal on the speaker, the other two being connected to the "outside" terminals.

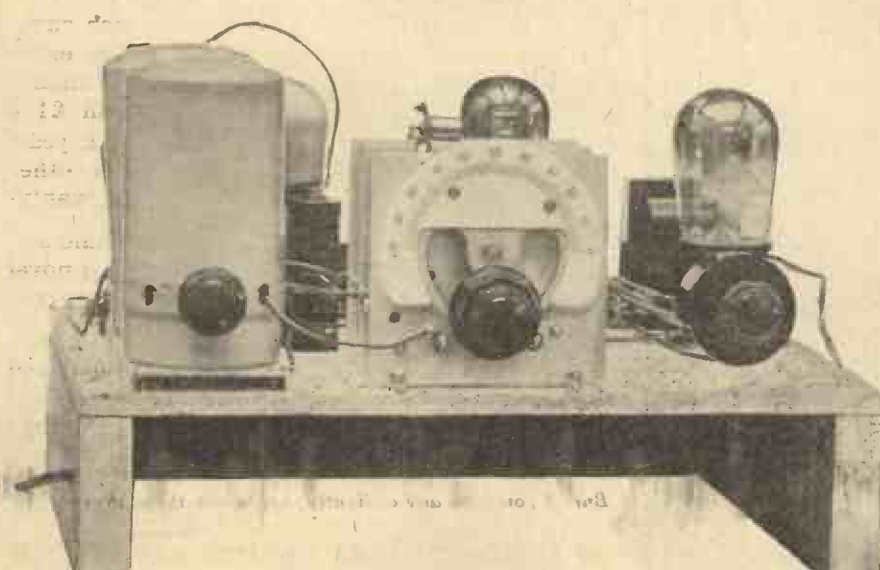


The front of cabinet layout for the knobs.

Selectivity Control

First of all turn the reaction knob fully anti-clockwise and the volume control to its "full-on," or clockwise, position. After that the wave-change switch can be turned to the medium- or long-wave position (right or left, respectively) and tuning carried out by the main condenser knob. After a station has been tuned in, it can be increased in strength by advancing the reaction knob, whilst selectivity may be increased by turning back the variable-mu volume control. By using the two latter knobs in conjunction it is possible to obtain just the required degree of selectivity and the volume level required.

When receiving distant stations it will be better to turn the volume control full-on and to secure the necessary selectivity by advancing the reaction setting. On nearer stations, however, it will generally be found that reaction can be turned right off, and the volume reduced to a comfortable level by means of the potentiometer.



A front view of the receiver

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1 B.R.G. 2-gang Tuning Condenser, type .0005	0	12	6
2 Colvern Coils, type K.G.O. and K.G.R. on baseplate	0	19	6
3 Clix 4-pin chassis-mounting Valve Holders	0	2	0
1 Clix 7-pin " " " "	0	1	0
1 B.R.G. H.F. type H.F. Choke	0	3	6
1 B.R.G. Midget Reaction H.F. Choke, type 46	0	2	0
1 Burne Jones Magnum 25,000 ohm Potentiometer	0	5	0
1 B.R.G. 3 : 1 L.F. Super Transformer ..	0	5	6
1 B.R.G. Class "B" Driver Transformer ..	0	7	6
1 Varley 1 meg. Electronic Resistance ..	0	0	9
1 T.M.C. .0003 mfd. Tubular Condenser ..	0	0	6
1 " .0002 " " " ..	0	0	6
2 " .0001 " " " ..	0	1	0
2 " .005 " " " ..	0	1	6
1 " .01 " " " ..	0	0	9
1 " 1 mfd. Condenser, type 25 ..	0	2	3
1 Ebonite Terminal Strip, 6" × 1½" ..	0	0	6
1 B.R.G. 3-pt. On-Off Switch	0	1	3
5 Clix Terminals, marked "A," "A1," "E," "PU," "PU"	0	1	0
1 Belling Lee 6-way Battery Cord with L.T. + and — Terminals and H.T. —, H.T. +1, H.T. +2, and H.T. +3 Wander Plugs	0	2	6
3 Clix Wander Plugs, marked G.B.+, G.B. —1 and G.B.—2	0	0	4½
Length of Flex, connecting wire, screws, etc.	0	2	3
1 Microfuse 100 m/a	0	0	6
KIT "A," Cash or C.O.D.	£3	16	6

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MORE ABOUT HISTORIC LOCOMOTIVES

PART III.

By E. W. TWINING

This month we deal with a number of fine old locomotives including Stephenson's famous "Rocket."

Fig. 6.—Stephenson's "Lancashire Witch," 1828.

IT would perhaps be scarcely fitting if, in running over the early history of the locomotive, no mention were made of the engine which ran upon and pulled the train which opened the first public passenger-carrying railway in the world (in the year 1825), although it is not proposed to illustrate it here. This engine was, or rather is, since it is still in existence and well preserved, No. 1, named "Locomotion," of the Stockton and Darlington Railway.

Locomotion, No. 1, 1825

The engine, when first built by the Stephensons at Newcastle, was almost exactly similar to the Killingworth locomotive shown in Fig. 5, except that it had driving wheels 4 ft. in diameter and a more complicated arrangement of half beams and levers instead of simple slide bars for securing straight motion for the piston rods and crossheads. This was certainly not an improvement, but the abolition of endless chains between the axles, running over sprocket wheels, and the substitution of coupling rods on crank pins outside the wheels for maintaining the cranks and motion of the cylinders at right angles was certainly an advance on the previous practice and the earlier engine.

As the centenary of the S. and D. Railway took place in 1925, and "Locomotion" was freely illustrated in the railway and other Press, besides having been on exhibition at Wembley, most of my readers will be familiar with its appearance, and will remember the form of its four driving wheels. Although these are 4 ft. in diameter and of cast iron, they are not the Stephenson original set, but were placed on the axles and substituted for the first four by Timothy Hackworth, who was appointed as mechanical engineer to the railway through the influence of George Stephenson. Hackworth adopted the heavy webbed form of wheel for all engines constructed by him. The original wheels of Locomotion were of the open-spoked pattern, with thin rims, similar to those shown in Fig. 5. The cylinders had a diameter of 9 in. and stroke 2 ft.

Royal George, 1827

The next engine worthy of note was built wholly by Timothy Hackworth for the Darlington Line at the Company's works, which had by this time, viz. 1827, been established at Shildon. It was named "Royal George," and ran upon six wheels, all coupled by outside rods. There were two vertical cylinders, 10 in. by 22 in. external from the boiler, and arranged in an inverted position to drive downwards on to crank pins in the rear coupled wheels. The boiler measured 12 ft. 10 in. long by 4 ft. 5 in. diameter, and had a return flue.

Hackworth built other engines both before and after the Royal George, and he appears to have had ideas which, had they been put into practice, would have secured to him the credit of doing what Robert Stephenson shortly afterwards did, namely, developed the locomotive by big and rapid strides. Even after the foundations had been laid and the form which the locomotive assumed and maintained for the next seventy years had been evolved by Stephenson, Hackworth was content to adhere to antiquated types, although he was, unquestionably, a clever engineer.

The Lancashire Witch, 1828

From 1825 to 1828 the Stephensons had been designing, building and gaining experience. In the latter year they produced the "Lancashire Witch," illustrated in Fig. 6. This engine was at first intended for the Liverpool and Manchester Railway, and was known as the Liverpool Travelling Engine, but it was afterwards, by arrangement, delivered to the Bolton and Leigh Railway in the year 1828, where it was christened as above. A number of new and original ideas appear to have been tested out in this engine, particularly as regards the furnace arrangements. Eventually, however, it had two furnaces side by side with straight through flues leading into one chimney which broadened out to embrace the flues and form a smokebox.

The Lancashire Witch was the first engine to have outside cylinders, inclined at an angle, driving directly on to the wheels, and was in this respect the prototype which led up to the design of the famous "Rocket." These cylinders were 9 in. diameter by 2 ft. stroke. The wheels were four coupled of 4 ft. 6 in. diameter built of wood with wrought-iron tyres shrunk on. This improvement was found to be far superior as regards wear to cast-iron wheels. The boiler had a length of 9 ft. and diameter 4 ft.

A further noteworthy point in the design and construction of this engine was an arrangement for obtaining expansive working of the steam, and was the first locomotive in which any attempt was made to secure this economy. The mechanism which gave this result was in no way connected with the valve gear, but operated semi-rotary valves in the main steam pipes leading to the cylinders, a timing gear being arranged to cut off the steam at a

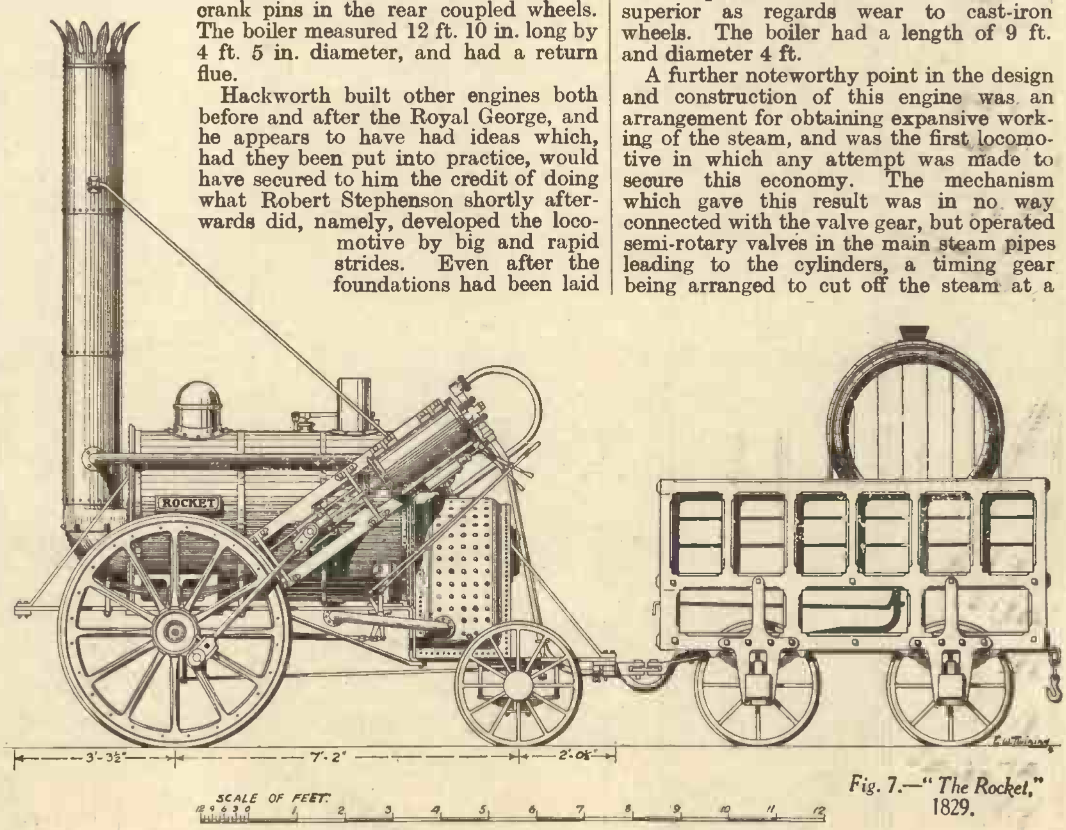


Fig. 7.—"The Rocket," 1829.

definite point in the stroke of the piston, which point was variable at the requirements of the driver.

The Rocket, 1829

We come next to what is probably the most famous of all locomotives—the Rocket, built by Robert Stephenson, to compete for the £500 prize offered by the Directors of the Liverpool and Manchester Railway Company for an engine which should fulfil certain conditions. The trials of the competing engines took place on a straight and level stretch of the line at Rainhill in 1829.

There were five entries, as follows :—

- The Rocket, by Robert Stephenson & Co.
- The Sans Pariel, by Timothy Hackworth.
- The Novelty, by Braithwaite & Ericsson.
- The Perseverance, by Mr. Burstall.
- The Cyclopede, by Mr. Brandreth.

All the machines were steam locomotives except the last, which was an absurd contraption worked by a horse.

As everyone knows, the Rocket was the only engine which complied with all the requirements and performed in every way satisfactorily without break-down. It was accordingly added to the locomotive stock of the railway. In its original form, it is shown in Fig. 7. Here, as will be seen, the cylinders, 8 in. diameter by 17 in. stroke, were inclined, as in the Lancashire Witch. The driving wheels, of wood, had a diameter of 4 ft. 8½ in. The great advance made in the Rocket was in the design of the boiler—the very first to have, in combination, a rectangular firebox and multitubular flues. The firebox was really a separate unit bolted to the boiler back-tube plate. It was water-jacketed at the sides and top only, which jacket was connected to the boiler at bottom and top by two copper pipes at each point. The front of the box below the tubes and the back plate of the box were both covered or lined with fire-brick. There were twenty-five flue tubes of $3\frac{3}{16}$ in. diameter. The boiler barrel measured 5 ft. 11⅞ in. long over the tube plates, with a diameter of 3 ft. 4 in. The weight of the engine in working order was 4 tons 3 cwt.

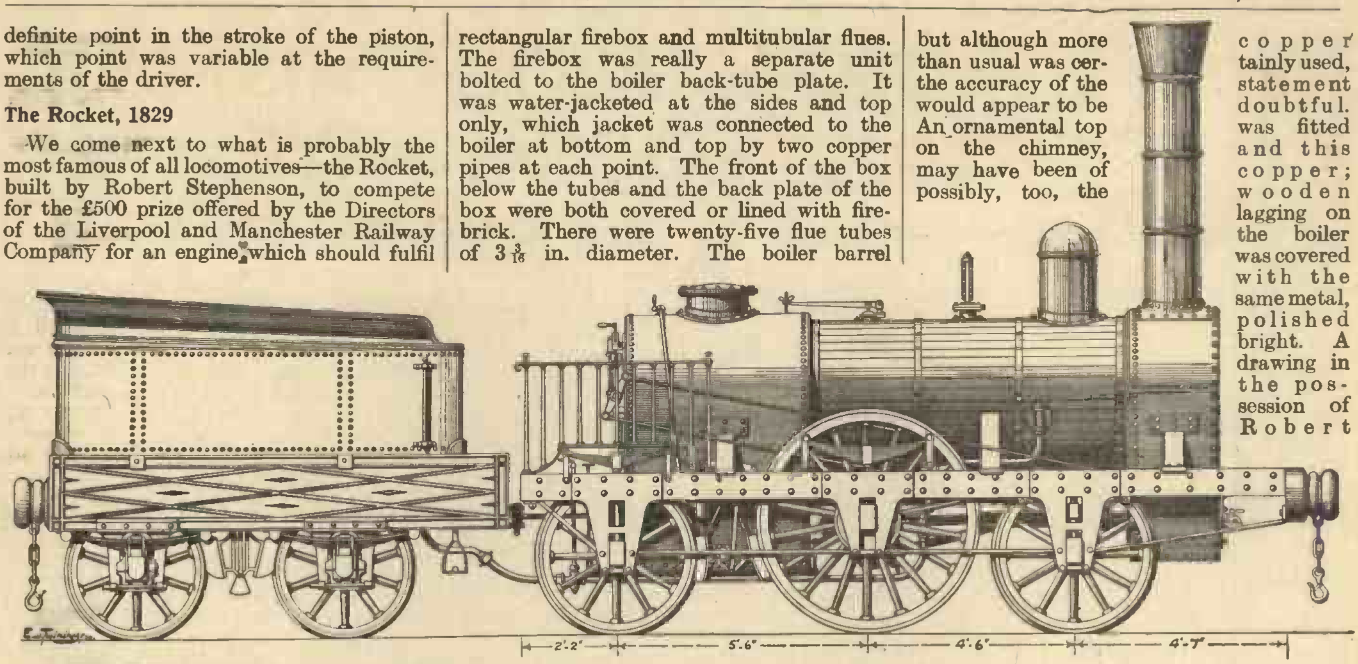


Fig. 9.—Stephenson's Patent Engine, 1834.

The Rocket did not remain very long in its original state, for the engines which followed it from the Stephenson Works had their cylinders bolted to a frame in a much lower position ; in fact, they were placed nearly horizontal, and the Rocket, within a year, was altered to correspond. Doubtless this made for much steadier running. All the engines had much the same firebox arrangement as that shown in Fig. 7, and then came a further development.

The Northumbrian, 1830

On August 9th, 1830, Stephensons delivered another engine, the Northumbrian, in which not only was a cylindrical smokebox provided, but the firebox inaugurated the modern type, built into and forming an integral part of the boiler and surrounded on all sides with water.

Besides this, the engine had self-contained plate framing, which took up all the working stresses of the cylinders and motion. The driving wheels were 5 ft. diameter and the cylinders 11 in. by 16 in. It was reported by a contemporary writer that the chimney and boiler were of copper, but although more copper than usual was certainly used, the accuracy of the statement would appear to be doubtful. An ornamental top was fitted on the chimney, and this may have been of copper; possibly, too, the wooden lagging on the boiler was covered with the same metal, polished bright. A drawing in the possession of Robert Stephenson indicates that there was sheet-metal cleading, and this is confirmed by an etching published in 1831.

The Planet, 1830

Only a few months elapsed after the construction of the Northumbrian when another engine was delivered in which still more startling improvements in design were made : in fact, at one tremendous bound the modern locomotive came into being. On October 4th, 1830, Stephensons put on the rails of the Liverpool and Manchester Company the engine named Planet, illustrated in Fig. 8.

In this locomotive there was for the first time embodied in one unit inside cylinders enclosed in and jacketed by the smokebox gases, a cranked driving axle and the new type of Stephenson boiler introduced in the Northumbrian. Furthermore, the, afterwards famous, sandwich type of frame was inaugurated. This frame in the Planet consisted of no less than six longitudinal members of timber to which the hornplates, or axlebox guides, and other bearings were bolted. The inner four members extended from the back of the cylinders to the front of the firebox only, and took up the working stresses of the machinery. The two outer ones ran the whole length of the engine, and formed, with the end cross beams, the carriage framing on which the engine rode. Strong brackets attached to the boiler and firebox rested upon the

(*continued on page* 492).

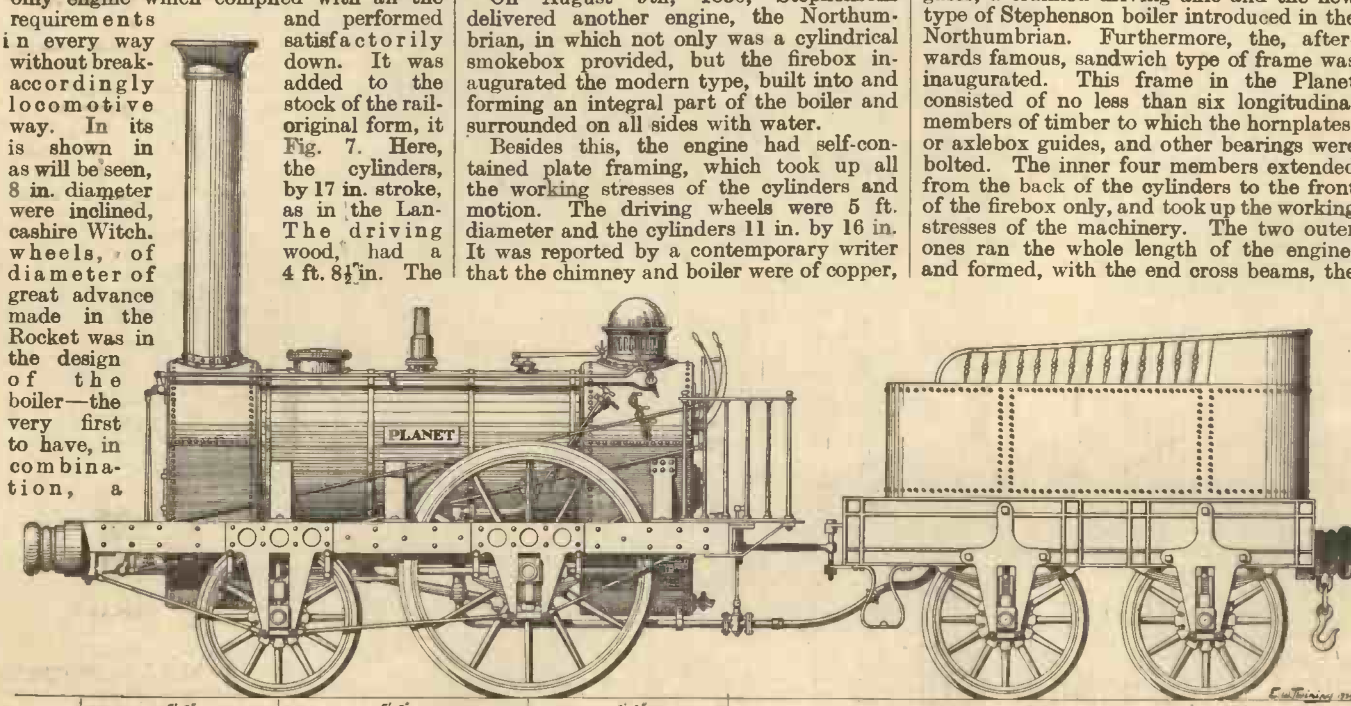
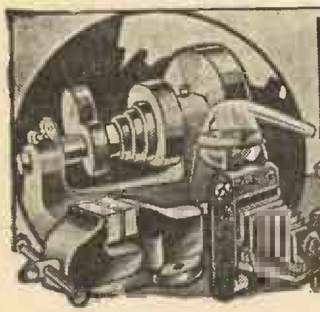


Fig. 8.—The "Planet," 1830.



Hints about Hobbies

THAT HINT OF YOURS
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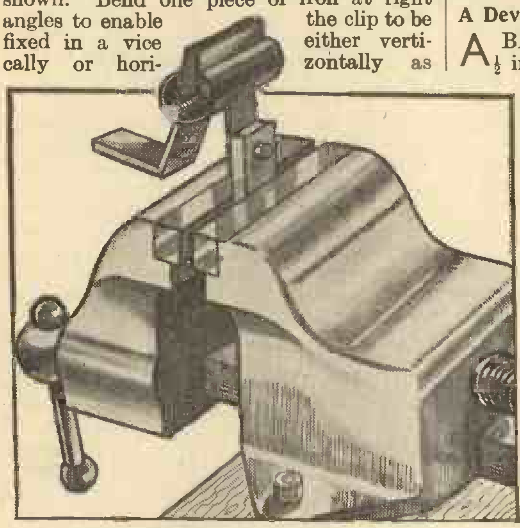
Soldering Light Articles

OBTAIN an ordinary paper clip and attach two short pieces of bar iron 1 × ⅛ × 2½ in. long to the legs as shown. Bend one piece of iron at right angles to enable the clip to be fixed in a vice either vertically or horizontally as shown. This little gadget is useful for holding light articles such as spectacle frames, etc., when soldering. T. W. (Nr. Bristol).



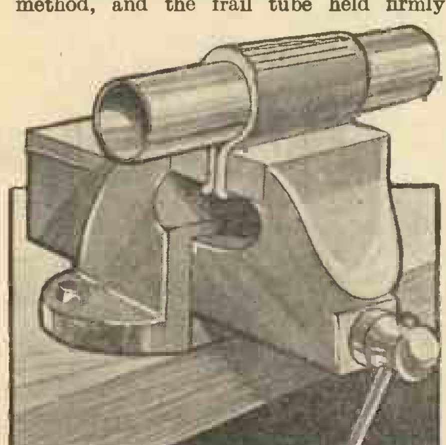
A gadget for holding light articles for soldering.

Clamping Delicate Tubing

THIN brass tubing cannot be satisfactorily held in a vice without becoming damaged. Anything but slight pressure—insufficient to hold it firmly—will crush the thin walls where the vice-jaws grip, and the tube will be ruined.

To overcome this difficulty, first place the tube in a section cut from an old motor or motor-cycle tyre (of suitable diameter and about jaw length), place the bead in the jaws of the vice, as shown, then tighten up.

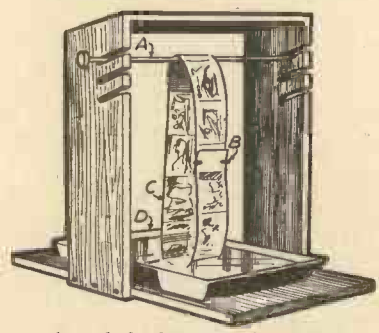
Pressure is evenly distributed by this method, and the frail tube held firmly enough for threading—or whatever is being done. F. G. (Ellesmere).



Holding delicate tubing by means of an old cycle tyre held in a vice.

A Developing Rack for Roll Films

A BASE of wood about 1 ft. square by ½ in. has uprights either end with cross piece at the top. The uprights are notched to fit a glass rod (A) from a towel rack, at several heights so that different lengths of film may be developed. The film (C) is looped over the smooth glass rod (A), and the two ends are held together with paper clips (B), so the film will hang in the developing dish (D), and can be pulled around the glass rod the required number of times. Two or more films can easily be handled together (see sketch).



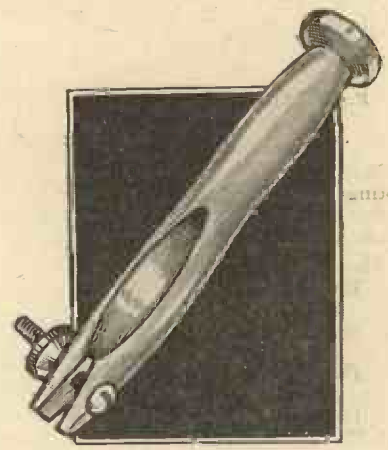
A simple developing rack for roll films.

A Handy Vice

THIS easily-made hand vice is extremely useful for holding small articles—especially threaded rod, which it will hold securely without damaging the thread. In small soldering jobs, too, it will hold the stick of solder or the work itself—thus preventing burns. Obtain an ordinary clothes peg; remove the points of the prongs and hollow out the middle of the peg with a knife or fretsaw.

Now carefully drill a hole through the prongs, near the end. Push a 4 B.A. round-headed bolt through this and thread on a 4 B.A. terminal head.

Screw up the terminal head and the jaws tighten-up; unscrew it and they spring back again. J. G. (Salop).



An efficient vice made from a clothes peg.

Two Useful Plating Hints

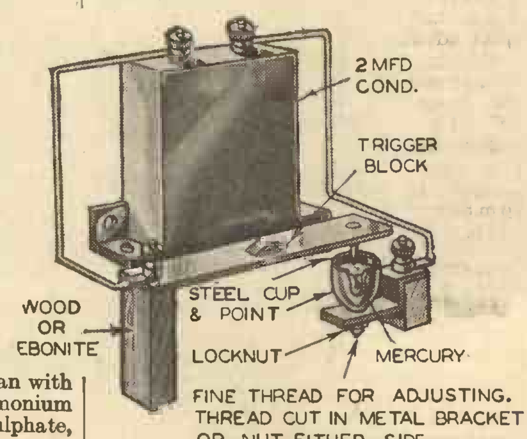
AN efficient nickel-plating can be put on brass and copper articles by boiling them in an aluminium pan with the following solution: 5 oz. ammonium chloride, 5 oz. nickel ammonium sulphate, and 1 pint of water.

Iron and steel articles can also be plated if 1½ oz. of *strong* ammonia are added to the solution. To produce an even plate the articles should be kept moving, but in contact with the pan.

All the articles should be cleaned by dipping them in concentrated nitric acid and then washing them in running water. An efficient silver-plating paste can also be made by using the following solution: mix ¾ oz. silver chloride, 1½ oz. cream of tartar, and 1½ oz. table salt together, and add water to form a stiff paste. This mixing should be done in the dark, as light decomposes the silver chloride. Rub on *briskly* with a soft cloth. V. K. (Liverpool).

An Efficient Contact for an Electric Clock

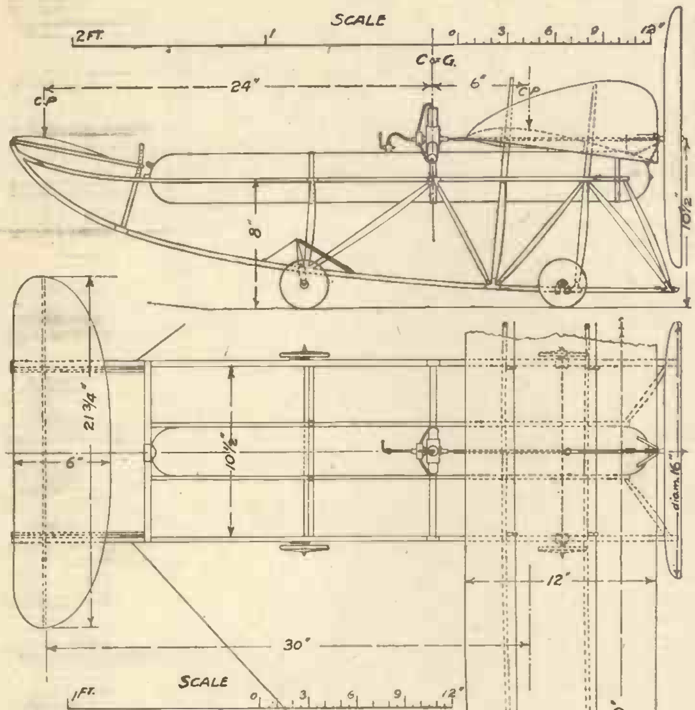
A READER who has made the electric clock described in our March issue states that the clock stopped owing to oxide forming on the contacts, and the voltage was not high enough to break it down. After trying several types of contact he at last made one similar to that shown in the sketch. He used a cup of mercury and a steel contact point which, he states, worked very satisfactorily. It will also be found that a 2- or 4-mfd. condenser can be fitted with advantage across the points as shown. S.W. (High Wycombe, Bucks.).

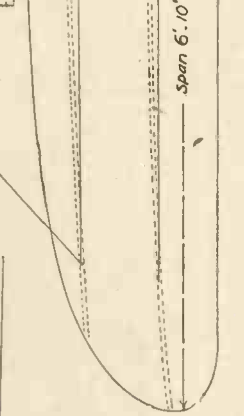


Details of the mercury contact for an electric clock.

A COMPRESSED-MODEL

When fitting a tractor-tailed aeroplane with a in protecting the engine and propeller from the deal with a plane of the Canard type.





Figs. 1 & 2.—A plan and side elevation of model fitted with the engine shown on this page.

UNFORTUNATELY, although we can adopt the Canard type with a compressed-air motor, we cannot without introducing gearing, which would absorb a lot of power, use two propellers. In the design for the machine which is given in Figs. 1 and 2, the great wing span and the low flying speed, coupled with a fairly high revolution speed to the propeller, will render the torque less effective than it would be were the propeller larger and used on a short wing span.

Although it has not been thought necessary to give a further design there can be no question that the best scheme of all would be just such a model as that shown in the drawings but fitted with two engines, one to port and the other to starboard, each driving its own propeller. Of course, one of two things would have to be done, either the air container would have to be made of larger capacity or else the engines would need to be smaller.

Before referring further to the provision of twin engines and propellers for the model, it may be as well to give a few particulars of constructional details of the machine illustrated in Figs. 1 and 2, a further view of which is shown in Fig. 3 herewith.

A Cardan Shaft

An examination of the drawings will show that there is one item introduced which is rather unusual though by no means new, this is the use of a cardan shaft between the engine and the airscrew. Its introduction is called for by the fact that the propeller is behind the main plane, whereas, owing to the centre of gravity of the whole model having of necessity to be in front of the leading edge of the plane, the engine cannot also be placed at the back, but must be on, or near, the centre of gravity. Obviously, if the engine were placed behind the main plane the centre of gravity would be moved backwards also.

The shaft is formed from a piece of aluminium tubing $\frac{3}{16}$ in. diameter and 10½ in. long, with a slotted end next to the propeller shaft. The slots fit over a cross-pin, passing through and fixed in the steel shaft. At the engine end of the cardan shaft a similar pin passes through the crankshaft, but holes instead of slots are provided at the end to engage with the pin. These and other details of the machine are sketched in Fig. 4.

Engine Fixing, etc.

The engine is placed so that the two lower cylinders saddle over the container on its centre-line. In this position it may be fixed in several ways, of which perhaps the best is a pair of bands encircling the container and having lugs through which screws, or nuts and bolts, pass into the crankcase, or the bands can first be soldered to the crankcase and clipped with screws underneath the container like the lagging bands on a locomotive boiler.

In order to allow the propeller to become disengaged from the cardan shaft and freewheel when all air is discharged from the container, the slots in the propeller end of the tubular shaft may be formed as a ratchet. From this ratchet the propeller will be withdrawn when the engine ceases to drive it and the propeller will not be compelled to rotate the engine, so reducing the head resistance in the glide which will terminate the flight.

The propeller shaft bearings, of which two must be provided, are soldered to the rear end of the container. This arrangement of bracket is shown in Fig. 4.

The ratchet arrangement is here shown. From the sketch it will be seen that a sufficient amount of end play must be provided for the shaft to slide in its bearings and so disengage the cross-pin in the propeller shaft from the cardan shaft slots.

Elevator Fixings

The elevator is so fixed that a small range of adjustment can be made in its angle of incidence: this by pivoting its leading edge on the nose of the frame of the machine, whilst two special ribs cross the plane underneath. The ends of these are provided with pins, which drop into holes in quadrant plates of aluminium fixed to the frame.

A photograph of the compressed air engine designed and made by Mr. F. J. Camm which is fitted to the model plane described.

The struts and longerons of the frame are fastened together with sockets formed from thin plate, cut out to shape, bent and soldered together. These can be of tin, but copper or brass would be better, and hard or silver soldering used instead of ordinary soft solder.

Starting Taps and Air Pipes

One point of importance must be attended to, namely, to see that air-pipes to each engine from the container are both of exactly the same length, same diameter, and both equally free from

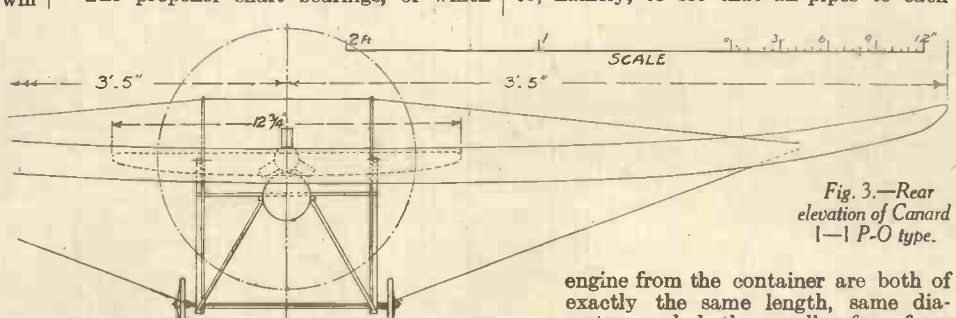
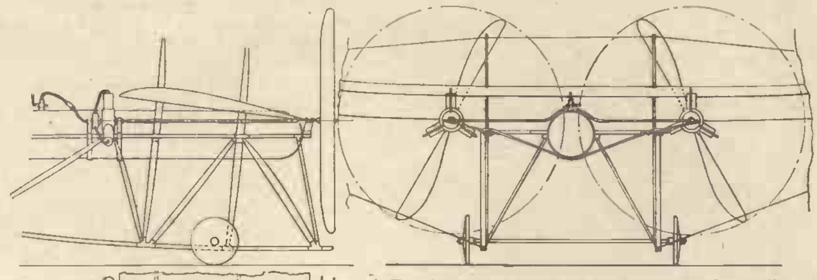


Fig. 3.—Rear elevation of Canard 1—1 P-O type.

AIR DRIVEN AEROPLANE

compressed-air engine there is a difficulty
effects of a crash. For that reason we
By E. W. T.



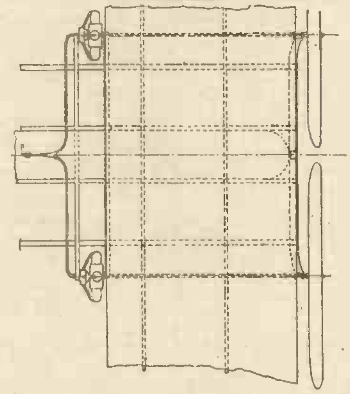


Fig. 5.—Arrangement of twin engines and propellers on 1—1—P2—O type.

partial closing by soldering or bending. If the air is not given an equally free passage to both the engines, one of them will run faster than the other, develop more power, and consequently give greater propeller thrust. One starting-tap should be used connected to a Y-shaped branch pipe.

Final Details of the Compressed-air Model Aeroplane

For the framework of the machine it is recommended that straight-grained birch be used, the longerons being made about $\frac{3}{16}$ in. wide by $\frac{1}{4}$ in. deep. It is, however, rather important that the total weight of the model should not much exceed 24 oz.

The writer considers it only right to mention here that Mr. Camm found, on testing the power plant, that with 150 lb. pressure in the container, the engine drove a propeller 18 in. diameter by 32 in. pitch, which gave a static thrust of $17\frac{1}{2}$ oz. This should be sufficient to fly a model weighing at least 3 lb. In spite of this, however, and in order to ensure a safe margin, it would be best to adhere to the weight given, namely, $1\frac{1}{2}$ lb.

The best way to go to work to arrive at this weight will be to get out all the spars, etc., of the elevator and main wings, including silk coverings. All framework members, wheels, axles, engine fixings, etc., add the propellers, engine and container, weigh the whole together; then, if the $1\frac{1}{2}$ lb. maximum is found to be exceeded, to commence planing down the wooden parts and file or turn away the metal parts, wherever possible, superfluous material which can be spared. All vertical, or approximately vertical, frame members, should be streamlined in cross-section.

Wheels are of wood, unless it is preferred that those of pressed aluminium be used. These wheels can be bought ready for use quite cheaply.

The type formula for model aeroplanes consists of a letter and numerals placed in a certain order, to be read from left to right, in exactly the same way as that recognised as standard for describing the wheel arrangement of railway locomotives. Such a formula applied to aeroplanes is a means of saving many words in either a spoken or type-printed description of a machine. In the formula a biplane of the de Havilland Gipsy Moth type would be written P.O.-2-1, a Puss Moth P.O-1-1, a two-engined plane, such as a Handley Page night bomber, would be P²-O-2-1. The Westland Pterodactyl, which is a tailless machine without a leading elevator, would be O-IP-O, whilst the Focke Wulf Ente would be classified as L-P²-1-0.

A Picture in Figures.

The formula really presents a picture of the machine as viewed from the left-hand side, in the same way as does the locomotive formula. This being the case the first figure, or cypher, indicates the leading plane, if there be one in front of the main wings; the second the main plane or planes, and the third the tail plane, again—if there be one. The letter P is the propeller or propellers, and its place in the formula indicates the position of the engine in relation to the planes. Referring to the de Havilland Gipsy Moth, there is one propeller 'in front', no front elevator, two main planes and one tail plane. The Pterodactyl, obviously a monoplane, has no elevator, no tail and one propeller behind the main surface. This formula arrangement at once shows, whether a machine is biplane or monoplane, how many propellers, and consequently engines it has, and in short shows exactly the type class to which a machine belongs.

Model Aeroplane Types

Now the type which is almost universal in models is the O.P-1-1, that is to say the tractor-screw, tailed monoplane, and yet in model form it is one which possesses the greatest number of inherent faults. The reason for this popularity is not far to seek. It is because it approximates most nearly in appearance to the majority of full-size machines. But, and this is the important point, the conditions governing models are vastly different from those which are applicable to pilot-controlled aircraft.

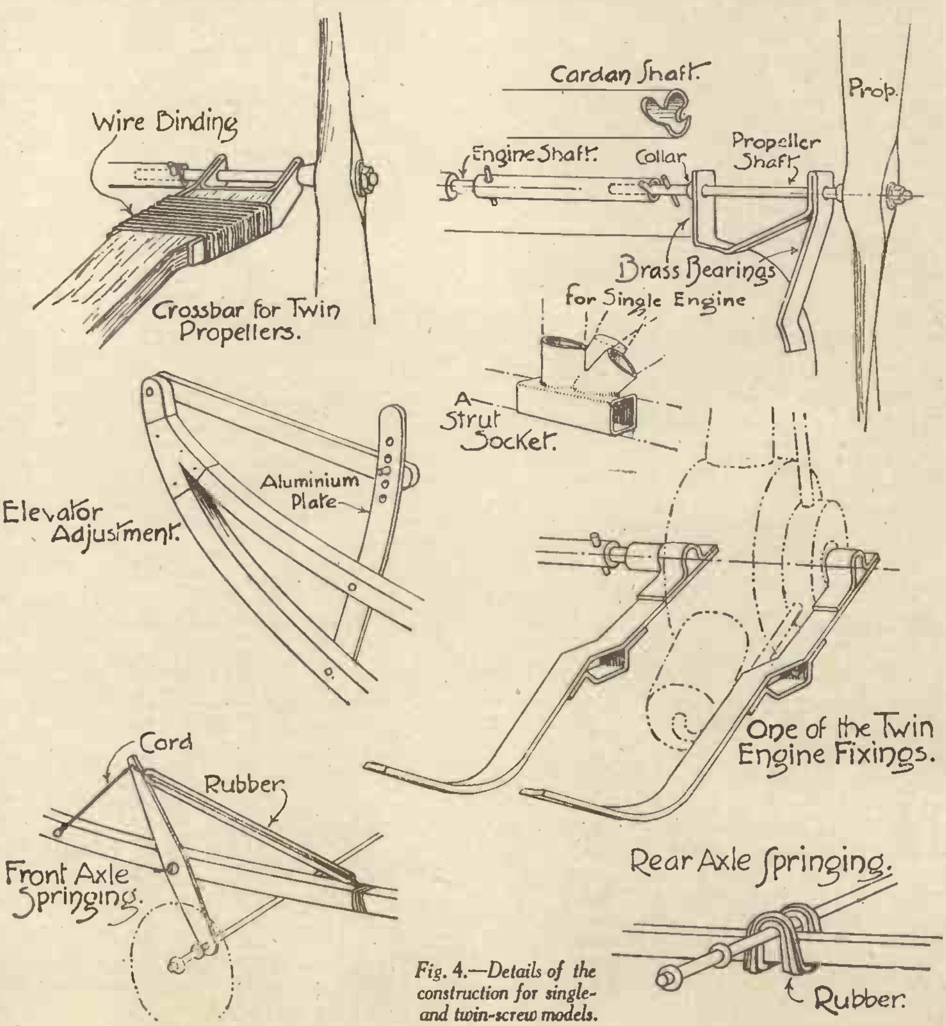


Fig. 4.—Details of the construction for single- and twin-screw models.

ACCUMULATOR CHARGING

Practical Information concerning the Methods of Charging Accumulators from A.C. and D.C. Mains.

THE subject of accumulator charging is a very interesting one from the point of view both of the amateur who wishes to keep his wireless batteries in good condition, and of the electrician operating a service station. Although the principles involved are just the same whether it is desired to charge a single 2-volt cell at 0·5 amp. or to charge half a dozen car batteries at 8 amperes, the practical details of the charger are vastly different in the two cases. In order to cover both classes of work, it will be best to commence by dealing with the points of similarity, and then later on circuits for both kinds of work can be given, along with information concerning their construction and use.

Charging Voltage and Current

The fundamental point in charging any type of accumulator is that a supply of D.C. must be available. This current can be taken directly from D.C. mains, it can be generated by means of a suitable dynamo and motor (electric, gas or petrol, whichever may be most convenient), or it can be obtained from an A.C. mains supply *viâ* a transformer and rectifier, or through a converter. In all cases the charging voltage (D.C.) must be greater than the nominal voltage of the accumulators to be dealt with; the appropriate voltage is 2·7 per 2-volt cell. For example, if three 2-volt cells are to be charged, a D.C. voltage of 8·1 must be provided. If the voltage were less than that of the cells on charge (and their voltage might rise to something like 2·4 whilst the charging current is being applied), there would be every chance of the batteries and the charging apparatus being damaged due to a "reverse" current flow being set up.

The next thing to consider is the charging current, and this depends principally upon the ampere-hour capacity of the accumulators being treated. It can be taken as a general rule that the optimum charging current for average accumulators in normal condition should be one-tenth of their ampere-hour capacity. Thus, when charging 30-ampere-hour accumulators the charging current should be 3 amperes. There is no harm in charging at a lower current, but a higher one may be harmful to the plates. When a number of batteries are to be charged together it is unlikely that they will all be of the same capacity, and therefore the charging current should be regulated to suit the smallest.

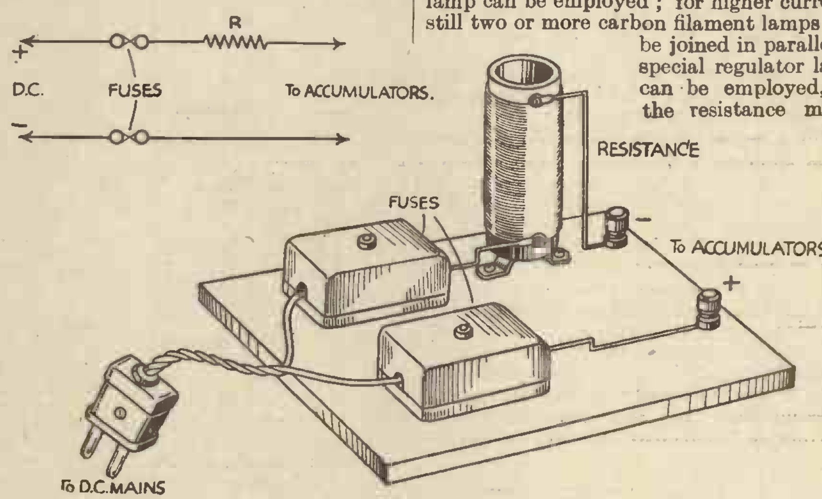


Fig. 1.—The simple arrangement required when charging accumulators from a D.C. supply.

Charging from D.C.

When charging from D.C. mains the very minimum of apparatus is required, and the circuit is that shown in Fig. 1. It will be seen that the mains leads feed the batteries through two fuses and a resistance marked R. The latter may be an ordinary electric lamp when the charging current is no more than 0·5 ampere or so; when the current is up to about 1 ampere a carbon filament lamp can be employed; for higher currents still two or more carbon filament lamps can be joined in parallel, a special regulator lamp can be employed, or the resistance might be one of the wire-wound variety made by connecting air-spaced coils of Eureka resistance wire in series. If lamps are to be used, the current which any particular one will pass can easily be calculated by dividing the rated wattage of the lamp by its marked voltage. Thus a 100-watt, 200-volt lamp will pass 100 divided by 200, or ½ ampere. The current could be doubled by putting two lamps in parallel, or trebled by using three in parallel, and so on.

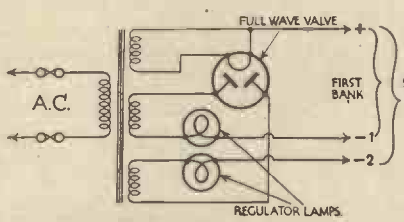


Fig. 5.—Two banks of cells can be charged at different rates from an A.C. supply by using the above circuit.

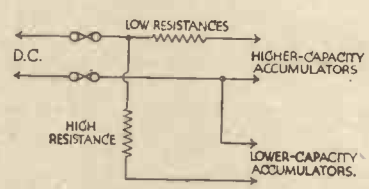


Fig. 4.—The circuit required when charging two banks of accumulators at different rates from D.C.

When there is only a single 2- or 4-volt cell to be trickle-charged (charged at a low rate, say, up to 0·5 ampere), it is often possible to charge it from D.C. simply by wiring it in series with an ordinary light, electric fire or other device. With such an arrangement the charging costs nothing, and the efficiency of the light or appliance is reduced only very slightly.

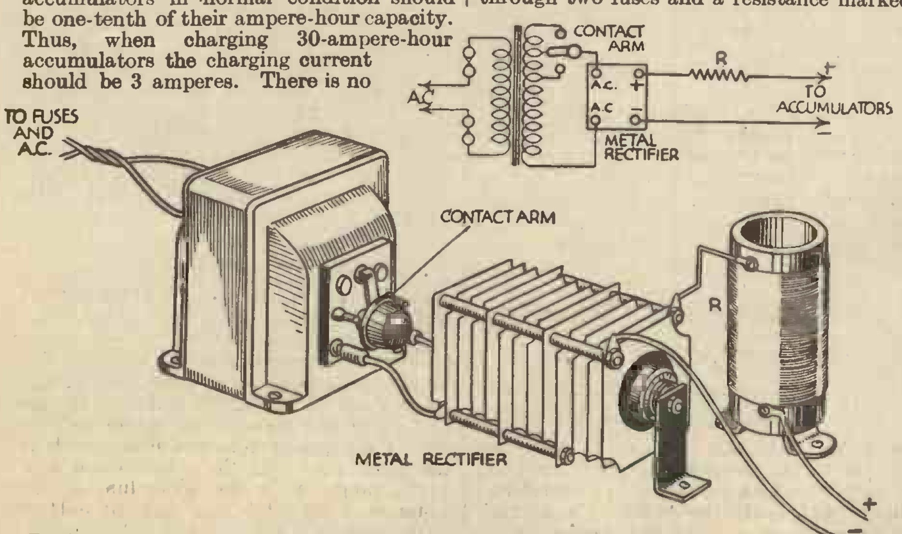


Fig. 2.—A convenient A.C. charging circuit in which a metal rectifier is employed.

Circuits for A.C.

Charging from A.C. is rather a different matter, due to the fact that a transformer and rectifier are called for. A suitable circuit for charging up to three cells (6 volts) at 2 amperes is given in Fig. 2, where a metal rectifier is indicated. An alternative system using a full-wave valve rectifier is given in Fig. 3, and it will be seen that this is very similar to the previous one. Different methods of current regulation are shown in the two circuits, a plain resistance being indicated in the first example and a pair of regulator lamps in the second. As a matter of fact, the two systems of regulation are interchangeable and produce the same effect; that is, they ensure that the charging current shall remain reasonably constant irrespective of the state of charge of the accumulators. To explain this point more fully, it may be stated that when an accumulator is well "down" its internal resistance is comparatively high, but after it has been partly charged the resistance falls off. In consequence of these varying conditions the charging current—if regulators were not employed—would be low when the batteries were first connected, and would gradually increase as charging progressed. This would be harmful to the accumulators.

Reducing the Charging Rate

It is obvious that, if a charger is designed to supply, say, 27 volts to charge ten cells, the voltage would have to be reduced when only eight or five cells were in circuit. One method of reducing the voltage is to replace the fixed regulator resistance by a variable component or by a series of fixed resistances in series with tappings between them. This certainly gives the desired effect, but it is not economical, since the drain on the A.C. supply remains constant irrespective of the number of cells on charge. A much better method is that illustrated in Figs. 2 and 3, where the secondary winding of the mains transformer is tapped to provide varying voltages. The exact points at which the tappings must be made depends upon the particular rectifier in use, but for a metal rectifier such as the Westinghouse L.T. 6 (maximum output, 9 volts at 2 amperes), and when using the

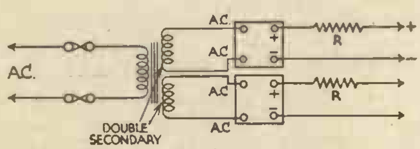


Fig. 6.—An alternative method of charging two banks of cells from a single full-wave rectifier. The full output of the rectifier can be obtained by joining the two negative leads together.

regulator resistance shown in Fig. 2, tappings should be made at 7·5 and 9 volts, the whole winding giving 11 volts. When using a Philips 451 full-wave valve rectifier (maximum output 8·1 volts, 1·3 amperes) in the circuit given in Fig. 3, the secondary winding should supply 16 volts on each half, and tappings should be taken at about 12 and 9 volts respectively. It will be found most convenient to arrange a rotary switch or a series of sockets for changing from one secondary voltage to another, and these arrangements are shown in the two circuits under discussion.

It need scarcely be stated that the two arrangements considered can be applied to any required charging voltage and current by making a suitable choice of rectifier and transformer. The regulator lamps or resistance would also have to be chosen according to the rectifier, but particulars regarding this point are always supplied by the makers of the rectifiers.

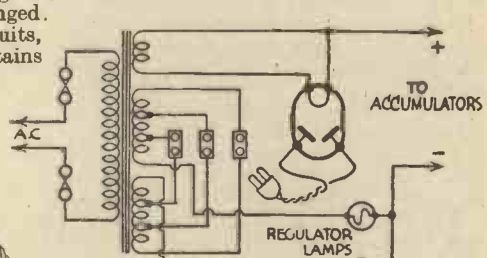
Double Output Arrangements

It is very often desirable that one should have two charging circuits, one to charge at a higher rate than the other. That supplying the lower current is used for small accumulators, or any which have become slightly sulphated and therefore require to be given a slow charge; and the other is used for larger batteries which are in normal condition. When charging is from a D.C. supply, this can be arranged quite easily by having two parallel circuits, as shown in Fig. 4. One of these contains a higher value of resistance than the other, and both resistances can be varied to obtain exactly the current required.

The method is rather different when the supply is A.C., but the circuits given in Figs. 5 and 6 can be used with success. The former circuit uses two metal rectifiers, each fed from a separate transformer winding, and the latter makes use of a full-wave valve rectifier with similar secondary windings to those used in the circuit in Fig. 3. When using metal rectifiers it will generally be most convenient to have two of different types, although if both are of the same type the D.C. outputs from each can be connected in series if desired, so as to obtain twice the charging voltage of one of them.

In the case of the valve rectifier, there is a common positive lead and two separate negatives, but a single charging circuit which will give an output equivalent to the maximum rating of the full-wave valve can be obtained by connecting the two negative leads together; the circuit then becomes identical with that in Fig. 3.

Power transformers suitable for any of the A.C. circuits described can be bought ready made from such firms as Messrs. Heayberd, or they can be made at home by following the instructions given in the article on this subject in the January issue of PRACTICAL MECHANICS. It is obviously impossible to give particulars here because the design of the transformer must depend entirely upon the type of rectifier employed, and also upon the charging voltage and current required. These latter details will be found on the makers' instruction sheets, however, so that all constructional details can eas ly be worked out by following the methods outlined in the article above referred to.



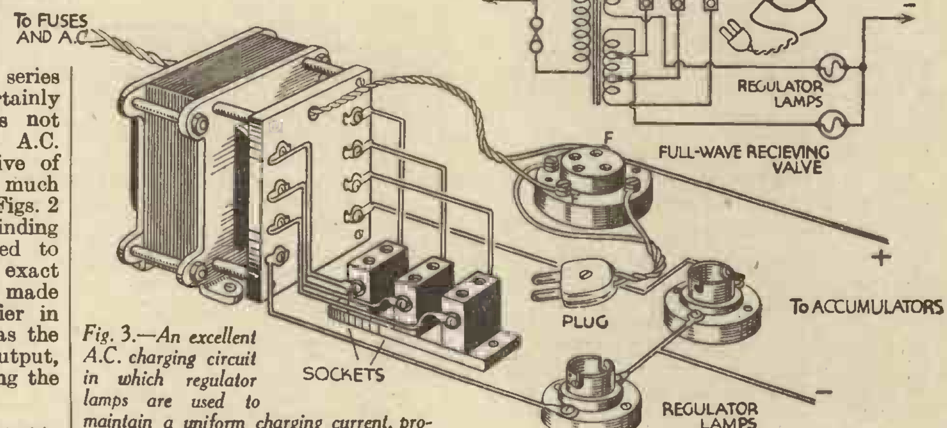


Fig. 3.—An excellent A.C. charging circuit in which regulator lamps are used to maintain a uniform charging current, provision being made to obtain alternative charging voltages.

There is one point which is worthy of mention, which is that when using a valve rectifier it will often prove more convenient to employ one transformer for supplying the higher (charging) voltage and another for the valve filament or heater supply. By this means it is possible to use smaller transformer cores, and so to simplify the constructional work.

Charging H.T. Accumulators

Although transformers are nearly always required when charging low-tension accumulators from the mains, they can be dispensed with when dealing with H.T. accumulators of the type used for wireless purposes. When these are connected in series to a total voltage of 120 to 150, they can be charged from A.C. merely by inserting a metal rectifier between them and the mains points. The charging current will not generally exceed about 200 milliamperes, and therefore an ordinary rectifier of the kind used in larger types of battery eliminators can be employed. In using an arrangement such as this great care must be taken to ensure that adequate insulation is provided between the accumulators and earth and a 0·5-ampere fuse should be included in each mains lead.

No reference has been made to the use of convertors and dynamos because the output will be D.C. and equivalent to a D.C. mains supply.

THE MICROMETER AND VERNIER

(*Continued from page* 464)

should be 3·450 in. On some verniers the beam is graduated on the reverse side and a separate scale is marked with datum lines for inside and outside settings, the fine adjustment being carried out as before. Vernier callipers are also to be had, which read in English on one side and metric on the reverse side.

Other classes of measuring tools are made incorporating the vernier principle. Notably these are depth gauges, height gauges for marking out as with a scribing block and gear tooth verniers. The depth gauges need no comment. Height gauges are similar to the vernier described excepting that the fixed jaw is attached to a machined block that holds the beam in a vertical position in relation to the surface plate. Attached to the sliding jaw is a scriber of special design enabling the measurement to which the tool is set being transferred in the form of a line to the work.

Gear-tooth verniers are a combination of two slides working at right angles both reading off independent scales. On the one which has jaws like a vernier calliper is set the required thickness of the tooth at the pitch line. On the other which is a depth gauge is set the addendum or the distance of the pitch line from the outside of the gear.—W.H.D.

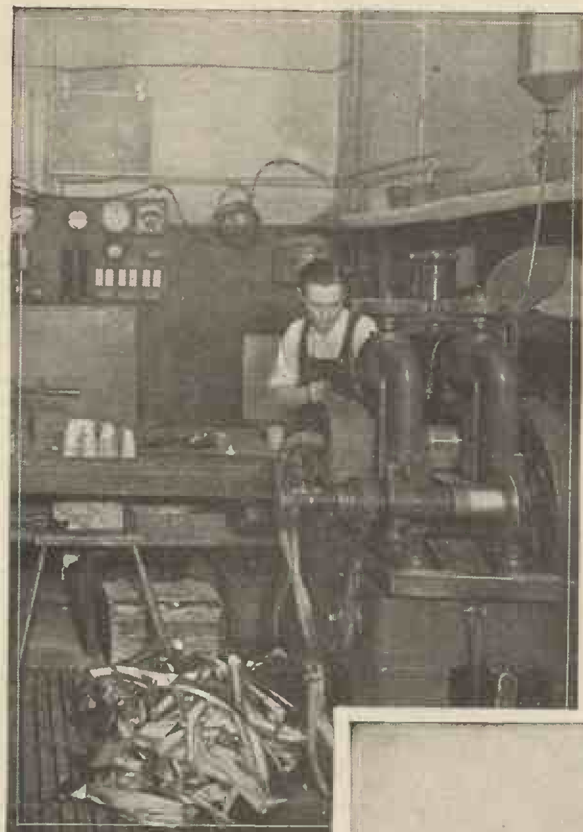


Fig. 2.—This simple machine, the only machinery used, rolls the ingot repeatedly into thin ribbons.

GOLD-BEATING

By DAVID CHARLES

There is a peculiar appeal about the ancient craft of gold-beating, quite different from that of most handicrafts. First, the character of the product—a metal foil of extraordinary and almost unbelievable thinness, considering that it is an everyday commercial product, yet one that preserves its durability where even stone and bronze decay! Gilding done by Egyptians 4,000 years ago is still perfect!

NOT only does gold itself defy change, but the methods of producing it do too! There has been no material difference in either the methods or the tools used, as far back as can be traced. Like the mason's mallet, the gold-beater's hammer and the marble block on which he beats are not only similar, but in many cases these apparently primitive tools have actually been in use by several generations, to the extent that dents are worn in the marble slabs where son, father, and grandfather have pressed their left thumbs. The only machinery used is in the preliminary preparation of the metal. The gold is first melted in small crucibles (see Fig. 1) where it is cast into ingots measuring 6 × 1 in., and ⅛ in. thick. These ingots are passed through rollers as many times, and with as many increases of pressure, as turn them into golden ribbons just 1¼ in. wide, and a "thou." thick. This is the only part in which machinery, and that of a simple kind, is used, as shown in Fig. 2. This gold ribbon is then cut with scissors into inch squares, when they are ready for beating by hand.

Each little inch square of gold, a thousandth part of an inch in thickness, has now to be beaten, by hand, until it is exactly 200 times as thin, sometimes even thinner than that, and still it must not have any pinholes, cracks, or other faults to spoil the appearance and durability of the gold-leaf when applied to all its various decorative purposes, architectural or commercial. The hammer never touches the gold itself. The latter is always placed between sheets of vellum or in the last stage of "gold-beaters' skin." A sort of pack of little square skins and gold in alternate layers is made, the skins 4 or 5 in. square, the bits of gold in the centre of each skin being 1 in. square. When the pack has been beaten for some time, the gold, as it gets thinner, spreads to the edges of the skin. The gold foil is then cut into inch squares again, and the process is repeated. Once more the thinning foil reaches the outside of the pack. Still again each single foil is cut into quarters, again sandwiched between skins, and again beaten till it reaches the edges of the pack. That, roughly speaking, is the process of gold-beating.

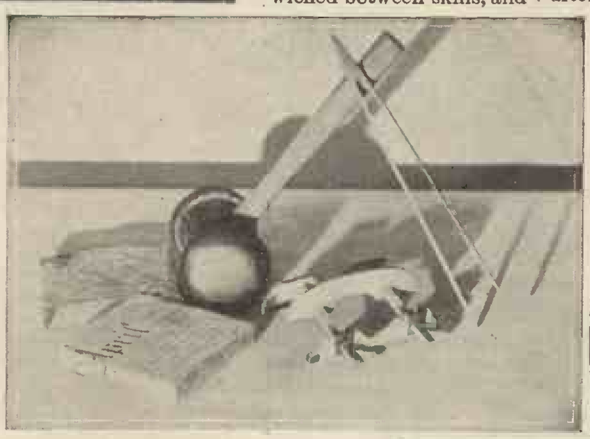


Fig. 3.—The hammer in use to-day is often centuries old, being handed down from father to son. The vellum "bands" for the "mould" of skins shown here is over 100 years old, and the "waggon" and wooden pincers are of very ancient design.

Technical Points

Actually there are several extremely-technical points involved in these stages, both as regards the number of layers, the character of the skins, the weight of the hammer, and the length of time for which the pack is beaten. As it is of the highest importance that no one layer should slide about, and as in any case it would be impossible to keep a pack in perfect shape while beating, a pair of vellum bands are used to hold the sheets together, as shown in Fig. 3. Old legal parchments are used for this and for other purposes, and it is astounding to realise the amount of beating with a heavy steel hammer that this and the inner skins will stand. The gold itself has to stand the three successive beatings, totalling about eight hours' continuous hammering. But the skins, some of them costing almost as much as the gold itself, are used over and over again, for great numbers of hammerings. Here are some curious facts concerning the pack of valuable little skins between which the gold is placed for beating. In the first stage the pack consists of 200 layers of parchment, and is called a "cutch." After half-an-hour's beating with a 20-lb. hammer, the 200 layers of gold, cut into quarters, become 800, and these are laid alternately between rather stronger skins. This time the pack is called a "shoder." In the third stage 1,000 sheets at once are beaten. In this case the skins are very thin and smooth. They are each actually less than a thousandth of an inch in thickness, and are of perfect smoothness. This pack is called a "mould." Why these names probably no one knows, but they serve to distinguish the stages of beating. The "shoder" is beaten for two hours with a 12-lb. hammer. But the "mould," although beaten

Continued on page 486).

Fig. 1.—Gold is prepared by melting it, in small crucibles, into ingots.

EXPERIMENTS WITH AN INDUCTION COIL

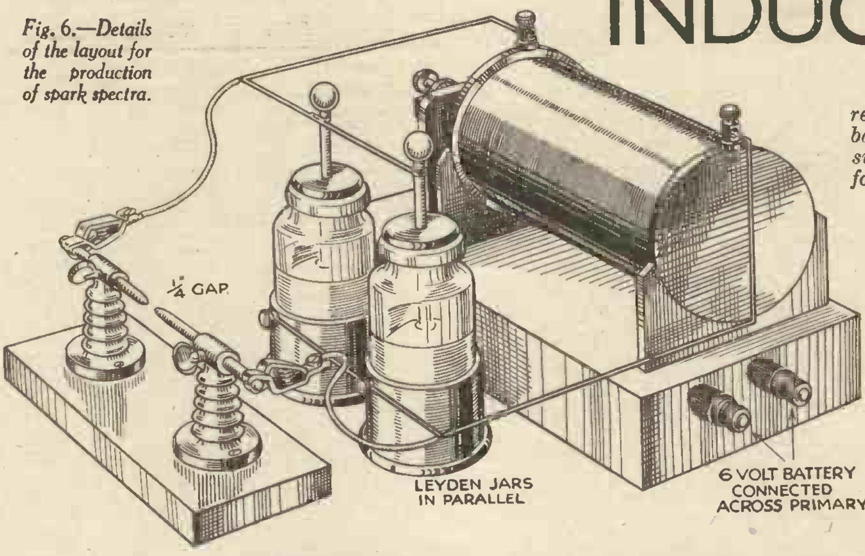


Fig. 6.—Details of the layout for the production of spark spectra.

This article deals with experiments which do not require any elaborate apparatus except the coil and batteries. Some of the experiments require only a single 2-volt cell, while others need a 12-volt car battery for their successful operation.

To commence you should ascertain the approximate voltage generated by the coil, and to do this place fine-pointed knitting needles in the secondary terminals of the coil and adjust for the maximum spark. The following table gives the voltages corresponding to the gap distances. These must be regarded as only very approximate, as the atmospheric humidity, temperature and pressure have a considerable effect on the spark:—

VOLTAGES FOR SPARK GAPS IN INCHES

Voltage	Gap
30,000	1 in.
50,000	2 in.
63,000	3 in.
75,000	4 in.
100,000	6 in.
122,000	8 in.
170,000	12 in.

To increase the spark place two wires from the coil on a glass sheet with the ends about 10 in. apart. Start the coil and breathe on the glass. Large multi-branched sparks will pass, running all over the sheet. Another method of increasing the spark is to warm the air in the gap with a Bunsen or candle flame. Before warming observe the reddish-blue glow, known as the brush discharge, at the tips of the wire. Similar experiments may be performed by pasting a sheet of tin-foil on a glass slab and cutting a design on it, separating the foil into many narrow strips. If wires are connected from the coil to points about 10 in. apart, sparks will pass, illuminating the design.

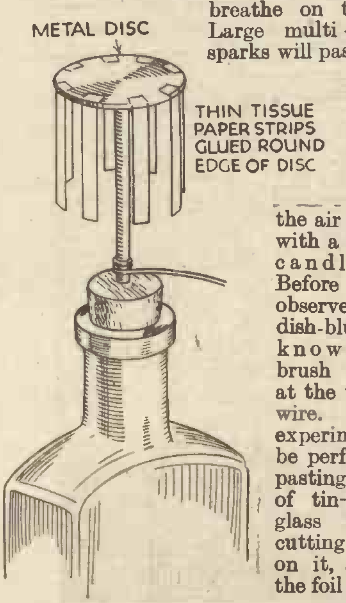


Fig. 2.—The electric "umbrella."

The electrical wind, so noticeable with a Wimshurst, is quite apparent if the coil is worked from a 12-volt battery; place only one needle in the coil with the point beyond the coil and earth the other terminal, switch on and hold a small candle flame just below the point; observe that the tip of the flame blows away from the needle.

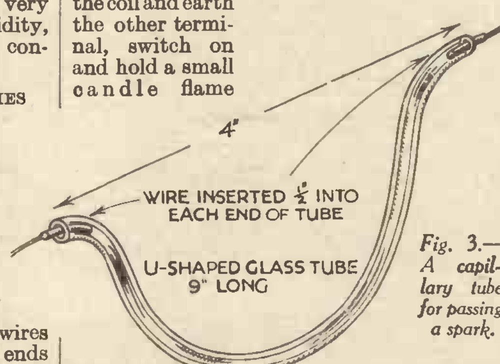


Fig. 3.—A capillary tube for passing a spark.

If various substances, such as dry salt, soil or sugar, are sprinkled on a glass plate and the wires set about 2 in. apart the spark will pass, giving a very marked and brilliant effect, the material appearing to glow and burn, although no actual combustion takes place.

Igniting Petrol, Gunpowder, etc.

The coil may be used to ignite petrol, methylated spirits, gunpowder, etc., by adjusting the spark to about 1/8 in. Place a small piece of cotton-wool soaked in the spirit over the gap, switch on, and it will ignite almost immediately. The experiment may be repeated, using gunpowder, but be careful to keep the hands and face clear, as sometimes the experiment is rather violent, the substance blowing up rather than burning. Fireworks may be set off at a considerable distance from the coil by soaking the touch paper with petrol and igniting it with a spark, using fine wires run from the coil. Keep the wires off the ground by supporting them in hedges, etc.

The spark may be photographed in a very simple manner. Place a piece of gas-light paper on a sheet of glass and arrange the wires for a spark to pass. This must be done in a dark room; that is, one in which the main lights are off. Fire-light, etc., will not affect the paper. Switch on just long enough for one spark to pass, remove the paper, and develop and fix in the usual way. Several sparks may be taken on the same sheet of paper. They are not true photographs and appear as a black line on a white ground, but they illustrate the various types of discharge as well as a photograph.

Objects may be spark photographed by a method similar to the above, the results being rather interesting, as they are so very like the objects used. The sparkgraphs, as we will call them, are made in the following way:—Use a 4-volt battery in the primary. Place a large sheet of metal on the bench; on it place a sheet of glass. Lay a piece of gas-light paper on the glass, and on this place some metal object, as a key or coil. Connect wires to the object and the plate and let the spark pass for twenty seconds. During this operation screen the paper from the light of the interruptor. The operation is shown in Fig. 1.

An Electric Umbrella

A rather startling effect may be produced by means of an electric umbrella. Solder

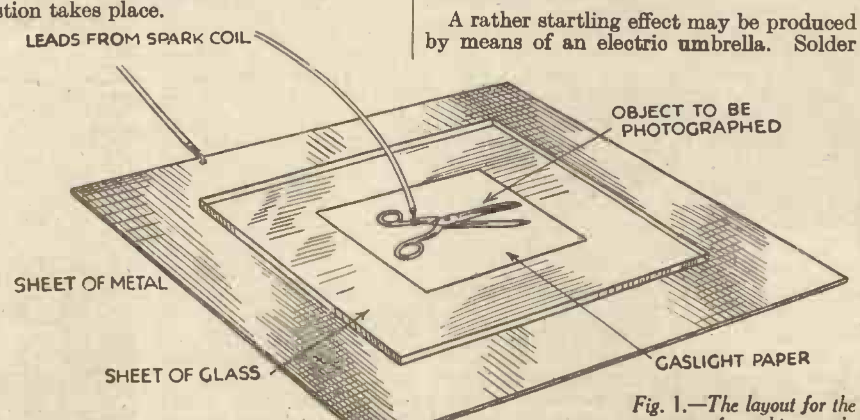


Fig. 1.—The layout for the apparatus for making sparkgraphs.

a stout copper wire to the centre of a metal disc about $\frac{1}{2}$ in. in diameter and support in the cork of a bottle. Cut strips $\frac{1}{16}$ in. wide from *very thin* tissue paper; glue them to the metal cap and bend them so that they hang vertically. Connect one wire to the copper and earth the other;

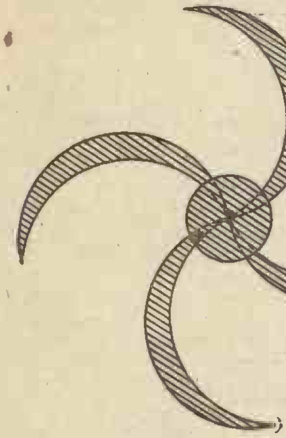


Fig. 5.—How the wheel is laid out.

switch on, and notice that the strips all fly out into a horizontal position.

A spark may be made to pass down a narrow glass tube of much greater length than the normal gap. The effect may be increased by blowing down the tube. Take a 9-in. length of thermometer tubing and bend it to any desired shape, keeping the ends about 4 in. apart. Push a wire from the coil $\frac{1}{2}$ in. down the end and switch on. The effect is similar to a vacuum tube (Fig. 3).

A substitute for Geisler tubes takes the form of a collection of vacuum lamps. These may be of all types, from motor car to mains sizes and tubular, festoon and plain bulb. Some lamps when not burnt out will light in an almost normal manner if the wires are presented to the correct contacts. A bulb will glow if held in the hand with the metal cap touching one terminal of the coil; several lamps may be connected in series by cementing a metal cap to the tip of the glass and connecting it to the cap of the next. Old wireless valves are very effective and should be used in a holder mounted on a block of wood. There is a form of tubular lamp on the market used for shop-window lighting made up to 14 in. long. They make excellent tubes when burnt out.

The principle of the horn type of arrester may be demonstrated by bending two stout wires as shown. On starting the coil sparks will pass and rise up, until the distance becomes too great and they blow out. This arrangement is used on some power lines to protect the plant from sudden voltage surges due to atmospheric electricity. The arc formed automatically blows itself out (see Fig. 4).

The output of the coil may be measured by a milliammeter of either the direct or alternating type, and the polarity may also be determined by using the same instrument. Do not short the coil through the meter, but connect a spark gap or tube in series.

The electrical wheel may be shown by cutting a wheel as shown and balancing it on a needle point connected to one terminal of the coil. Switch on and note that the wheel rotates quite merrily. It is necessary to make the wheel of silver paper and balance it correctly. Before cutting out draw the wheel accurately with geometrical instruments (Fig. 5).

The coil is very useful for the production of spark spectra. A condenser of two or three Leyden jars is connected across the gap which has for electrodes the metals to be tested held in suitable clamps. The gap should be about $\frac{1}{4}$ in., and a 6-volt battery should be used in the primary. The spark must appear more as an arc and should be hot and flaming (see Fig. 6).

To charge a Leyden jar from the coil connect it in series with a spark gap and allow sparks to pass. Alternatively, earth one terminal of the coil, connect the other to the knob of the jar and hold the outer casing in the hand. On discharging observe the white and noisy spark, unlike the normal coil discharge.

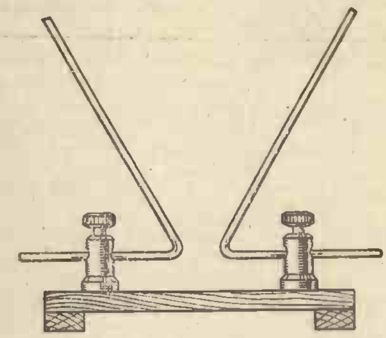


Fig. 4.—A horn type of arrester can be made quite easily as shown.

It may be mentioned here that for these experiments everything should be perfectly dry, and to obtain the most spectacular effects work the coil in a dark room. Be careful when giving and taking shocks, especially when discharging Leyden jars.

Showing the model speed boat under way.

A POWER-DRIVEN SPEED BOAT

Although this is a steam-driven boat it lends itself equally well to an electric drive. Many suitable motors are listed by the principal model engineers.

POWER-DRIVEN model boats are usually flat at the bottom, and it is therefore easier to build up the hull than to carve it out of a solid piece of wood, as is frequently done for the sailing yachts.

The hull may be made from any straight-grained wood, but if it is preferred to chip it out from the solid, a hard close-grained wood, such as teak, mahogany, oak or elm, should be used. Obtain a board equal in thickness to the total depth of the hull to avoid a fair amount of planing.

The hull shown in Fig. 1 is particularly easy to construct, for in the case of every joint, except the bow, the wood can be trimmed to its final shape after the joint is made.

Mahogany is recommended as the most suitable wood. Cut out the bottom to the shape shown in Fig. 1 from a piece of wood 2 ft. 1 in. long by 4⅝ in. wide by ⅜ in. thick. Mark out the straight lines first to the dimensions given, then draw a long, smooth curve touching the straight lines tangentially, taking care that the two sides are quite symmetrical about the centre line.

The Watertight Compartment

Fix the blocks at the stem and stern, also the bulkhead, the object of the latter being to form a watertight compartment to prevent the boat from sinking should it become flooded as the result of a collision or any other cause. All three pieces of wood should be attached by brass screws put in from underneath, and a little white lead painted on to the surface of the wood before fixing. These pieces of wood should all be bigger than required, so that they project beyond the bottom of the boat, and trimmed off quite flush after they are fixed. In the case of the stem and stern blocks, the grain should run along the length of the boat, but the grain in the bulkhead should run across the boat. A ⅜-in. hole should be drilled in the bulkhead to accommodate an ordinary small bottle cork; by removing the cork the compartment can be drained of water if it should happen to spring a leak. It is easier to drill this hole before the bulkhead is fixed; arrange it near the top and to one side, so that it will be reasonably accessible after the boiler is fitted into position.

Method of fixing the Sides of the Boat

The sides of the boat are of 3/16-in. mahogany fretwood, and should be 2 ft. 4 in. long and a little over 3½ in. wide, to allow for trimming after they are fitted. Don't be tempted to use three-ply wood on the grounds of economy, for the glue will soften in water (even when the wood is painted) and the hull will be ruined.

Start fixing the sides at the front end and fit the two pieces together very neatly, as shown in Fig. 2; a sharp paring chisel is the best tool to do this with. Screw the sides on to the stem block with small brass screws after applying white lead to prevent water from soaking in at the joint. After fixing both pieces firmly to the stern, pull the back ends together against the stern block and bind them temporarily with string. Now screw the sides to the bottom with fine brass screws about 2 in. apart and put a few extra screws into the bulkhead and the stern block; all joints in the hull should be made with white lead. Keep the screws rather nearer to the top surface of the floor of the boat so as to give as much room as possible for rounding off the outside corner. The sides, when fitted, should project a little below the bottom of the boat. This projection should now be planed off smooth and the corners rounded off (Fig. 3).

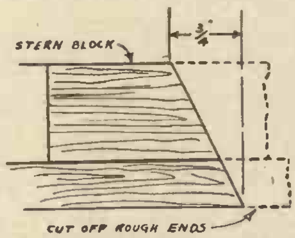


Fig. 4.—Cut through the whole boat at an angle as shown to form the flat stern.

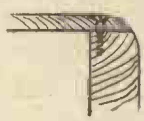


Fig. 3.—The sides when fitted should have their corners rounded off as shown.

Now with a fine tenon saw cut through the whole boat at an angle, as shown in Fig. 4, to form the flat stern.

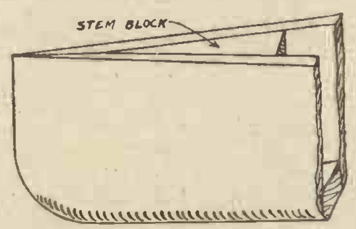


Fig. 2.—How the two sides are joined together.

This form of stern is easy to make and presents quite a smart appearance; the bow, however, should be rounded off as much as possible at the foot (Fig. 2).

The top edge of the sides—together with the stem and stern blocks and bulkhead—should now be trimmed down until the boat is 3½ in. deep at the bow, tapering down from the bulkhead to 2 in. deep at the stern (outside measurements).

The Front Compartment

This may either be covered in with a flat deck, which may be made of wood, or a curved spray hood, which is best made of sheet aluminium. The flat deck is, of course, easier to make, but the spray hood looks smarter and more "racy."

If you decide on a flat deck, this is simply a piece of 3/16-in. wood screwed on with a white lead joint. Pine looks well for the deck instead of mahogany, and "planking" can be ruled on with a hard pencil.

If, however, you prefer the spray hood, the bulkhead must project above the sides of the hull about ¾ in., and the top edge should be shaped to the curve of the hood, which should be made of sheet aluminium about 22 gauge. The shape of the hood is as shown in Fig. 5, but dimensions are not given, as it is best made to fit on the job. Screw down into position with small round-head brass screws about 1¼ in. apart and make the joint watertight with frayed string which has been liberally anointed with white lead.

Painting the Hull

The hull is now ready for painting, in fact, the inside should be painted and allowed to dry before decking in the watertight compartment. Ordinary oil paint will be quite suitable for the inside, but a good enamel should be used outside. Cellulose enamel gives quite a good finish and stands sea water very well. The final coat of paint should be given after the aft deck, rudder and machinery are fitted. Almost any engine and boiler will do that can be got into the hull.

The Engine

Whatever engine is chosen, it should be placed, together with the boiler, in the hull while the latter is floating in a bath of water; by doing this you can find the best position for the machinery to make the boat trim nicely in the water. Mark out the positions for both engine and boiler, making sure that enough room is provided to allow the lamp to be inserted under the boiler; it is rather annoying when everything is ready for a trial run and you find the lamp won't go in. Arrange a piece of sheet asbestos under the boiler casing before screwing the boiler down. It is a good plan,

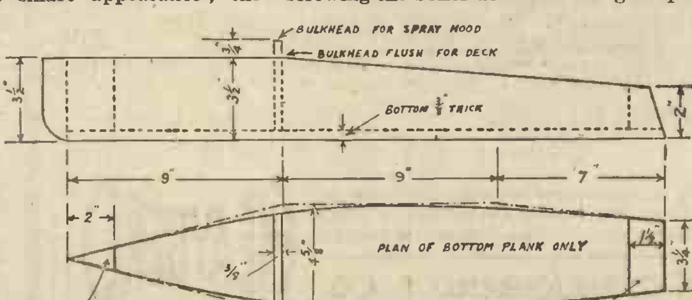


Fig. 1.—Details of the bottom and sides.

too, to stand a bit of the same material on edge between the boiler and the sides of the boat, also the bulkhead. There is no need to fix it, for it will protect the wood more effectively if the air can get at both sides.

Keep the weighty parts as low as possible and tilt the top of the engine backwards so that the centre line of the crankshaft, when continued, runs through the bottom of the boat so as to come out about 4½ in. from the stern. The engine should then be screwed down, after which the hole for the propeller shaft tube may be drilled. This is a rather awkward job to do with an ordinary drill, but it is quite easy if the drill shank is ground square and forced into a piece of tube about 4 in. long so as to lengthen the drill. Cut a groove with a small gauge on the underside of the hull, 4½ in. from the stern, to provide a start for the drill, and then get an assistant to watch the drill while you make the hole, so as to make sure that the drill does not wander off its appointed path. The hole should be ¼ in. diameter.

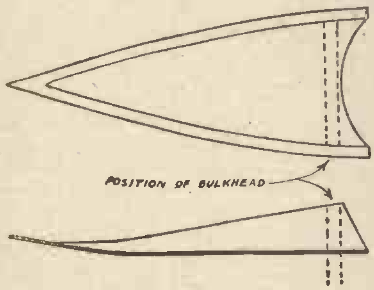


Fig. 5.—The shape of the hood.

The Tubing for the Propeller Shaft

The tubing for the propeller shaft should be brass, ¼ in. outside diameter by about 4 in. long, and the shaft itself should be of brass rod, $\frac{5}{32}$ in. diameter by about 7 in. long, the exact length being determined on the job. The inside of the tube should be about $\frac{3}{16}$ in. diameter, and to provide bearings for the shaft fill up one end of the tube with solder for a length of about ½ in. and drill out the plug of solder with a $\frac{5}{32}$-in. drill to fit the shaft, the other end of the tube should then be treated in a similar manner; if you try to put the second plug of solder in before drilling the first one, you will find the air pressure inside the hot tube introduces difficulties.

The solder provides an effective white metal bearing in which the shaft will run with less friction than if it fitted the tube along its whole length. A little white lead should be introduced into the hole in the bottom of the boat before the tube is pushed into place. The tube, must, of course, fit tightly into the hull.

The engine shaft should be coupled to the propeller shaft by means of a piece of closely wound spiral spring, which fits tightly on the end of each shaft, allowing about ¾ in. between the two shafts; if both shafts are not the same size, file down the larger one at the end. This coupling provides a certain amount of flexibility, but the two shafts should be aligned as truly as possible so as to avoid loss of power. The spring should be fixed to the shaft with a spot of solder if it shows any tendency to slip.

The Propeller Blades

The propeller blades are cut out of one flat piece of brass and soldered on to the face of a Meccano collar; the collar, being provided with a grub screw, forms a ready means of fixing the propeller to its shaft. Make the propeller 1½ in. diameter with two blades, and bend the blades to suit the rotation of the engine. The angle to which the blades are bent determines the pitch of the propeller. This should be adjusted to give the best result when the engine is running. The pitch will make a lot of difference to the speed at which the engine runs, and the blades should not be bent so far as to make the engine labour, or it will not develop its full power. You can, if you prefer it, buy a propeller with shaft and tubing from the principal model engineering stores.

The decking over the stern can now be fixed; it is simply a piece of $\frac{3}{16}$ in. fretwood (not three-ply, of course). Although not shown on the drawing, you can make a second watertight compartment under the deck with advantage.

The rudder is made as shown in Fig. 6, the spindle being a piece of the same material as the propeller shaft. A washer should be placed between the rudder and the bottom of the boat. The tiller is made from a similar collar to that for the propeller, the tiller handle being soldered on. A $\frac{5}{32}$-in. hole is to be drilled in the stern block for the rudder spindle, which should be a tight fit. If the rudder turns too easily, the spindle should be tinned with a soldering iron, leaving on a liberal coating of solder.

The steam-pipe connections will, of course, be obvious, while the exhaust should lead out overboard to one side. It is an advantage to "lag" the steam-pipe where it is exposed by binding it round with asbestos string; lagging the cylinder is also good practice if it can be managed, but it is usually a difficult matter. Good lubrication makes a lot of difference to a small engine, so keep it well oiled, also the propeller shaft bearings. The cylinder may be oiled by putting oil in the exhaust pipe and turning the engine backwards.

Electric Speed Boats

This boat lends itself equally well to an electric drive. Many suitable motors are listed by the principal model engineers for this class of model, while dry batteries and accumulators are also available. The instructions given above regarding propeller, couplings, etc., are equally applicable to an electric motor. Electric launches are very convenient and clean, but generally look less imposing than a steam-driven model, though a dummy boiler—to house the battery—fitted with a good funnel, will overcome this matter of appearance.

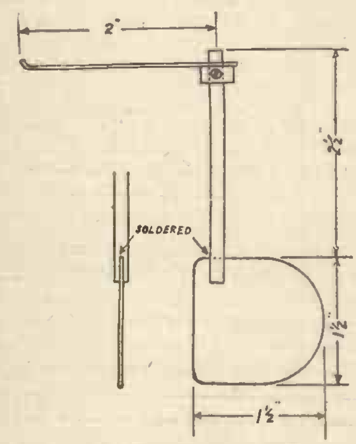


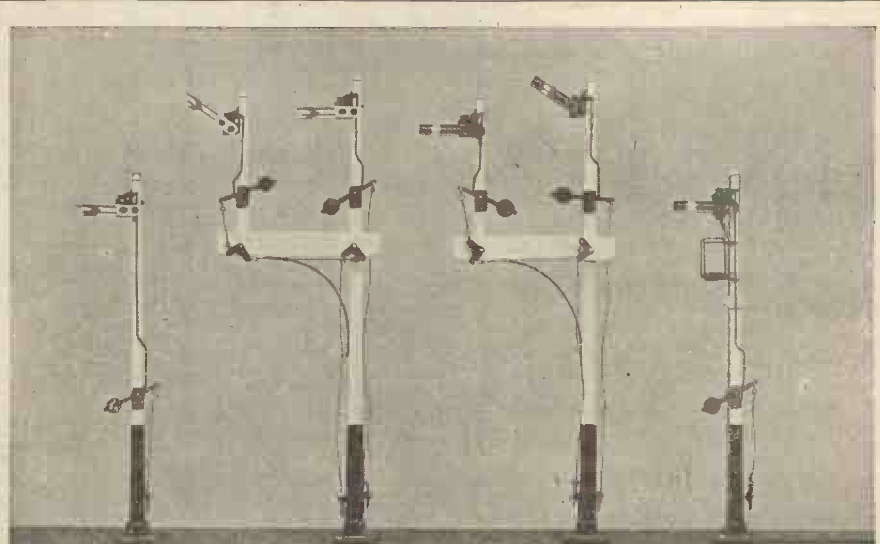
Fig. 6.—Details of the rudder.

Another alternative method of propulsion is clockwork. This may be fitted under a dummy boiler casing and has a vertical spindle for winding, which could be arranged under the funnel.

UPPER-QUADRANT SIGNALS

HERE is something new for your model railways! A range of Upper-Quadrant Signals made by Bassett-Lowke Ltd., the well-known model-makers of Northampton. These were first shown at the Model Railway Exhibition, where they were so enthusiastically received by lovers of accuracy and detail in their model railways, that the makers have decided to make a full range, including superdetail models with ladder, platform and wired to light up. The range comprises single arm signal, either home or distant; double-arm signal, home and distant on one post; and two-arm bracket signal, home or distant.

As these signals are hand-made from official drawings, any pattern of signal gantry can be made for model railway owners, providing a rough sketch giving number and position of the arms is sent, together with the main dimensions. The signals are built to a scale of 7 mm. to the foot, and would be a welcome addition to any Gauge "O" railway.



A range of Upper-Quadrant Signals made by Messrs. Bassett-Lowke.

FURTHER EXPERIMENTS WITH GYROSCOPES

The apparatus described in this article costs about half a crown to make, and with it can be performed nearly all the experiments which are generally carried out with what is known as a compound gyroscope costing several pounds.

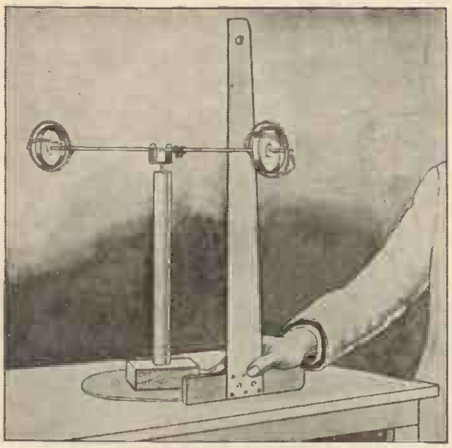


Fig. 1.—Details of the apparatus for carrying out the experiments described in this article.

THE apparatus shown in Fig. 1 consists of two shilling gyroscopic tops. One screw end on each gyro is soldered into the end of a piece of brass tubing, through the middle of which a hole is drilled and the gyros and rod turn in a vertical plane on a horizontal spindle which passes through this hole. This spindle is mounted on a U-shaped piece of brass, and to this is fixed a piece of steel forming a vertical spindle, as shown in Fig. 2. The steel spindle, which is vertical, turns freely in a piece of brass tubing fixed in the wooden pillar of the apparatus, thus making a universal joint for the gyros and brass rod part of the apparatus. The central vertical pillar is merely a piece of broomstick let into a block of wood, glued and nailed on to a piece of three-ply wood 10 in. in diameter. The height of the wooden pillar is 13½ in., and the length of the brass rod is nearly 16 in. A paper clip, which acts as a weight, is attached to the brass rod and by shifting it the apparatus can be made to balance or have a tendency to fall *on either side.* Since *both* gyros are used for only one experiment it is sufficient to mount one gyro for all the others, and fix on a weight to balance the gyro, when the clip is near the centre of either side of the rod.

Experiments 1 and 2

Spin one of the gyros so that it turns clockwise as seen from the centre and move the clip, thus making one end descend. Release the rod when it is in a horizontal position, and without being pushed it will turn round in an anti-clockwise direction as seen from above.

If given a horizontal push with a T square as shown in Fig. 1, the clip having been shifted so as to make the rod and gyros balance, it will dip down.

Further Experiments

Repeat experiments 1 and 2, but with the gyro spinning in the opposite directions. Notice carefully what happens.

Spin the gyro, the brass rod and gyros being balanced, and give the arm (1) a vertical push down (not a hard one), (2) a vertical push upwards. Note in which direction the arm and gyros move. You will be struck by the crab-like action of the gyro in these experiments. A moderate rate of spin is all that is necessary.

Experiment 3

Spin the gyro, rather harder this time, and grasp the apparatus by the brass bracket at the top of the wooden pillar *and by the wooden pillar as well;* you do the former to prevent the steel spindle (Fig. 2) from rotating and the latter to raise the entire apparatus from the table. Stretch out your arm and turn round, first in one direction, noting carefully that every time you reverse your rotation the arm carrying the gyros swings over in a vertical plane as far as it can go, and that it will do this, or tend to do so, no matter how slowly you may try to reverse your rotation. Note carefully in which direction the gyro is rotating and you will find in these experiments that the gyro is always quite consistent, and that the following rules apply in every case:

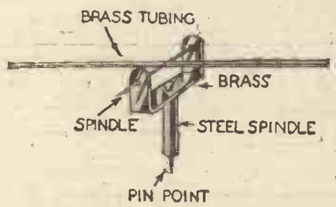


Fig. 2.—How the spindle is mounted on a U-shaped piece of brass.

(1) *The direction in which the gyroscopic axis sets itself is such as to put itself in better agreement with the axis about which it is rotated,* (2) *and the tendency of the gyroscope is to set its spin in the same direction as that in which it is rotated.*

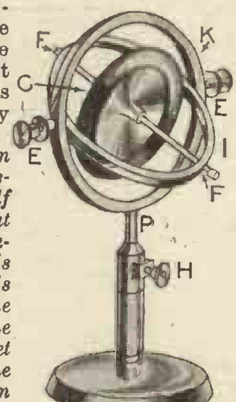


Fig. 3.—Showing a compound gyroscope.

Now the earth is a rotating body, and we thus see that all rotating bodies, flywheels and others must all have a tendency to turn themselves towards the pole star and set their rotational axes parallel to that of the rotating earth on which they themselves rotate.

Experiment 4

Spin the gyro briskly and, grasping the wooden pillar in one hand, arm outstretched, set the rod (balanced) so that it points at some distinct object in the room, and turn round completely several times, and you will find at the end of your gyrations, if you stop in the same position you started from, that the carrying rod and gyros still point at the object, the objection that the gyro disc has to change its plane of rotation being sufficient to overcome the friction at the constraints of the universal joint.

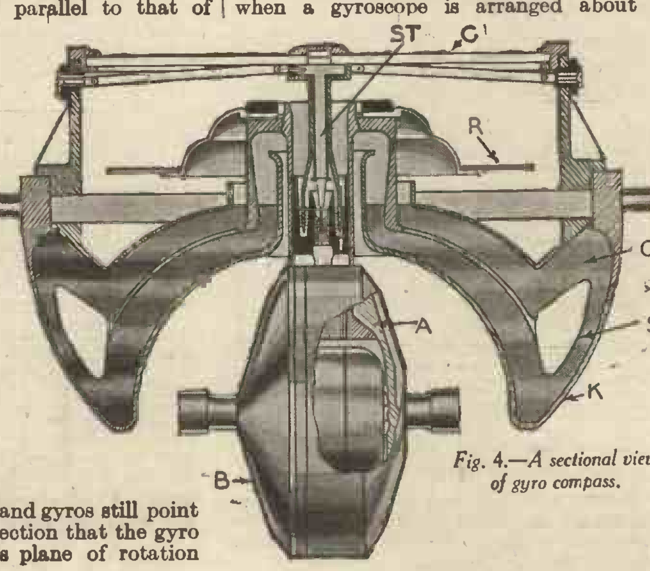


Fig. 4.—A sectional view of gyro compass.

Experiment 5

As a final experiment with this apparatus (provided you have two gyros, as in Fig. 1) spin *both* gyroscopes as follows: Wind up both in the same direction, using the same length of string for each gyro, spin one after the other as quickly as possible and give as near as you can the same pull in both cases. You will find that *all gyroscopic action has disappeared,* one gyro cancelling the effect of the other.

The Compound Gyroscope

Fig. 3 is an illustration of a standard compound gyroscope. G is the heavily-rimmed rotating disc turned up absolutely true and balanced; I is the inner ring, containing the pivots or bearings on which G rotates; K is the outer ring, in which are fixed the pivots E and E, which have binding screws attached to them so that the inner ring H can be clamped in any position if desired. P is a vertical spindle on which the whole apparatus so far described can turn, and H is a clamping screw by which this turning or rotating movement can be prevented if desired. Now if you screw H up so as to prevent P turning and spin the gyro and perform experiment 3, FF will turn a half somersault every time you reverse, setting FF vertical, which remains so as long as you continue turning in the same direction, but the two F's will at once reverse their positions as soon as you reverse.

By hanging weights on either end marked F you can repeat the earlier experiments described above, the gyro obeying the same laws as those shown in Fig. 1. Having spun the gyro (EE and H *unclamped*), give the ring a smart light blow; the whole apparatus will quiver like a jelly.

How the Gyroscope Steers a Torpedo

It will be seen from experiment 3 that when a gyroscope is arranged about a universal joint so as to have three directions of movement and is spun, it will continue to point in the same direction in which it was pointed originally, so long as the spin is maintained. Originally the apparatus was used for torpedoes and worked as follows (now it is practically all done by electricity, but the principle is the same). When the torpedo passed through the firing tube a projecting trigger caught against a bolt in the tube and released the steel spring which spun the gyro. Suitable mechanism was provided, by means of which the gyro axis pointed in the correct direction when spin commenced. Whilst travelling through the water it still continues to point in this same direction. Any duration of the torpedo only changed the position of the torpedo relative to the gyro axis or *vice versâ*.

Fitted into the torpedo in such a position as to be affected by the changes were two valves connected with a compressed-air reservoir, by means of which the torpedo's screws were driven. Normally, both valves were shut, but when the torpedo swerved one way or the other one valve was opened, with the result that air was admitted into a cylinder in such a way as in one case to move a lever which actuated a vertical rudder so that when the torpedo swerved to starboard the rudder steered to port and *vice versâ*.

The real path was then not a perfectly straight one, but a zigzag a foot or so broad.

And lastly a few words about the gyro compass now employed to steer all the largest and best ships and many others, which is probably the most successful practical application of the gyroscope (see Figs. 4 and 5).

Fig. 5.—The complete gyro compass.

It is mounted (see Fig. 4) in such a way that if the gyro disc were not spinning and the system were disturbed and then left alone, it would swing back to its original position with its axis horizontal. Fig. 4 is a vertical section through the apparatus; B is the case carrying the gyro bearings and is supported by a vertical spindle ST below the float S. This float consists of a circular hollow metal ring attached to a dome-shaped upper part. K is a circular bowl full of mercury in which the metal ring, etc., floats. R is the compass card rigidly attached to the system. The gyro axle is under the north and south line of the card. G is a projecting glass cover, and any tilting of the system is shown by means of a spirit-level suitably mounted. The containing bowl is fitted on gimbals in the usual manner, special means being adopted, in the manner in which the outer ring is mounted in the binnacle case, to protect it from all outside shocks as far as possible. The gyro compass is therefore really a liquid compass, in which a rapidly revolving gyroscope, axis pointing N. and S., replaces the ordinary magnetic compass, pointing truly N. and S. The gyro is electrically driven at the respectable speed of 20,000 revolutions a minute. At this speed the stress on the rim is 10 tons per square inch. The normal speed of the rim of the gyro is 340 miles an hour, quite a fair speed, even in these fast days. No less than 95 per cent. of the energy of the spinning gyro is absorbed in air friction. Special means are adopted for damping out the swinging motion of the system; this was one of the greatest difficulties that had to be overcome. Actually, use was made of the air carried round by the gyro to accomplish this.

The gyro compass is marvellously accurate; under favourable conditions an accuracy of 1 degree in either direction can be reckoned on; under unfavourable conditions an error of 2 degrees in either direction may occur. It is entirely free from lag, and its directive force N. and S. is fifteen times greater than that of the magnetic compass.

GOLD BEATING

(*Continued from page* 480.)

with only an 8-lb. hammer (a far too heavy tool still for most people!) has to stand five hours of pounding.

The great "snag" in the process of gold-slogging, quite apart from the great and necessary individual skill of the worker in obtaining a perfectly even foil, of course, is the fact that the leaves of the "mould" have to be perfectly dried between successive lots of beating. How any moisture can get in between those damp-proof layers in spite of the continuous pounding they receive, beats the ordinary intellect. The fact remains that it can, and does. And if it does, the foil will stick to the skin, have to be scraped off each one of the 1,000 one by one, re-melted, and the seven or eight hours of skilled work will have been wasted. For this reason the mould, immediately before use, is placed in a little heated press. On taking the pack out of the press, each one of the 1,000 sheets of skin has to be lifted, for the steam to escape, before it can get cold and condense again into surface moisture. This is indeed a performance of skill, and as the escaping moisture is invisible the worker has recourse to another sense than sight. Fortunately the heated skins give a peculiar and characteristic smell to the escaping steam, and his nose is as important as his rapidly moving fingers to the workman at this stage. When dry, each single sheet of the "mould" is dusted over with French chalk, to cause the foil, as it spreads in the course of beating, to slide sweetly, and nothing but a genuine hare's foot is ever used for the purpose of brushing on this powder.

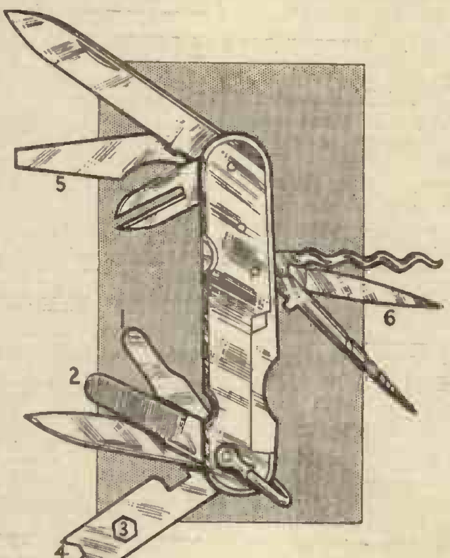
After beating, the gold leaf is cut, usually into small squares, and placed between the leaves of a little paper booklet.

The tools used in cutting, and in handling subsequently, like those used in beating, are in close resemblance to those used hundreds, possibly thousands, of years ago. The cutting tool is called a "waggon." This carries two sharp parallel wooden reeds, with which the roughly shaped foil, as it leaves the mould, is cut first one way, and then across, to produce a square. This cutting operation is performed by girls on a leather cushion, on to which the foil is lifted from the "mould" by means of boxwood tweezers, reminiscent of chopsticks, and it is spread flat by the aid of a gentle breath. The foil is so thin that a single ounce of gold, if laid out flat, will cover 200 sq. ft., or the floor of a really large room. In a ¼-in. wide lining reel, an ounce of gold will cover nearly a mile.

A Review of the Latest Devices for The Amateur Mechanic. *The address of the Makers of the Items mentioned can be had on application to the Editor. Please quote the number at the end of the paragraph.*

Everything for the Motorist

A TOOL which can easily be carried in the pocket and which fulfils a number of different purposes is a valuable accessory to the keen motorist, and will no doubt save much time and temper on many occasions. The instrument illustrated has a gauge for the magneto contacts, a file for cleaning platinum contacts, a device to enable the contact-breaker to be held whilst adjustments are made, a hollow punch for cutting holes in leather and a turnscrew and crown bottle opener. The complete instrument costs 13*s.*, post free. [66.]



A useful combination penknife for the handyman.

A Simple Hand Counter

THERE are many occasions when it is found necessary to keep a record of some sort where counting would be tedious. For example, the passage of vehicles past a certain building; the number of revolutions made by some piece of machinery; a record of outgoing telephone calls, etc. The little device shown herewith consists of a metal container, similar to a watch, with a small metal plunger at the upper side. When this is depressed and released the units figure in the centre of the device moves up 1. Every complete depression of the plunger gives an additional unit, so that it is a simple matter to keep a record of even quickly moving objects. The counter records up to 999, when the numbers return to 000. The price is 15*s.* [67.]

A simple hand counter—useful for a number of purposes.

A Lawn Mower Sharpener

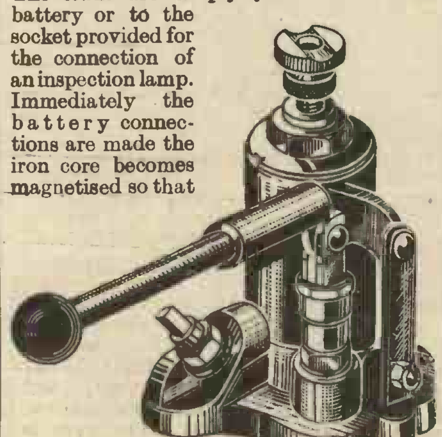
THE lawn mower naturally becomes dull after continued use, and although it is possible to resharpen the blades with a whetstone, it is necessary to preserve the cutting angle, and this is not a simple matter unless proficient at this particular business. The handy device shown on the next page enables anyone to carry out the sharpening process without experience, the arrangement of the abrasive material being designed to ensure that the correct angle is maintained. It is simply slipped over the edge of the cutter and drawn backwards and forwards, a few rubs sufficing to produce a keen edge. The sharpener will last a lifetime, and costs only 2*s.* 6*d.*, post free. [70.]

Handy Hydraulic Jack

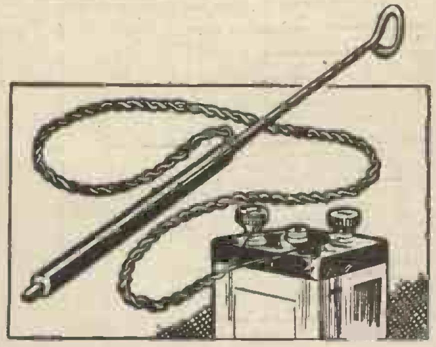
WITH the introduction some years ago of portable jacks operating on the hydraulic principle, the jacking-up process of a car was made much less laborious and more rapid. That shown here is designed for use with small and medium-sized cars. Constructed with very substantial castings and fittings, it is extremely robust, and yet it is compact and, therefore, can be kept in the tool locker of a small car without difficulty. As can be gathered from the illustration, this jack is operated by a hand lever, it being only necessary to move it through a few up-and-down strokes to obtain the required lifting movement. To lower it, the lever is detached from the operating arm and used as a key to open the release valve, the extension of which is seen immediately below the lever. The height of this jack when closed is 6½ in., and it extends, with an extension piece, to 12 in. The price is 25*s.* [68.]

Retrieving Small Parts from the Engine

A MAGNETIC device just received for test will be much appreciated by a number of amateur mechanics who do much of their own work on the car. The "Magnetic Retriever" illustrated on the next page consists of a powerful electro-magnet to the end of which is attached a long hooked handle and a pair of flexible leads. The leads are simply joined to the car battery or to the socket provided for the connection of an inspection lamp. Immediately the battery connections are made the iron core becomes magnetised so that

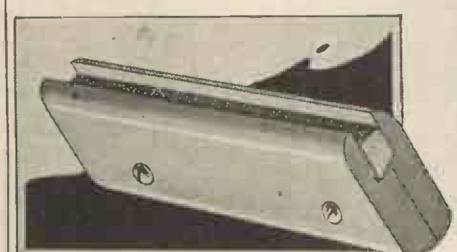


Quick action and ease of operation are the principal features of this compact and powerful hydraulic jack.



Named the "Magnetic Retriever," this electro-magnet saves much time and trouble in recovering small metal parts inadvertently dropped in awkward spots.

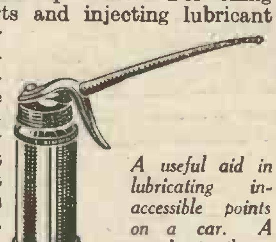
it can be used for picking up small screws, nuts, etc., which have been dropped into the engine tray, clutch casing or other inaccessible part of the engine. The handle can be bent or twisted as desired so that the magnet can be used in the most difficult corners. Needless to say, the retriever can be used under water, petrol or oil, just as readily as in open air. Its current consumption is negligible and the device can be operated from any accumulator of 2, 4, 6 or 12 volts. When the latter voltage is employed parts up to ½ lb. in weight can be lifted. The price is 6s. [69.]



A sharpener for a lawn-mower.

Pistol-grip Oil Gun

THE practical motorist will be attracted by the handy Wesco oil gun which is illustrated here. As will be seen, it is operated by a trigger, actuation of which forces the lubricant through the nozzle under considerable pressure. For oiling inaccessible parts and injecting lubricant into partially choked and restricted oil-ways, this type of gun is obviously very effective. It has a ½-pint capacity and is listed at 3s. 3d. [71.]



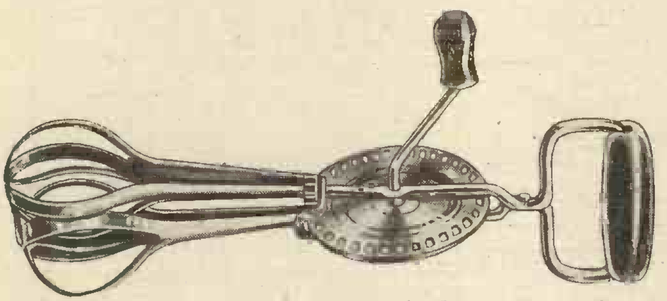
A useful aid in lubricating inaccessible points on a car. A pistol-grip oil gun.

The Latest Novelties

The address of the makers of any device described below will be sent on application to the Editor, PRACTICAL MECHANICS 8-11, Southampton St., Strand, W.C. 2. Quote number at end of paragraph.

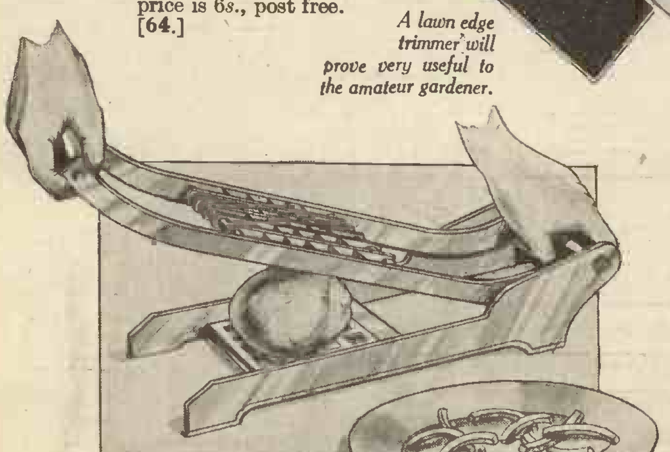
A Novel Egg Beater

MOST housewives can beat an egg quickly and thoroughly with an ordinary fork, but there is much to be gained by using one of the special beaters prepared to avoid the risk of splashing, and also to ensure a thorough mixing of air with the beaten egg. With the beater which is illustrated, the egg may be more thoroughly beaten in an extremely short time, owing to the high gearing, and only half the usual time need be spent on the task. Furthermore, owing to the fact that the apparatus is made from stainless steel, the cleaning difficulty is removed, the apparatus being simply rinsed in hot water immediately after using and all the dirt is instantly removed. The gears are thoroughly protected and cannot slip or get out of order. The price is 6*s*., post free. **[64.]**



An ingenious egg beater.

A lawn edge trimmer will prove very useful to the amateur gardener.



A device which facilitates the cutting of chip potatoes.

A Lawn Edge Trimmer

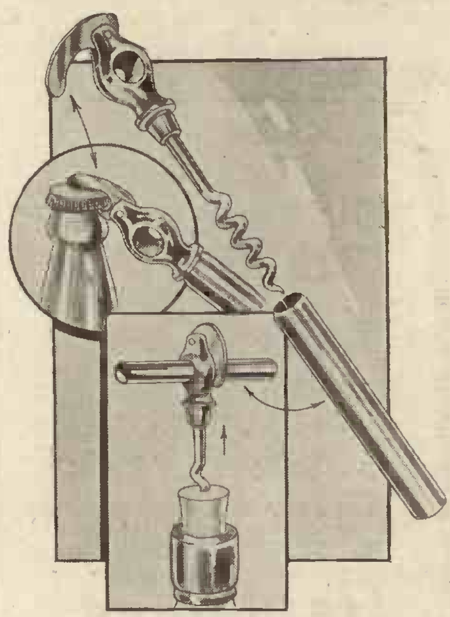
THE average gardener is content to go round the edge of the flower-beds with an edging tool, but unless keen of eye, the result can be far from good. True, a board may be laid as a guide, but the process takes time and consequently is only carried out at infrequent periods, with the result that the edges never look really trim. With the edge trimmer illustrated, all difficulties are removed, the machine being laid against the edge and pushed along after the manner of a lawn mower. It is moved backwards and forwards a few feet at a time, and owing to the roller and the arrangement of the cutting edges a perfectly straight and clean edge is made. If desired, a box may be fitted to catch the clippings. At 2 guineas this is a very useful instrument, and if it is used after every mowing of the lawn, it will be found necessary only to use the "half moon" or other cutting device about once or twice a year in order to keep a really tidy and smart garden border. **[65.]**

For Chipped Potatoes

ALTHOUGH appreciated by many, chips are not easy to cook in the home, owing to the fact that they are usually prepared by slicing a potato, and they do not have the same appearance as the chips with which we are familiar in the restaurant. With the aid of the handy instrument depicted at the foot of the first column, a potato may be converted into a number of chips merely by the pressure of the hand, and an advantage claimed for this apparatus is that it cuts them on a curve, rendering a shorter cooking time necessary. The cutters are well tinned and rust-proof, and it is British-made throughout. The price is 3*s*. 11*d*., post free. **[66.]**

A Double Purpose Corkscrew

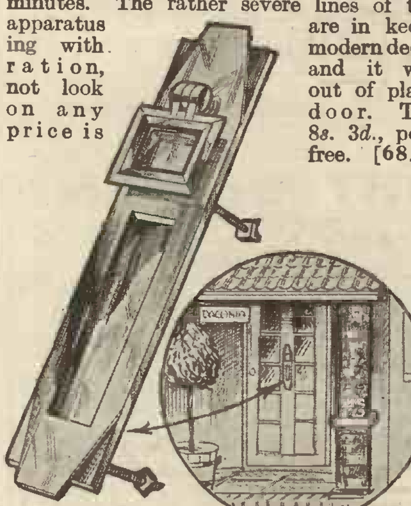
THE type of bottle cap known as a crown cork is always difficult to open unless the correct key is at hand. The device shown embodies, in addition to the usual spiral corkscrew for drawing corks, a simple arrangement which enables crown corks to be removed, and it thus serves a dual purpose. The sharpened end is protected, when not in use, by a metal cover, and this is passed through the hole in the upper portion to serve as a handle when the corkscrew is in use. A handy and cheap device, which costs only 1*s*. 9*d*., post free. **[67.]**



A corkscrew for removing corks and caps.

A Useful Letterbox

MANY doors to-day are furnished with a rather narrow stile, and the problem of fitting a receptable for letters, as well as a knocker for callers, is not always easy of solution. A novel combined device is shown at the foot of this page, and it incorporates both of the above-mentioned pieces of apparatus, as well as a door pull. Two holes are necessary for retaining bolts, and the fitting should not take many minutes. The rather severe lines of the apparatus are in keeping with modern decoration, and it will not look out of place on any door. The price is 8*s*. 3*d*., post free. **[68.]**



A useful and neat type of letterbox.

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If a postal reply is desired, a stamped addressed envelope must be enclosed. Every query and drawing which is sent must bear the name and address of the sender and be accompanied by the coupon appearing on page iii. of Cover. Send your queries to the Editor, PRACTICAL MECHANICS, Geo. Newnes Ltd., 8–11 Southampton Street, Strand, London, W.C.2.

Stratosphere Effects

"I HAVE read the article on 'Stratosphere Effects' in your excellent magazine (quite the best in its class), and think that the miniature transmitter would be useful for some experiments I intend to make.

Could you supply details about

"(i.) The number of turns on the coils and condensers so as to give a wavelength of between 280–400 metres?

"(ii.) Is a piezo-electric crystal an ordinary crystal used in crystal receivers?

"(iii.) The nature of the control operated by the barometer?

"(iv.) The ratio of the transformer?

"I shall be very much obliged if you can answer these queries for me." (J. H., Northants.)

The "Radio-Sondes" described in the article are those used by the Russian Government in their recent stratosphere investigations. They are kept more or less "secret," so that precise constructional details are not available.

The wavelengths mentioned by you are on the long side, as the size of the trailing aerial must be kept down to reduce weight. For the closed circuit a coil of twenty-five turns on a 2-in. former with a fixed condenser of 0·0002 mfds. would give you a wavelength of 280 metres.

Any fairly robust crystal would do, as the power output is small.

A 500 to 1 step-up transformer would be required for the voltages mentioned in the article.

The barometer-tone control is effected by causing the level of the mercury to change the level of the oil in a dash-pot arrangement in which part of the tumbler reed is immersed. This alters the damping of the reed and therefore its periodicity.

A Foreign Correspondent

A. E. McCloune, 1 Clyde Street, Portrack Lane, Stockton-on-Tees, Co. Durham, would like a foreign correspondent (preferably a French boy or girl aged about nineteen) to get into touch with him.

No Coupon Attached

"Would it be possible to supply me with the following addresses as mentioned in the June edition of 'Practical Mechanics' on the 'Month's Science Siftings'? A carpet beater by a Keighley firm for 1s. 3d. Glass curtains by a Lancashire firm. A flying bicycle by a German policeman." (B. T., Liverpool.)

We cannot answer your question as you omitted to enclose a coupon and stamped addressed envelope.

Lithography

"After reading in the March issue of 'Practical Mechanics' the article on Lithography, by S. J. Garratt, I am writing you for advice.

"I have half a dozen leather-covered rollers which were used by an apprentice and are in good condition. As they are now lying idle I should like to dispose of them. Could you please advise me the best way to do this?

"They could be secured for a very reasonable sum and would, no doubt, prove very useful to anyone in the trade, or an amateur.

"Trusting you will be able to do this, and thanking you in anticipation." (H. M., Manor Park.)

We think the best way of disposing of your lithographic rollers would be to offer them to a litho printer at a reasonable price. We do not think you are likely to get more than a few shillings each for them second-hand.

Staining Clear Celluloid

"Can you please inform me how to stain clear celluloid an opaque orange colour, as used in motor car direction indicators, or where I could purchase the celluloid ready made, thanking you for any advice you can give on the matter." (E. H., Manchester.)

Celluloid is stained in process of manufacture. Clear celluloid may be frosted, either mechanically, by rubbing it down with fine valve-grinding compound, or chemically, by rubbing lightly with an acetone-soaked rag. It may be stained by either painting or spraying with a cellulose enamel of the desired colour suitably thinned. Why "opaque orange colour"? Surely direction indicators are either transparent or translucent, since they are illuminated from behind.

I strongly recommend querist to buy his material ready made, and certainly do not recommend celluloid. This substance is almost out of date. The new "non-flam." celustoid products are fast replacing it.

Decomposition of Water

"I read with interest an article which appeared in your October issue, namely, 'The Decomposition of Water by Electricity.' I would like to carry out the experiment on a larger scale, *i.e.*, to produce a larger quantity of the gases. Could you give me some idea of the apparatus I should need to do same? Also can you oblige me with the name and address of a firm who will supply me with 6 ft. of Balsa wood, $\frac{1}{32}$ in. × $\frac{1}{16}$ in.? (B. C., Lancs.)

In order to produce a large quantity of oxygen and hydrogen by the decomposition of water electrolytically, a large tank is required equipped with two collecting towers which also house the electrodes, which may be of carbon. The tank and towers are filled with water slightly acidulated with sulphuric acid and the current switched on. From 2 to 5 amperes at 20 volts pressure should be passed, control being exercised over the amount of current being passed. If this is excessive the water becomes heated and boils. The generated gases gradually displace the water in the towers, and they may be drawn off from time to time and pumped under pressure into storage tanks. This is not an economical method for the large-scale production of H and O.

Patent Advice

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How to Apply for a Patent

An Application for a Patent, stamped £1, may, in an ordinary case, be accompanied either by (*a*) a Provisional Specification (no stamp), or (*b*) a Complete Specification, stamped £4. It is usual to apply with a Provisional Specification, the advantages being the small initial cost and the opportunity for working out details which latter may be incorporated in the Complete Specification to be filed at any time within the following twelve months (or thirteen months with extension fee), assuming the applicant wishes to proceed. If, however, the invention is fully developed, then a Provisional Specification may be dispensed with and a Complete Specification may be filed straight away. Complete Specifications of mechanical and electrical inventions require, usually, to be accompanied by drawings.

The Patent Office does not require a model, but if time and other circumstances permit it is often advisable for the inventor to construct one so that he may be in a position to describe in his Specification the best form of his invention known to him.

The Patent Office does not make any search, as to novelty, on Provisional Specifications, but only on Complete Specifications. If time permits it is generally advisable to have a search made before applying for a Patent.

Who may Apply for a Patent

Disregarding inventions coming from abroad, the true and first inventor's name must be in the Patent Application, but he or she is at liberty to apply for the Patent jointly with any other person or with a firm, partnership or company.

In cases where financial or other assistance has been rendered by a capitalist, employer, etc., the Patent is often applied for in the joint names of the parties interested.

Where two or more parties decide to apply for a Patent it is prudent for them clearly and at once to define their respective rights by means of a written agreement.

The Position of Employee and Employer

An employee who brings out an invention even although he may have done so in his master's time, is entitled to apply for a Patent. Further, he may be entitled to the benefit of the Patent unless this would inflict an injustice on the master in view of the relations between them, such, for example, as a high salary and the confidential character of the employment, or a contract, express or implied, between them, in which cases the Patent may be obtained by the employee in trust for the employer. The Solicitor-General, in *re* Heald's Patent (1891, 8 P.O.R. 430), said: "I am not aware of any authority which lays it down that the invention of a servant, even made in the employer's time, and with the use of the employer's materials and at the expense of the employer, thereby becomes the property of the employer, so as to prevent the person employed from taking out a Patent for it."

If, however, the master suggests the main idea and the employee, in carrying it out, merely incorporates small improvements, the master's name must be in the Patent Application. If the master and servant have jointly produced the invention, both of their names must be in the Patent Application, and, if the master is to receive the sole benefit of the Patent, the Patent can be granted solely to him.

Single Patent for Cognate Inventions

It sometimes happens that, as a result of experiments, certain improvements, which are not covered by the original Provisional Specification, are made. In such a case a further Provisional Specification (or more than one) may be filed, and when concurrent Provisional Protection has been obtained on two or more Provisional Specifications in respect of inventions which are cognate or modifications one of the other, and which constitute a single invention, a single Complete Specification may be filed and a single Patent may be obtained.

Official Investigation and Sealing of Patent

The official search made in connection with Complete Specifications usually results in the Examiner referring the applicant to prior knowledge disclosed in one or more Patents and sometimes also in other documents. This is an objection which generally can be overcome by curtailment of the applicant's claims.

When the official objections (if any) have been overcome, the Complete Specification is "accepted" and laid open to public inspection so as to give any interested person an opportunity to oppose the grant of a Patent if he can bring himself within certain specified grounds of opposition.

In normal cases, and reckoning from the date of application, the period allowed for "acceptance" of a Complete Specification is eighteen months (extensible with fine to twenty-one months) and for sealing of a Patent, twenty-one months (extensible with fine to twenty-four months).

Duration of Patent

Patents are granted for the term of sixteen years, reckoned from the date of application, subject to the payment of annual renewal fees commencing before the expiration of the fourth year. (The date of application in the case of Patents granted under the provisions of the International Convention is to be taken as the date of the first foreign application.)

Foreign Patents

An International Convention, of which the important countries of the world are members, exists, and under it the applicant has the right, within one year of his date of application in this country, to apply in any of such countries and claim a priority date based on his application in this country. This is an important point as otherwise public knowledge of the applicant's invention might prevent his obtaining certain foreign Patents or, if obtained, they might be rendered invalid.

MODELLING HISTORIC LOCOMOTIVES.

(*Continued from page 474.*) PART III.

frame. The cylinders had a diameter of 11 in. and a stroke of 16 in. Driving wheels were 5 ft. in diameter. The boiler barrel measured 6 ft. 8 in. by 3 ft. ½ in. diameter. Firebox 2 ft. 3 in. long by 4 ft. 3 in. wide. The weight was 8 tons.

In my drawing I have shown the timber outside frames covered from end to end by iron plates, but it is not certain whether they were so covered in the original Planet, or whether the horns were the only plates bolted on. These horns were certainly applied separately. In all subsequent engines of the Planet type the timber was covered with iron plate, as shown in my drawing.

Many locomotives were built by Robert Stephenson & Co., of the new class, for the Liverpool and Manchester, the Glasgow and Garnkirk, the Leicester and Swannington and other railways as well as by such firms as Fenton, Murray and Jackson, and other builders who worked from Stephenson drawings. In fact, the design, with sundry improvements, became almost standard for a number of years except that four-coupled as well as single-driver engines were constructed.

The Patentee, 1833

Within a short time of the inauguration of the Planet type it became evident that the increasing weights were too much for the permanent way of that time, and it became necessary to add a pair of wheels behind the firebox. In 1833, Robert Stephenson took out a patent for a new type on six wheels, and both single-driver and front four-coupled locomotives were built. It appears to be probable that two engines, both four-wheeled coupled, the Goliath and the Samson, on the Leicester and Swannington Railway, were the very first to have six wheels, excepting, of course, one or two very early experimental machines and Hackworth's contemporary engines. According to the late C. E. Stretton, these were already in service on four wheels, but being found unstable, were altered by Stephensons, who had supplied them, in the early part of 1833.

The first 2-2-2 type engine for the Liverpool and Manchester Railway was named Patentee, and is illustrated in Fig. 9.

The four-coupled engines, 0-4-2 type, were exactly similar except, of course, that the leading wheels were of the same diameter as the drivers, and coupled to them by rods and cranks outside of the axle-boxes.

Six-coupled goods engines were soon in demand, and became standardised within a year of the granting of the patent rights.

It is perhaps needless to point out that the great advantage which at once accrued from the introduction of the axle behind the firebox was that this part of the boiler could be considerably lengthened, thus increasing the effective grate area and heating surface.

In Fig. 9, which is largely copied from the original Stephenson drawing, made probably in 1833, the reader will notice a most interesting feature, namely, the provision of brake blocks between the driving and trailing wheels applied by steam cylinders. A pair of these cylinders were fitted, one on each side of the engine, steam to both being admitted through one valve or cock placed within reach of the driver on the top of the firebox. Strangely enough, this remarkable invention does not appear to have been put to any extended use, although its advantages should have been at once evident.

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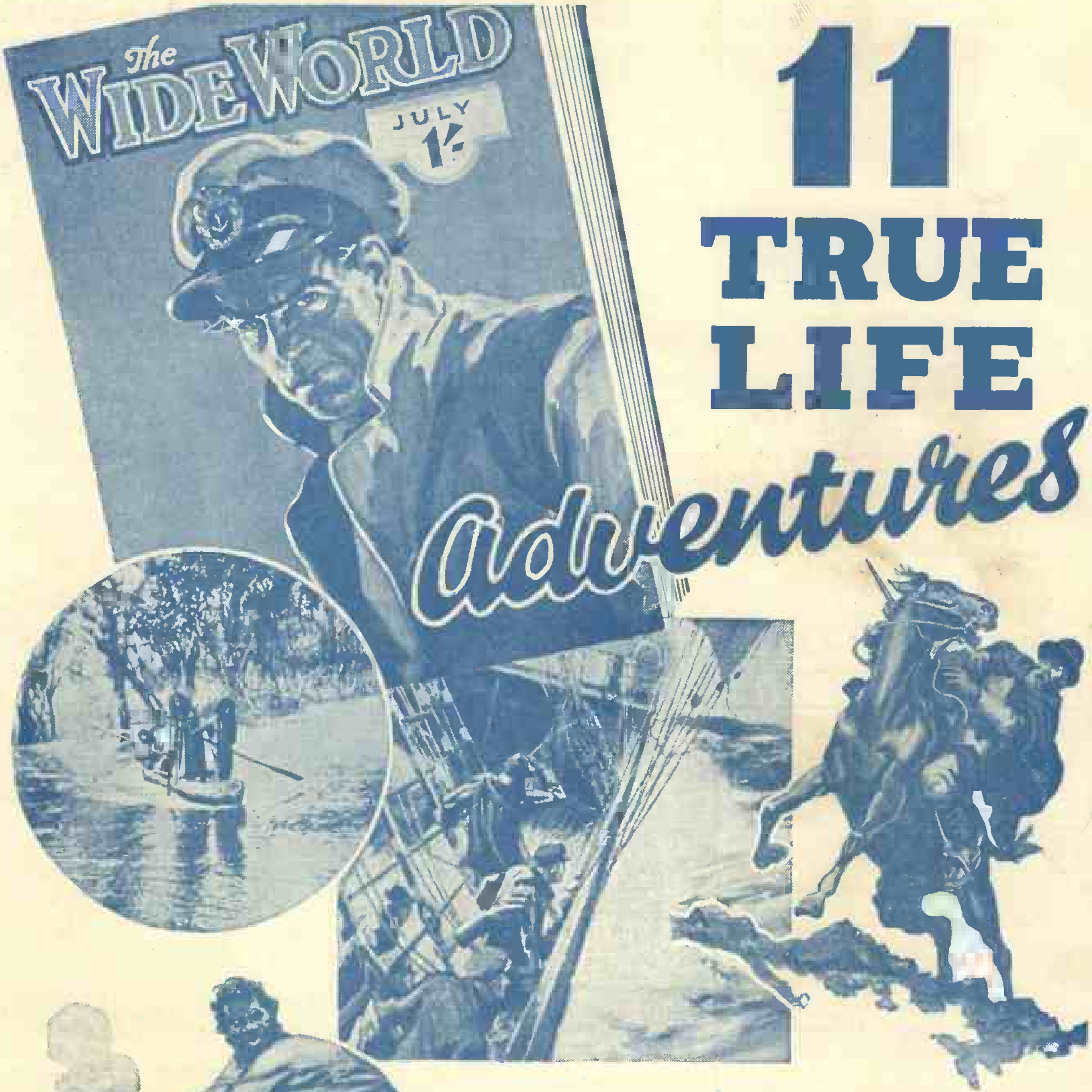

11 TRUE LIFE *Adventures*

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