TELEVISION IN THE CINEMA

NEWNES

PRACTICAL MECHANICS

MARCH

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EDITED BY F. J. CAMM

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PRACTICAL MECHANICS

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Fair Comment

By The Editor

A Note to Intending Contributors—

FROM time to time I receive from readers of this journal enquiries as to whether they may contribute an article on a particular subject. Whilst I am always delighted to encourage contributions from my readers, and indeed I give them first and earnest consideration (I can modestly claim to have trained many successful journalists of to-day), I always require to know what experience and training the intending contributor has, and what authority he can bring to bear in writing upon the particular subjects. It is an unfortunate fact that there are many hack journalists who merely visit libraries or regurgitate material from other publications without knowing in the least what they are writing about, or whether the information they are paraphrasing is up to date or has been superseded. In some cases, I regret to say, contributors without scruples will not hesitate to copy an article word for word without even going to the trouble of re-writing it. They seem to be particularly careless with the truth, and have no regard for the copyrights of other publishers.

It is most necessary that a contributor should have had experience of the subject before writing about it. It is his *experience* which makes his manuscript valuable, for unless he has invented something or discovered some new method he must for a large part draw upon the world's heritage of knowledge. Unless experience can colour your manuscripts it would be sufficient for a scholar merely to contribute notes from his lessons.

A contributor the other day took offence at my request for details of his experience. He wished to write about wireless control of models—a most involved subject which does not lend itself to practical experiment except by those who possess a transmitting licence and a fair amount of money. In his annoyance this reader disclosed the accuracy of my judgment in declining his services. He apparently is of the opinion that even unknown persons should be taken for granted. Of course, if a contributor has attained a reputation, such questions are unnecessary, and a man who knows his subject will be delighted to answer any questions as to his experience and ability. Annoyance at such a request merely indicates that the shaft has gone home. It is a theatrical display of artificial indignation which some try to make effective in disarming too shrewd a criticism.

To intending contributors I should like to offer some helpful advice. Do not write on both sides of the paper; leave ample margins on each side of the sheet; use wide spacing to permit of editorial marks; append your name on the top left-hand corner of the first sheet of manuscript; enclose a stamped envelope for reply; and give details of your experience and, where necessary, references. Rough sketches should accompany the manuscripts where necessary, and if the article describes a particular device which is to be made, it must first be made by the contributor and photographs of it should be sent showing that it has been made. Drawings, where the reader is able to make them, should be done in Indian ink on Bristol board (not cartridge paper). Drawings and photographs should be sent flat and not rolled. Articles are considered promptly and payment for them is just as promptly made. I have endeavoured to set a very high standard in PRACTICAL MECHANICS. I desire to publish only reliable and authoritative material. It is only by adopting the methods to which I have referred that this standard can be maintained. Hack journalists please note that I do not desire to receive contributions from them.

—And to Querists

A VALUABLE part of our reader service is our Questions and Answers department. The success of this journal is due to the prompt and reliable service we give. We desire, however, that querists will help us to deal with their problems by being as helpful as they can, and giving the full information to enable us to frame a useful reply. Some querists give but the scantiest details, some omit to sign their names and addresses, others forget to enclose the Query Coupon, a stamped and addressed envelope, and the necessary stamps, whilst others request constructional details which would require the preparation of a lengthy article and many diagrams. We would ask our querists to write on one side of the paper only, and to write queries on separate subjects on separate sheets of paper, appending their name and address to each. We do not undertake to value old coins or prints, nor to answer medical queries. I make these observations in the best interests of querists. I think it is true to say that there is no journal in the world which handles a greater variety of questions or which deals with them more promptly. It is seldom that a query is not answered by return of post.

A FURTHER reminder that we receive queries which, for want of a better term, I will liken to a recurring decimal. They crop up with unfailing regularity week after week, although the information has been given time after time in this journal. I do appeal, therefore, to readers to obtain copies of the annual indexes which we produce specially for their convenience. The preparation of an index is a tedious and costly undertaking, and whether you have your copies bound or not you should keep a folder of these indexes so that you can rapidly turn up a particular subject dealt with in past issues. The indexes cost 7*d*. each, or complete with binding case 3*s*. 6*d*. each, from the Publisher, Geo. Newnes, Ltd., Tower House, Southampton Street, Strand, W.C.2.

A new eye-testing apparatus for detecting imbalance. *See paragraph on next page.*

THE MONTH IN SCIENCE AND

A New Broadcasting House

THE B.B.C. Corporation have submitted plans to the Belfast City Surveyors Department for the construction of a new broadcasting house for the Northern Ireland Region in Belfast. The site chosen for the building, which will cost roughly £70,000, is at the junction of Dublin Road, Ormeau Avenue and Linenhall Street West.

Improved Television Service

APRIL will see the introduction of Sunday television transmissions. This will form the first step taken by the B.B.C. towards the improvement in the television service.

Seeing Stars

THE new Radcliffe Observatory in Pretoria is to be fitted with the largest telescope south of the Equator. The telescope was recently assembled at a Tyneside optical works. The duralumin tube measures 35 ft. and the telescope will have a 74-in. mirror.

"Flying-wing" Aeroplane

WITH a view to its possible development into a large liner, carrying passengers and cargo in its wing, the Bureau of Air Commerce at Washington are building a tailless plane. The plane, which will cost about £3,000, is being constructed at New Philadelphia, Ohio, and is of the "flying-wing" type.

Information Please!

NEXT year Londoners will find one more use for the telephone. By dialling "Ask" they will be able to ask such questions as the posting time for the next air mail, etc. The Post Office are setting up an information bureau in Central London where a large staff of experts will be employed in answering questions. No extra charge will be made for enquiries other than the usual penny call fee.

A Hot Machine

A MACHINE has been invented by Mr. J. H. Lee, of Watford, for smoking and breaking-in pipes. He states that four or five pipes of tobacco are necessary to condition a pipe.

L.N.E.R's 1938 Programme

THE L.N.E.R., in addition to building 125 locomotives this year, are also constructing 730 carriages, 10,240 wagons and 1,250 containers, and renewing 587½ miles of track and 70 bridges.

A New Power Station

THE opening of the power station at Chitaura recently by Sir Harry Haig, Governor of the United Provinces, marked the virtual completion of 18 years' work on the Ganges Canal Grid scheme. It has been designed to provide energy for agricultural machinery on private farms, electrify 88 towns and supply power for pumping from rivers for canal irrigation. The scheme cost £2,610,000.

Treasure Trove

A NEW attempt is to be made by a Dutch engineer to raise from the sea the millions of gold coins which are reputed to be on the bottom of Tobermory Harbour, Isle of Mull. The coins, which were minted when Philip of Spain was at war with Queen Elizabeth, were in a galleon which was sunk by an angry Highlander who could not get the money for goods he had supplied.

Atlantic Planes

THE Air Ministry, some time ago, gave an order for two Albatross Atlantic monoplanes, and the first of these is now nearly ready at Hatfield for delivery to Martlesham Heath, where R.A.F. pilots will try them out. These two experimental Atlantic planes are to be fitted with mechanical de-icers by the De Havilland Company.

The tail unit and the leading edge of the wings are the main features which must be given protection from ice-forming cloud, as, owing to the streamlined form of the plane, there are no extraneous surfaces to de-ice.

The New German Zeppelin

THE new German airship LZ130 is now nearing completion in the construction hangar of the Zeppelin Company. The light metal structure has already been completed, and about three-quarters of it have been covered with fabric. A feature is that water will be gained from the exhaust gases by chemical means. This will counteract the weight losses caused by fuel consumption.

A 14-ft. Electric Bulb

DEDICATED to the memory of Thomas Edison, an electric bulb, 14-ft. in height, has been constructed in America. It took eight months to complete, and in preparing the bulb for transportation more than 6,000 lb. of amber-tinted pyrex glass was fitted over a steel skeleton, which together weigh six tons. 960 incandescent electric lights with a 24-in. reflector are being fitted inside the bulb. It will be used for an aeroplane beacon, which when set up will be visible for several miles around.

Still Going Strong

A 300-YEAR-OLD clock with wooden works was recently unearthed from among a pile of rubbish in the Port of Elizabeth Museum. The clock is dated 1640, and now it has been repaired, keeps perfect time.

Huge Diamond Found

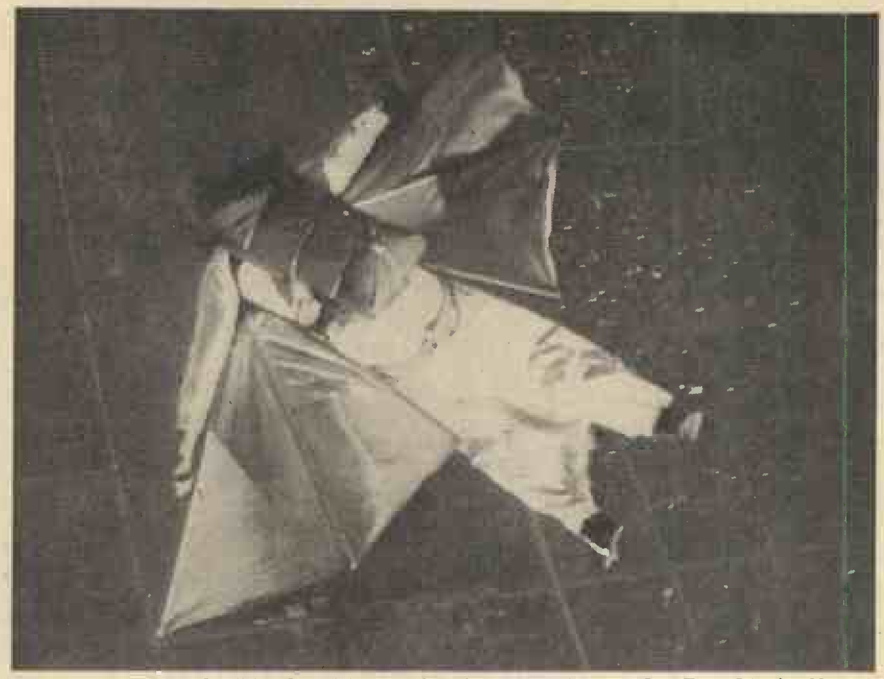
A PROSPECTOR at Coromandel, in the Triangulo Nuneiro, has discovered a huge diamond, the value of which is estimated at more than £52,000 after cutting. It was found near the spot where the famous diamond "Southern Cross" was discovered.

Foiling the Burglar

DEVICES for foiling the burglar have been described in these pages from time to time, and now one more has been invented by Herr Karl Novak, a young Viennese inventor. A box sends out infra-red rays, and a network of these are spread throughout the room to be protected, by means of special mirrors. As soon as the path of one of the rays is broken by a person passing through it a bell rings and warns the police.

Non-stop Atlantic Flights

IT is claimed of a huge flying boat just completed in Baltimore, U.S.A., for Russia, that it will be capable of crossing the Atlantic non-stop with a commercial load of passengers and cargo. 200 m.p.h. is given as its cruising speed, and it is capable of flying from New York to London in 24 hours, with reserve fuel left over for another 1,000 miles.



M. Morgan making his first "bat flight" from a cabin plane 10,000 ft. above Bay Farm Island. He uses bat wings 8½ ft. across, constructed of steel and aeroplane fabric attached to his arms.

THE WORLD OF INVENTION

The lightest broadcasting station.

Aluminium Funnels

THE new 30,000-ton *Mauretania*, now being built at Birkenhead, will be fitted with funnels made of aluminium. She will have two instead of the usual three or four.

World's Lightest Broadcasting Station

ON this page is shown Professor Anthony Easton, of the California Technology Institute at the radio receiving set, with a new parabolic reflectory antenna, enabling the operator to measure the direction of ascension of a radio-meteorograph, a radio broadcasting set that weighs less than one pound in weight, which has been developed at the California Institute of Technology at California, to be used for weather forecasting.

The radio-meteorograph, consisting of a delicately adjusted transmitter that broadcasts on a 1·5 metre band, is carried aloft by a balloon, to record the weather in high atmospheres during any kind of weather. It is equipped with a small barometer, thermometer and other devices, which broadcast signals to the ground, that are interpreted accurately in terms of atmospheric pressure, temperature, wind velocity and humidity by the ground receiving set.

Eye-testing Device

AT the recent eye-specialist congress held at the Egyptian University at Cairo, a new apparatus for testing the eyes was demonstrated by Dr. Erich Zeiss, grandson of the famous optician, Carl Zeiss. With the new apparatus, the use of exact filters, and the employment of the projecting method of test marks no external illumination need be depended upon any longer. Examination is made in a darkened room leaving only the coloured test-marks perceivable, an elimination is affected of the compulsive fusional movements and stimbulance of accommodation. By taking readings off a recording diagram an imbalance can be accurately identified, be it relation to the side or to the group of eye-muscles affected. (See picture on page 310.)

Magnesium

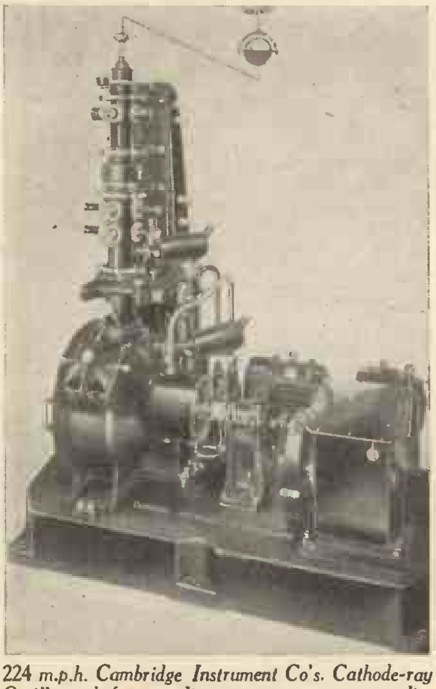
FROM being a laboratory curiosity used solely for making flashlights and fireworks, magnesium, the lightest of known metals, has become of immense and world-wide importance. It has become the chief constituent of the light alloys which are now required in vast quantities for aeroplanes. Alloyed with 10 per cent. of aluminium, it gives the light strong metal magnalium. It is made largely from magnesium chloride by electrolysis of the molten salt. Salts of magnesium are amongst the commonest of the constituents of the earth's crust. Sources of material are therefore not lacking. Water power generated electricity and big demand give cheapened production. A few years ago magnesium metal cost 25*s*. a lb., to-day the price is 1*s*. 3*d*.

New Mercury Vapour Lamps

THE ghostly blue light typical of the present mercury vapour lamps on our highways is a very definite drawback to this form of lighting. But scientists have overcome the disadvantage very quickly. They have perfected a method of chemical coating of the inside of the lamp with a compound which absorbs the blue light, and re-emits it with much more red and yellow rays.

Cathode-ray Oscillograph

THE cathode-ray oscillograph, which is now familiar as the final stage of television reception, finds many scientific applications. It can provide a visual trace of the passage of any electric current. The Cambridge Instrument Company have fitted one such instrument for the purposes of the study of current surge at the British Short-Circuit Testing Station at Hebburn-on-Tyne. One of the biggest difficulties in power transmission over electric grids is the momentary and swift passages of heavy currents when switches are thrown in or out. It is important to get exact knowledge of the extent of these current surges. They can be shown up on a cathode-ray oscillograph as zig-zag lines. But the lines may zig-zag back and forth as fast as 100,000 times a second, such is the speed of current surge across the poles of a switch. To record this terrific frequency it is necessary to photograph the lines of the oscillograph at enormous speed. This is done by winding a photographic film on a drum rotating in vacuo at the speed of 3,000 r.p.m. At every revolution the focus of the oscillograph is shifted one step along the axis of the drum. Afterwards the film can be removed, developed and projected at slow speed on a cinema screen enabling engineers to study in detail a flash of electricity which took only a fraction of a second to occur. In fact, when photographing the film travels at the rate of 224 m.p.h.



224 m.p.h. Cambridge Instrument Co's. Cathode-ray Oscillograph for recording current surge on power line switch gear.

A 4,000,000 cubic foot waterless gas holder.

Automatic Water Softener

IN West Chester a water softening plant has been installed which softens water automatically. It is a Permutit Base Exchange plant and performs the complicated operations of softening, regeneration and washing entirely by itself. It treats over 100,000 gallons per hour.

All-welded Gas Holder

WHAT must be the largest cylinder and piston in this country is really a new water-less gasholder erected at Ford's Dagenham works. The gas holder is a welded steel tower 185 ft. high and 126 ft. diameter. The welds are ground flush inside so that the interior is glass smooth. The gas is confined under a sliding roof which is nothing more or less than a piston fitting the cylinder exactly. Gas-tightness is secured by a flexible fabric packing ring round the piston. So tight is the fit that the holder is built by first laying down the piston, then building the walls round it. As the walls rise the piston is floated up by compressed air and acts as a construction platform. This gas holder will contain 2,000,000 cu. ft. of gas. It is a mere baby beside the one at the Dearborn works of Ford's in America. This, with a capacity of 22,000,000 cu. ft., is the world's biggest gas holder.

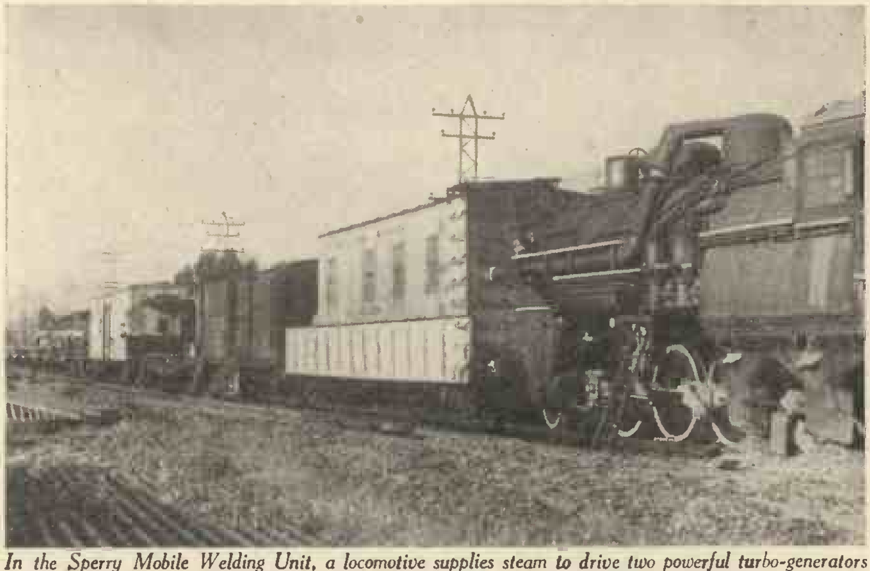
Hotel 1938

MECHANISED comfort describes the engineering layout of the new L.M.S. Queen's Hotel at Leeds. It is fully air conditioned and fully mechanised. Its ventilating fans aggregate over 100 h.p. between them. Its boilers generate 10,000 lb. of steam per hour, and they are automatically stoked by coke conveyor belts.

Rails 1,500 Feet Long

RAILS in 1,500-ft. lengths, flash welded from the standard 39-ft. lengths by a method developed by the Sperry Products Inc., will be laid in the tracks of the Delamar and Hudson railway. The development of the continuous rail now available for widespread use, gives promise of rivalling in importance to the railroads the development of the streamline train. The elimination of the sound of train wheels over rail joints, one click for each train-wheel and each 39 ft. of rail-length, is one factor. More important is economy, for those clicks cost money. The steady battering of the wheels ruins the rail ends. Some experts estimate that 45 per cent. of the cost of track maintenance is the expense of keeping up the rail joints.

For four years continuous rails have been used on test stretches of track in lengths of 6,700 feet. It was long believed that the contraction and expansion caused by temperature changes would make the continuous rail impracticable, but the test has shown that the weight of the long rail itself and the firm fastening of ties, well buried in ballast, solves this problem. Technical progress has reached the stage where it will be possible to fabricate a continuous rail reaching from New York to San Francisco. Railroad operating conditions, however, are such that it seldom is desirable to use a rail much over a mile in length.



In the Sperry Mobile Welding Unit, a locomotive supplies steam to drive two powerful turbo-generators which provide current for welding machine and auxiliary equipment. Behind the generator is a supply car, next comes a rack car carrying standard rail, followed by the welding car and a string of flat cars.

What Shape is the Earth?

Although Most People are Willing to Accept the Theory that we live on The outside of the Earth, There Are Some Who Argue Against This Theory

TO most people the very thought of questioning the facts of astronomical science seems almost like sacrilege. Who, for instance, would question that the earth is a planet which travels in an eliptical orbit around the sun; or that it is a solid oblate spheroid? These things are accepted generally, and form the basis for many logical deductions which are in turn accepted as facts, specially as these deductions agree very well with observation.

From time to time, however, there arise attempts to challenge these fundamentals. For instance, some years ago the "Flat Earthists" had a considerable following, but of recent years we have heard very little of them.

Since the advent of Einstein and Planck, scientists have been a little less sure of themselves than they were at the close of the last century. Astronomy has "grown up," and is reaching that mature state of mind when it realises how much it does not know. Theories which had come to be thought almost axiomatic are coming under critical scrutiny, and new theories of quite a revolutionary character are being quite calmly studied.

The "Inside Concept"

Possibly the most revolutionary of these is what has been called the "inside concept," with which is associated the field theory of the universe.

According to the "inside concept" the earth is a hollow oblate spheroid, of the shape and size accepted in orthodox geodesy and astronomy, but with a concave instead of a convex surface.

This at first sight appears quite ridiculous, yet when the theory is studied it is found that actually it is quite feasible, and well worthy of careful examination.

Immediately the "inside concept" is mentioned, dozens of objections to it are apparent. The well-known phenomenon of the ship disappearing "hull down" on the horizon; why can't we see right across to Australia? Where are the sun and the stars, and why are we not burnt up by their heat if they are contained within the hollow earth? The shape of the earth's shadow on the moon; and so on.

These, and a hundred other objections are easily explained by the field theory, and in addition some phenomena which have baffled astronomers and other scientists are cleared up in very elegant fashion.

Field Theory of the Universe

What, then, is this field theory? According to this theory, the earth is a hollow sphere, on the inside surface of which we live, and the sun, stars, and other heavenly bodies are near the centre. The space inside this sphere is not, however, euclidean space, as we presume the space outside our earth to be under orthodox theories, but increases progressively in density towards the centre according to a very simple mathematical law. This concentration of space has the effect of refracting light and other forms of radiant energy in such a way that objects near the centre are magnified through 180 degrees.

The basis of the field theory is illustrated in Fig. 1. If a point A outside a circle is taken at a distance OA from the centre, it is obvious that another point, B can be found inside the circle, at a distance OB from the centre, such that $(OA) \times (OB)$ is equal to

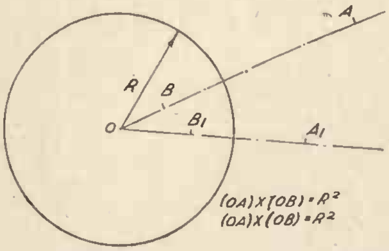


Fig. 1.—This diagram shows the basis of the field theory.

the square of the radius of the circle. The point B is then said to be the geometrical inverse of the point A.

In a similar manner any number of points outside the circle can be transferred to the inside as geometrical inverses, and so lines and figures outside can be transferred inside. Fig. 2 shows how this transformation appears for some simple figures. The reader will find it interesting to try a few transformations for himself.

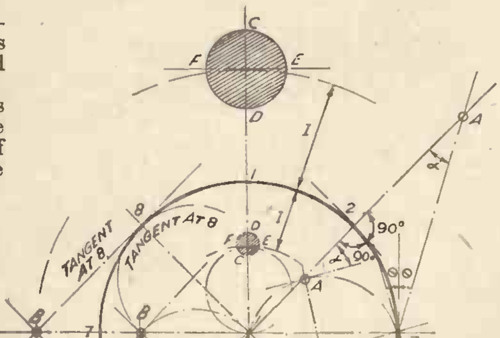


Fig. 2.—Transferring a number of points on the outside of the circle to the inside.

This process is known as inversion geometry, and a part from its application to the "inside concept" of the universe, it is a very interesting field of study in itself.

Geometrical Inverse of Infinity

One or two points about the type of field this inversion geometry produces inside the circle are immediately apparent. In the first place it will be seen that for every point outside the circle there is a corresponding point inside, so that the whole of the infinite space outside can be got into the space within the circle. Again, it can be seen that as the point A recedes from the centre, the point B approaches it, but B only reaches the centre when the point A recedes to infinity; therefore, the centre is the geometrical inverse of infinity.

A further, and most important point which is not at first apparent, but follows logically, is that if lines of sight outside the circle are transferred inside, their directions as seen by an observer on the surface *are not altered.* Thus if we imagine an observer on the outside, i.e. in orthodox space, at the point 3 (Fig. 2), he sees an object A at an angle (theta) above his horizon. His geometrical inverse on the inside sees the geometrical inverse of A at the same angle (theta) from his horizon.

The reader can check this up with other angles and arrangements, and he will find that in as far as angular observation is concerned, the observer has no means of telling whether he is on the inside or the outside.

Strange as it may seem, there is evidence to support the belief that the surface of the earth is indeed concave instead of convex.

One phenomenon which has long puzzled scientists is the observed fact that the cosmic rays appear to fall perpendicularly on the earth's surface wherever they are observed. This would be easily understandable if the earth were a hollow sphere and the source of the cosmic rays were at the centre.

An Elaborate Experiment

It may not be generally known that in the year 1897 a very careful and elaborate experiment was carried out in U.S.A. to determine the curvature of the earth without optical aid. This experiment was devised by Prof. U. G. Morrow, and was carried out by a staff of experienced geodetical engineers. It consisted in producing a straight line 3,800 metres long (4,180 yards approximately) by purely mechanical means, and measuring the offsets from this line to a "level" line produced by means of mercurial levels.

This experiment gave the astonishing result that the physically straight line *approached* the level line, and the offsets agreed almost exactly with a concave curvature equal to the convex curvature which would be expected under orthodox assumptions.

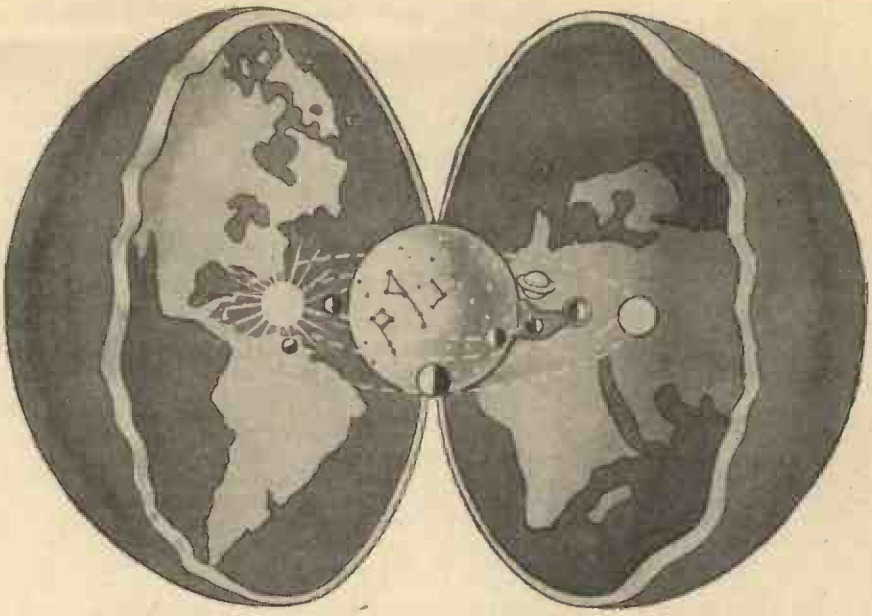
In this experiment the most scrupulous care, and the most elaborate precautions were taken to eliminate all possible sources of error, and finally it was repeated in the opposite direction to check the results, which were found to be correct.

A Remarkable Case

Another remarkable case occurred at the Calumet Mines, Michigan State, U.S.A., in 1901. In connection with certain works which were being carried out, two plumb-lines were dropped down two deep shafts (4,250 ft. deep), and the distance between their lower ends was carefully measured, and was found, to the astonishment of all concerned, to be *greater* than the distance between their upper ends. This so puzzled the engineers that they called in the Geodetic Survey Department of the U.S. Government, whose representative verified the measurements, but could not explain them.

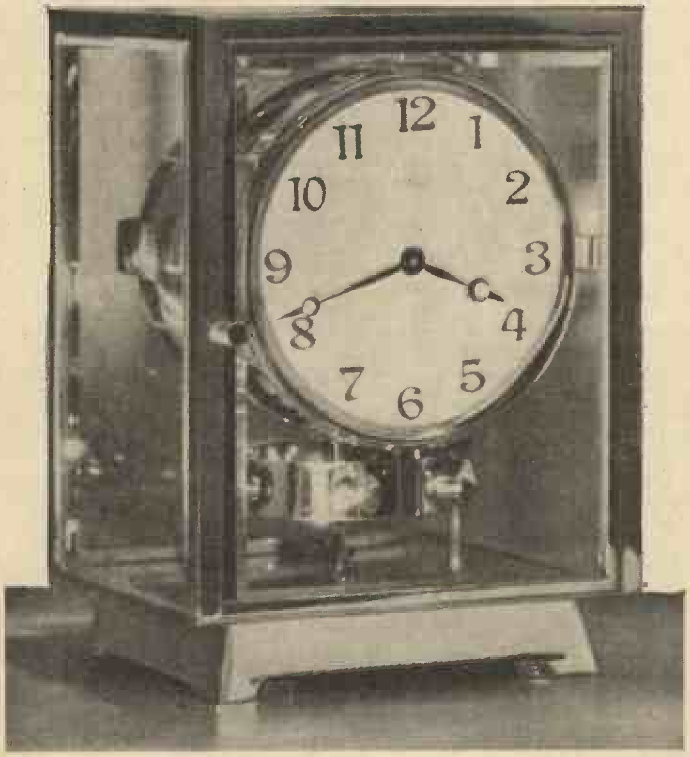
Whether the inside concept is true or not, it is a very interesting theory, and it is hoped that these notes may stimulate some investigation on the subject.

"G. M. B."



A pictorial representation of the theory of the Universe propounded in this article.

IS IT PERPETUAL MOTION?



The atmosphere clock which derives its motive power from changes in the atmosphere.

MANY people have tried to solve this centuries old problem of perpetual motion, the key of which is held by the heavenly bodies, and it seems as though it has been left to the clockmaker to offer a solution.

A clock has been invented in which the human element, with regard to its functions, is entirely absent. This new departure in clock control turns yet another page in the history of clock-making. This Atmosphere Clock, as it is called, derives its motive power solely from the normal changes of temperature; an unfailing source. The essential part is the atmosphere unit which is shown in the sketch.

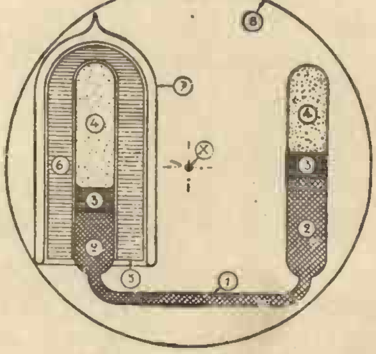
The principle of the motor is as follows: inside the small drum is a Pyrex glass U-tube (1). In each bulb is a quantity of Mercury (2), and above the mercury is a small amount of a volatile liquid (3), the remaining space being filled with its saturated vapour (4). One bulb is surrounded by a glass cover (5), containing a substance of high caloric value (6), the whole being enclosed within a vacuum jacket (7). The bulb is thereby kept at a constant temperature. A vent hole in the drum allows the other bulb to be exposed to the air.

The smallest variation in temperature will cause a change in the volume of the vapour. If the volume increases the mercury will be forced into the enclosed bulb. A decrease in volume will have the opposite effect. This displacement of the mercury causes the drum to turn about its axis, and by means of a delicate winding mechanism this movement winds the tiny main-spring.

The main-spring barrel is fixed at the rear of the clock unit. Provision is made for 16 complete turns of the main-spring, as it is only ·005 of an inch in thickness.

The large wheel attached to the main-spring barrel transmits the power through the 10 wheels of the train to the hands. A normal type of friction drive is provided for the hand mechanism.

The escape wheel and pallets are similar to those in an ordinary watch escapement. A torsion pendulum—like those used in 400 day clocks—takes the place of the watch balance.

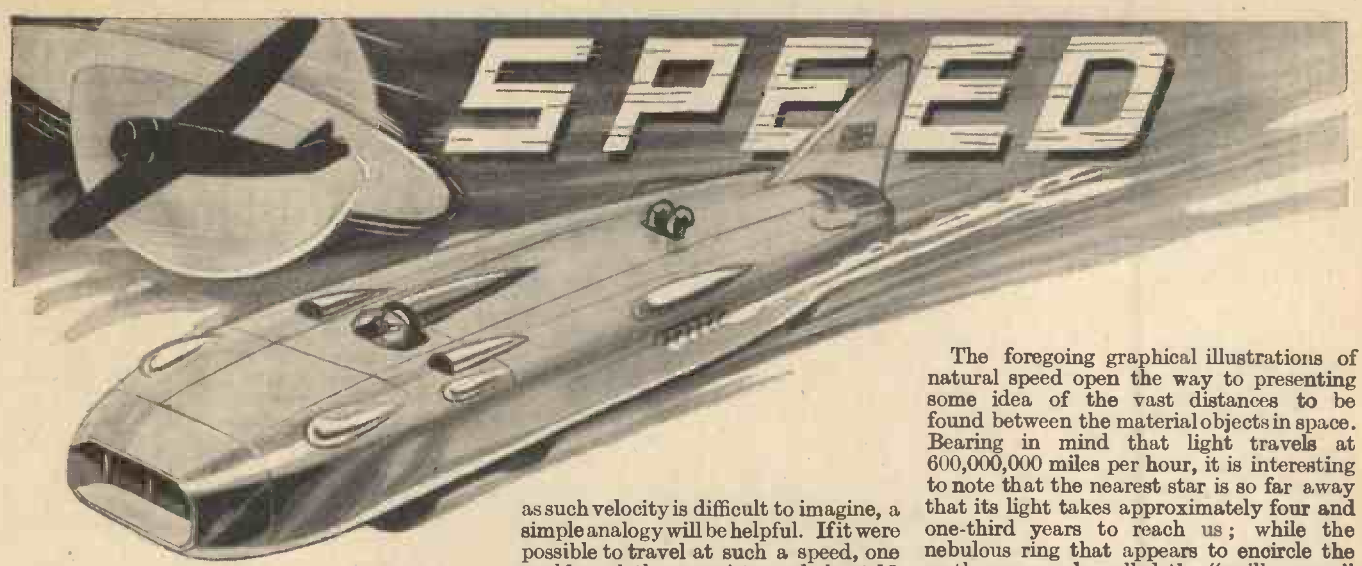


The principle of the motor.

The movement of the wheels is so slow that the clock is assured of an almost indefinite life. The heavy pendulum bob is suspended by a thin ribbon of steel, ·002 of an inch in thickness, and the pendulum takes one minute to make a complete vibration.

A change in temperature of only 1 degree centigrade provides sufficient power for 120 hours. Supposing the temperature changed only 1 degree twice in a week, which is somewhat unlikely, power and to spare would be available. These clocks are not likely to be without power whilst "modern" weather conditions continue.

Absolute silence and accurate time-keeping are among the many advantages of this revolutionary clock and maintenance worries are banished, for oil is unnecessary. The elimination of oil gives the clock a very fine rate, and when finally regulated, a variation of less than a minute a year can be expected.



NEARLY every day we hear that somebody or other has put up some new record, using a man-made machine designed to fly in the air, speed along the ground, or skim across water; sometimes the new achievement may take months of preparation, cost hundreds of pounds and yet only raise the record by a decimal point. Everywhere one hears about the terrific speeds at which motor-cars are alleged to travel along our roads and we read in the newspapers frightening accounts of aeroplanes which, travelling at a speed approaching 300 miles per hour, could be over London fifteen minutes after passing the coast.

Captain Eyston, driving a motor-car developing over 3,000 horse-power, has reached a speed approaching 320 miles per hour and has therefore travelled faster on land than any other human being. In the air, Lacombe, of France, reached what was referred to at the time as the incredible speed of 389·462 miles per hour. All credit to these gentlemen; as human achievements they are unsurpassed and may perhaps remain so for many years. Using these achievements as a jumping-off place, it is interesting to throw off the fetters of earth-bound speed and see what Nature can do in the way of annihilating time and distance.

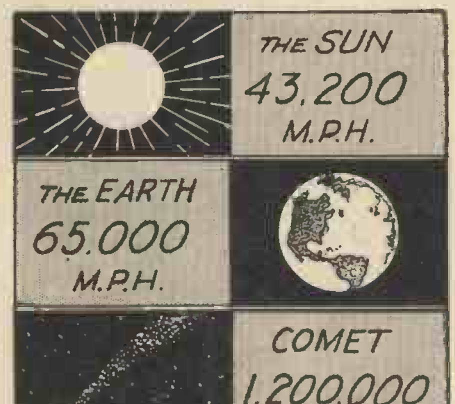
Fantastic Speeds

Starting with a well-known and comparatively slow-moving body we find that the sun travels through space at approximately 12 miles per second (towards the constellation Hercules) which, converted to a more usual denomination, is rather more than 43,000 miles per hour. The earth rotating on its journey round the sun travels rather faster at 18½ miles per second, which is approximately 65,000 miles per hour; both these speeds are, however, "slow" when compared to some of the comets, which travel at a truly fantastic rate. A comet may move at such a tremendous speed that its tail may be as long as 100,000 miles, which means that if it takes five minutes to travel the length of its tail through the heavens, it must be moving at a speed of about 1,200,000 miles per hour.

Leaving the heavenly bodies for the moment it is possible to find some remarkable examples of natural speeds in everyday life. The speed of the electron stream in an ordinary domestic television tube is round about one-tenth of the speed of light; as such velocity is difficult to imagine, a simple analogy will be helpful. If it were possible to travel at such a speed, one could reach the moon in round about 13 seconds, or travel to Brighton, from London and back over 150 times in a single second. Still faster, of course, is the speed of light, which ties with other forms of radiated energy, such as wireless waves, heat, etc., which travel at 186,000 miles per second; a speed which many scientists believe to be the fastest physically possible, and, by taking it as infinity, they set out to prove quite a number of things to their own and, less frequently, to other people's satisfaction.

600,000,000 m.p.h.

186,000 miles per second is, in round figures, 600,000,000 miles per hour. Let us think what this can mean. At this speed the time taken to reach the sun from the earth would be a little over six minutes, or to reach the moon almost exactly 1·3 seconds. Alternatively, if an earthly comparison is preferred, this speed is equivalent to just under 7½ times round the equator in one second.



The foregoing graphical illustrations of natural speed open the way to presenting some idea of the vast distances to be found between the material objects in space. Bearing in mind that light travels at 600,000,000 miles per hour, it is interesting to note that the nearest star is so far away that its light takes approximately four and one-third years to reach us; while the nebulous ring that appears to encircle the earth, commonly called the "milky way," has a diameter so great that it would take light from one point thousands of years to reach a point diagonally opposite.

Large Stars

Another interesting fact that arises is that some of the large stars are so big that a ray of light would take ten minutes to travel round their equator, whereas, as already mentioned, light could travel over seven times round the earth's equator in a second.

It would, perhaps, be well to interpose at this juncture to mention that the whole idea of light travelling round the equator is purely an imaginary one, as it is not possible for light to "bend" in this way. It is merely a composition of distance, and, unfortunately, a circular object such as the earth must be chosen in the absence of any straight path which is as tangible to the mind as the equator of the planet on which we live.

Halley's comet is given as being 3,300 million miles from the sun when at its farthest point. Now, a ray of light would accomplish this journey in about five hours, whereas, travelling at the speed of Captain Eyston's record-breaking car, it would take 10,600,000 hours, or rather more than 1,210 years.

Light, Heat, and Wireless Waves

The writer ventures to suggest that many of the figures used above are of such magnitude as to be incomprehensible to the human mind, but it is hoped that the use of the comparisons and analogies employed will convey some idea of the speed attained by natural forces, such as light travelling from the flame of a match, the heat from the fire, or the light from the sun, or the stars in the heavens. Light, heat, and wireless waves are considered to be forces bearing no relationship to solid matter. Thus, the inclusion of the speed of the sun's journey towards a given point; the earth's journey round the sun, and the speed of Halley's comet, serve to indicate the speed at which Nature is capable of moving a solid mass. In using the fastest machine on earth, and the fastest machine to fly in the air, as earthly comparison of the speed of man-made machines, the writer wishes to state once more, in the most definite terms, and with the greatest sincerity, that he has no wish in any way to belittle the achievements of either the men who handled these machines, or the men who made them, but rather to pay a tribute by choosing them as the fastest achievements of man.

Charles Head, another nature photographer, gets a close-up of a Sparrowhawk youngster.

Coaxing
Behind the Scenes
Astonishing Labor

SCIENTISTS and camera technicians, watching in private some new films, realised that here was shown something the human eye had never seen and science never seen recorded. They were seeing the astounding results of the harnessing of the camera to the microscope—and years of patient labour with them in an almost unknown, yet one of the most exciting laboratories in London.

Properly to understand the background of this, you must go back, briefly, nearly thirty years when a civil servant left a safe job and decided to devote the rest of his time to " taking the lid off " nature with camera and microscope. He decided to take this astonishing risk on the strength of overtime work put in in his bathroom, a makeshift laboratory. He was lucky to have a wife who backed him up and who is now his colleague.

Apparatus

At one time he had to make all his own apparatus, but to-day the film people will give Percy Smith any materials that he likes, although he still takes cameras and microscopes to pieces, adds bits and subtracts bit ; uses an astonishing collection of oddments and succeeds in making machinery that, literally, catches Nature at work. His machines have squeezed him and his wife out of the North London house in which they live, out of the garden and into another house at the end of the garden. The first home is now a whirring, clicking laboratory.

In his pioneer days he had to acquire his knowledge and his machines, as he went along : and, at one time, he was held up for lack of hard cash and the machines stood in dust sheets until the famous producer of the " secrets of nature " films came along and Percy Smith joined that select corps of naturalist-scientist-camera-experts. But, before then—optics, photography, biology, natural science—the man had to learn all these for himself as he gradually evolved the perfect apparatus for his purposes.

And the result ? Not only speeded-up films of flowers and plants actually growing : but " close-ups " and motion " movie-pictures " of unseen (and easily upset) delicate developments below the ground surface—as plant roots feel their sensitive way along. Then, for instance, a film record of a newt embryo and the hatching of trouts' eggs—things never before seen and certainly not recorded.

Difficulties to Overcome

The difficulties were innumerable and appalling : take, for instance, the cinema-photography of roots—work that ended in spectacular speeded-up films. Percy Smith reminds me that roots are vitally damaged by exposure to dry air and cannot stand light, and as strong light is essential to photography, the roots turn away, stop growing and die. Both these troubles, however, were successfully overcome. For instance, the whole outfit, camera, roots and all, were enclosed in a damp chamber, and the lens warmed to prevent fogging.

In the case of trout eggs—fishes' eggs must always be photographed from above, as, in whatever position the egg happens to be, the embryo always moves to the top !

(Above and Right) The frog, taken below water in a specially constructed tank.

Very well, Mr. Smith, his camera and his microscope had to climb up and look down on the subject, and both these complicated machines were adapted, by him, to a difficult and unusual angle. When birds' eggs are dealt with, part of the shell must be taken away and, to prevent its contents dying, the laboratory itself is heated to incubator level.

These details were not worked out except by the grim process of " trial and error "—and these details are but a few of the snags that always arise on these delicate jobs. To give a little idea of the cost of them in time and patience one film (it takes between ten and fifteen minutes to show) took " two years to make."

" Speeded Up " Growth

Percy Smith showed me how his results were achieved. Perhaps the most spectacular film we can ever see is the one of " speeded-up " growth. Actually—even in these days of sensational films, one of the earlier films of plant growth created a precedent for cinema-showing because the audience, when they saw it through once, forced the Manager of a Lewisham picture house to *re-wind* and re-show.

It is not an easy job, even when you have got your machinery there, to catch the plant " at it "—and here are some of the difficulties and results of their overcoming. Normally, pictures are projected on to the screen at the rate of twenty-four a second ; and so, if pictures of a growing plant are taken once every hour, day and night, a

Lava spinning wedge of silk in which to suspend itself.

24-hours' growth will flash past in one second, and some two months, in a minute. But to take photographs every hour, day and night, is by no means simple : and Percy Smith had to invent, and to make, a contraption that would allow the plant to grow, and therefore give it daylight ; allow pictures to be taken at intervals in strong, focused artificial light, and prevent the plant from growing " out of the picture."

Nature on to the Screen

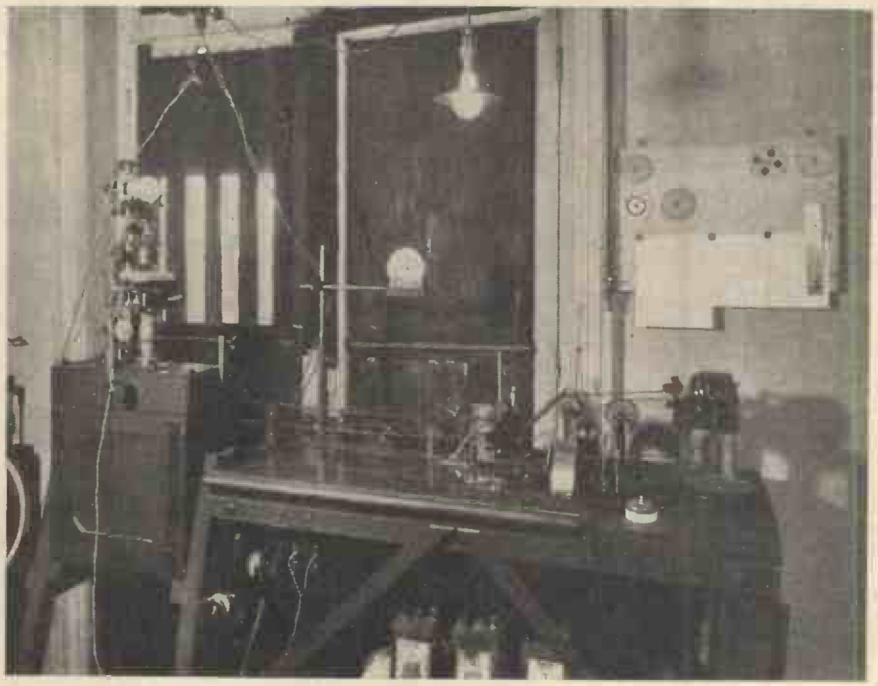
in one of the Most atories in London

This, Mr. Smith tells me, is a comparatively simple problem: it involves no microscope (these pictures are direct) and only patience is needed. He has evolved a home-made machine which allows the plant to grow in full daylight, but at stated intervals automatically shuts shutters, switches on a strong focused light, exposes a section of cinema film, switches off the light, then opens the shutters and—as the plant grows—a delicate device of the compensating type, lowers it to keep it in the picture. Finally, if any of these things fail to happen a bell rings in the house.

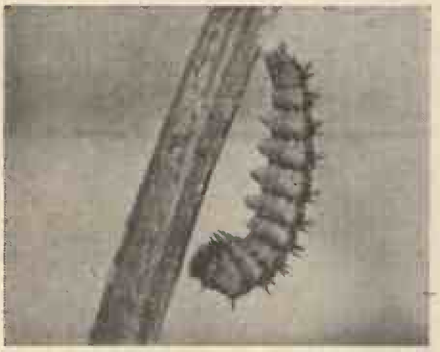
Snags Encountered

But, there are other snags, hot days and damp nights that fret the machinery; the spider who spins across the lens, the fly who commits suicide in the mercury timing bath and possibly causes the whole sequence of events to go on, rapidly and without cessation, until the fault is remedied.

In spite of this, it is interesting to hear that Percy Smith rarely exceeds 3,000 feet of film footage for every 1,000 that is used, while the more usual demands of directors are anything up to ten thousand for every valid thousand.



Here is the contrivance that opens and closes shutters, puts on light and so on—automatically—for the taking of exposures at regular intervals. Notice particularly the " bits and pieces " of which the machinery is made.



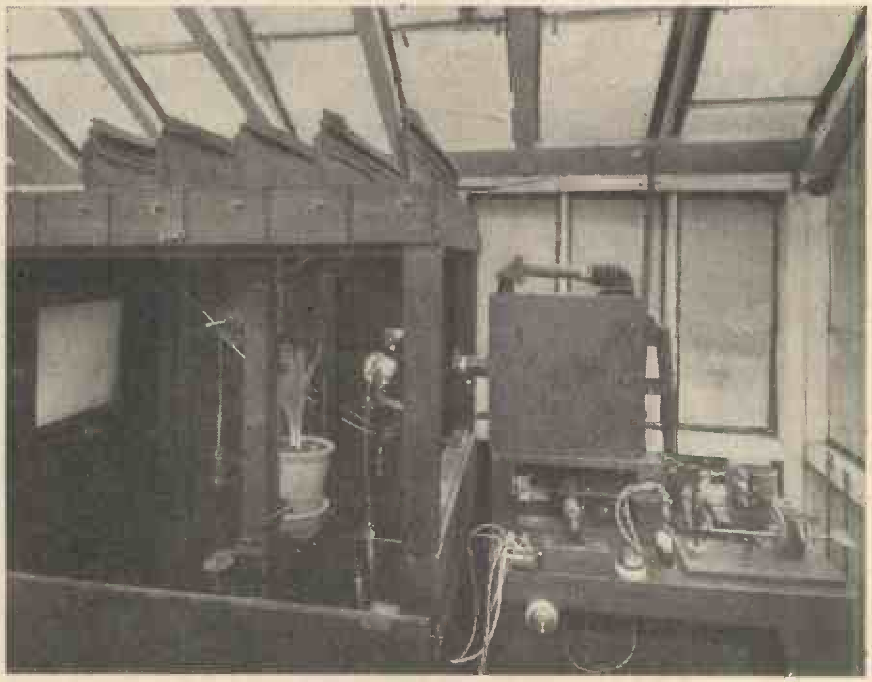
Lava suspended preparatory to change into pupa.

Perhaps one of the most amazing results he has obtained recently has been the success in photographing—*bread mould*; photo-micrography at its best under difficulties. He was fighting this out in his attic when the writer visited him: the usual machinery for intermittent photography was focused on to a glass cage in which—very dimly lit—it was possible to see something that looked like nothing but a thick growth of black whiskers. This was *mucor*, the black mould that feeds best on moist bread and rotten fruit, that can produce 10,000,000 offspring in 6 days, escapes from whatever traps are set for it, and pops up in the most unlikely places. Actually, it had found that the ceiling distemper of the attic laboratory contained gelatine (which it likes) and had started eating that.

Meanwhile, shut in the glass cage—preserved from dry air and from most of the spectrum, it was being photographed, relentlessly, at set intervals. Its diet was a problem, but Mrs. Smith evolved a diet that suited it. It consisted of slightly boiled and half cooled whites of new-laid eggs added to the selected portions of ripe plums and pears, mashed, with the acid removed; the whole being filtered and reboiled. The transparent jelly is ideal for photographic purposes and *mucor* thrived on it.

The Beating Heart

While, in the house that is a laboratory, Percy Smith still works on with that infinite patience linked to technical skill. The astonishing results just achieved—and seen by those young audiences at the Schools' Exhibition recently—in the " Chicken from the Egg " film are some indication of what can be done when patience and technical skill are harnessed. The shots of the *shadowy beating heart of the yet unformed chicken* were so sensational that the mixed audience of school teachers and cinema-fan youngsters, sat up and gasped. " How was it done ? " " Not—— " replied the scientiest under whose direction it was done " Not by X-ray, as you suggested, but direct."



Here you see a plant being photographed as it grows! The shutters shut and the lights go on every time an exposure is made, and also a special device prevents the plant from growing out of the picture.

BUILDING A 1-C.C. ENGINE

The crank case, crank-case plug, end cap and cylinder.

By W. H. Deller

Part III

Details of the Cylinder

(Complete Sets of Blue prints are now available at 5s. per Set)

The Crank Shaft

THIS item is made from $\frac{7}{8}$ in. diameter nickel-chrome steel. As the cylinder and cylinder head are also made from similar material a piece about 6 in. in length will suffice for the three items. It should be pointed out that it is not intended to heat-treat these particular parts, but to completely finish them with the material in a normalised condition.

First Operation

Cut off and face up on both ends a piece of bar to $2\frac{5}{8}$ in. in length, centring either end while chucked for facing. Turn a carrier hold at one end about $\frac{3}{8}$ in. diameter by $\frac{1}{2}$ in. in length.

Second Operation

Fix the carrier hold in the chuck and rough turn the opposite end of the bar to $\frac{9}{32}$ in. diameter, leaving the flange $\frac{5}{32}$ in. in thickness, and turn this portion to $\frac{13}{16}$ in. in diameter.

Third Operation

Mount on centres and turn the shaft exactly parallel to ·219 in. diameter, leaving a very fine tool finish. Finish turn the outside of the flange to ·796 in. diameter and face away to $\frac{1}{8}$ in. thickness. Turn the $\frac{3}{8}$ in. diameter recess in the face of the flange to clear the head of the bush, the depth being $\frac{1}{32}$ in., leaving a clean $\frac{1}{32}$ in. radius blending into the shaft.

Before turning away for the small threaded diameter, cut the oil groove while the shaft is well supported. This groove is really little more than a scratch, but it plays an important part in the running of the engine. Its form ensures that the lubricant is evenly distributed throughout the length of the bush, thereby maintaining an oil seal keeping the crank case gas-tight. For this reason, therefore, departure from the arrangement given, namely a spiral groove, may lead to bearing trouble.

Set the round-nosed tool at an angle so that the groove may be carried right up to the radius in the face of the crank plate. Start cutting the groove from a countersunk depression made with a $\frac{1}{16}$ in. diameter drill, situated at a point along the shaft $\frac{27}{32}$ in. from the finished face of the flange. The end of the shaft is now reduced to No. 4 B.A. screwing size (·141 diameter).

Next ease the bearing portion of the shaft carefully to ·218 in. diameter, leaving with a high finish. Scribe a line with the point of a fine screw-cutting tool $\frac{1}{16}$ in. away from the shoulder formed by the reduced end for convenience in positioning the squared portion. Screw the end of the shaft with a true 4 B.A. thread, afterwards reducing the centre portion to the core diameter of the thread. The shaft has now reached the stage shown in Fig. 22.

Fourth Operation

After cutting off the extreme end of the thread to remove the centre, face and dome up the end to leave the thread $\frac{1}{4}$ in. in length. Cut off the carrier hold at the opposite end. Chuck the shaft truly and face the front of the flange down to leave a thickness of $\frac{3}{32}$ in. Centre-drill and drill a $\frac{1}{8}$ in. diameter hole in the centre of the shaft to a depth of $1\frac{1}{16}$ in., measuring to the point of the drill. Tap $\frac{1}{8}$ in. of $\frac{5}{32}$ in. whit. thread in the month of this hole.

Fifth Operation

Mark out the face of the crank plate, taking great care that the position of the tapping hole for the crank pin is on the centre line at a distance exactly $\frac{1}{4}$ in. from the centre. Drill with a No. 32 drill and counter-bore the mouth barely $\frac{1}{32}$ in. deep with a No. 27 drill to permit the crank pin to screw in to the shoulder, before tapping out No. 4 B.A. left hand.

It will be noticed that the crank plate is cut away to form the balance plate into two $\frac{1}{8}$ in. diameter holes which are drilled $\frac{1}{16}$ in. below the centre line on a $\frac{7}{16}$ in. diameter pitch circle, and finished up to the shape indicated by the dotted line in Fig. 24.

Sixth Operation

The final operations on the shaft are drilling the $\frac{1}{16}$ in. diameter hole at the commencement of the oil groove, through into the $\frac{1}{8}$ in. diameter hole and squaring the end of the ·218 in. diameter to provide a drive for the cam plate. The squaring operation calls for little comment apart from the fact that it is purposely made slightly over $\frac{5}{32}$ in. across the flats to fit tightly into a $\frac{5}{32}$ in. square hole. The other point is that as the part which registers on to this square must run true, see that the flats are made equi-distant from the centre of the shaft.

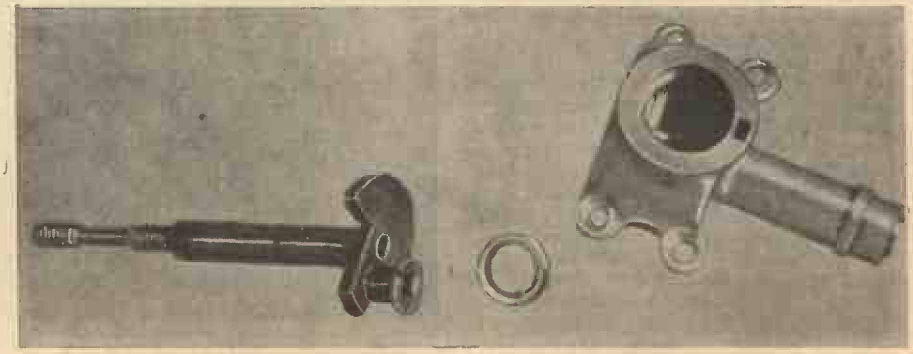
The Oil-retaining Screw

The hollow screw which fits into the end of the crank shaft is made from a piece of $\frac{5}{32}$ in. whit. steel screw drilled up and countersunk on the face and slotted to provide a means of driving in. It should screw in slightly below the surface of the crank plate when home in the bottom of the tapped hole.

The Thrust Washer

As the cam plate which operates the valve and make and break thrusts against the end of the crank case, it is necessary to provide a thrust washer at this point. This is made from $\frac{3}{8}$ in. diameter silver steel which is drilled and reamed $\frac{17}{64}$ in. diameter to fit over the end of the bush. The working face is polished before parting off with a fine parting tool. A small hole drilled in the face of the washer accommodates a short silver steel or piano-wire pin fitted into the end of the bearing boss on the crank case.

(*Continued on page* 348)

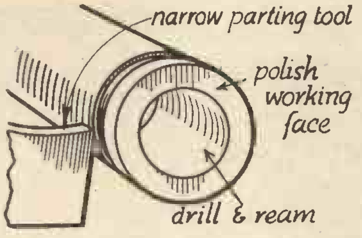


The assembled crank shaft, crank case, and thrust washer.

THE 1 c.c. TWO STROKE PETROL ENGINE

Stage-by-Stage Constructional Details

DETAILS OF THE CYLINDER



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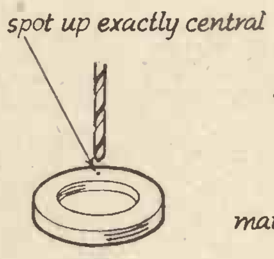

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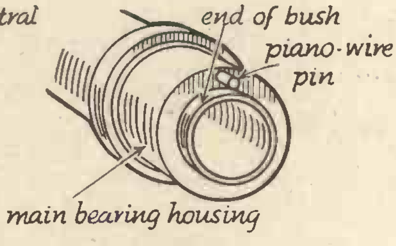

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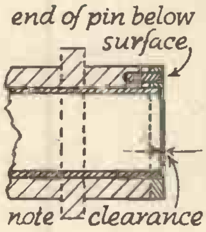

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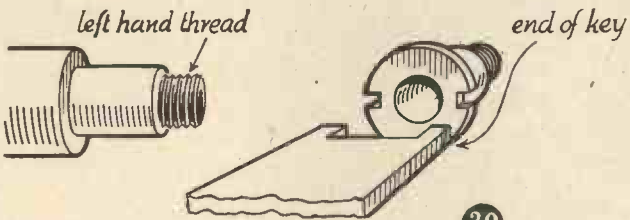

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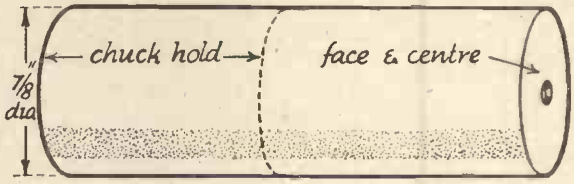

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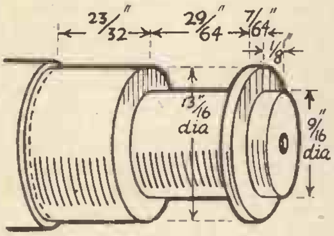

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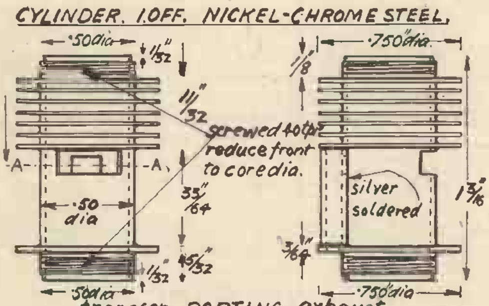

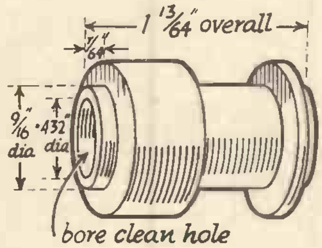

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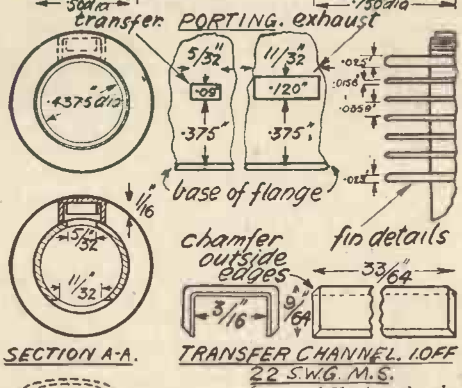

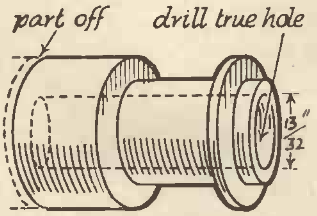

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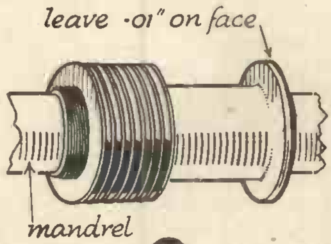

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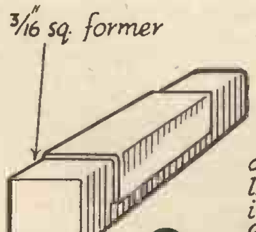

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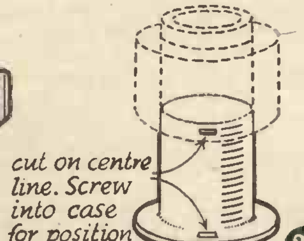

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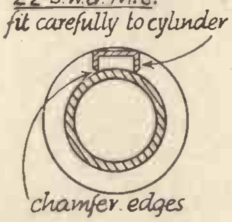

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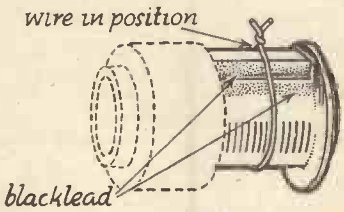

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An Electric Engraving Machine

An Electric Bell Forms the Basis of this Machine which is Suitable for Engraving Designs on Wood and Metal

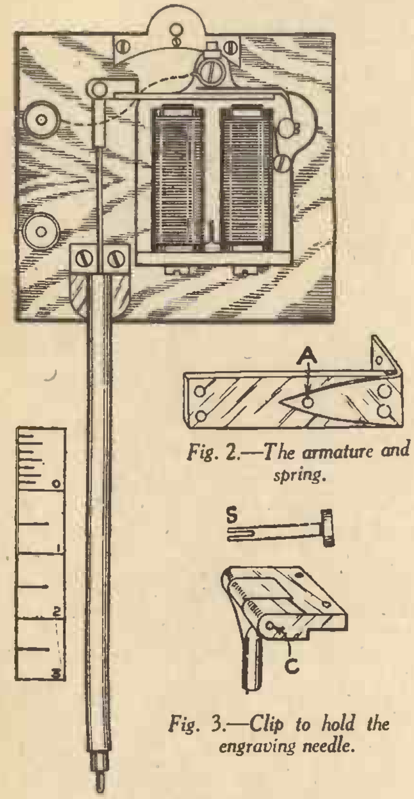


Fig. 2.—The armature and spring.

Fig. 3.—Clip to hold the engraving needle.

Fig. 1.—The completed machine.

THE electric engraving machine shown in Fig. 1 is so easily constructed that the merest tyro having the necessary tools need have no hesitation in starting to make one of these interesting instruments.

It will engrave designs in wood and metal, your name on tools, and in many other ways prove useful to the handyman. No screwing or turning is required, just plain drilling, filing, and simple soldering being all that is necessary. The most important part is a portion of an electric bell; this is the framework and coils, in this case part of an enclosed bell. The gong and gong pillar are taken off, not being required; the armature is also removed, and the hammer shank and spring unscrewed, the last named being too weak for the purpose required.

A Stronger Spring

The first job is to make a stronger spring. This should be of hard hammered brass. The brass spring is bent to the same shape as the spring taken off, and riveted to the armature. To do this, countersink the screwed holes in the armature on the bobbin side, place the new spring in the exact position on the armature and mark the holes. Drill these and then rivet the spring on with soft brass pins; on the countersunk side file the rivets flush.

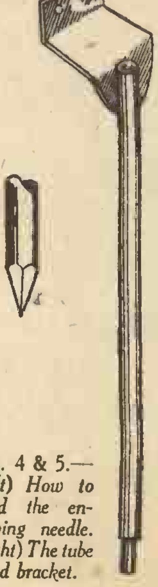
Now attach the armature to the frame, and where the point of the contact screw touches the spring solder a small disc of nickel as (Fig. 2). At the opposite end of the armature drill two holes as shown in Fig. 2, and countersink these also on the bobbin side. Through these the fitting to hold the engraving needle is attached. This fitting is filed from a piece of scrap brass to the shape shown in Fig. 3. The hole *C* can be drilled to fit a suitable size nail, as being the easiest way of fitting a pin. This should be nicked as shown at *S*, so that when in position it can be opened out to prevent it working loose. The swinging part of the joint is filed a working fit without play between the jaws of the upper part, and a hole drilled to take the stout steel knitting needle with which the engraving is executed. The end that goes in the hole is slightly jagged with a chisel and then soldered in. The point is then hardened so that it will not easily blunt. This is done by getting the extreme point red hot and quenching in water; it is ground to the shape shown by Fig. 4.

Testing the Movement

The movement should now be tried with two sack Leclanche cells and the effect noticed. If the armature is not attracted when fully away from the electro-magnets, the spring must be filed thinner between the spring brackets and the armature, until the armature goes to with a snap when the machine is held in the working position.

The tube and bracket (Fig. 5) next claim attention. The tube is of $\frac{1}{4}$-in. outside diameter copper, and is soldered to a bracket (Fig. 6). As shown, the part of the bracket on which the tube is secured is filed to the shape of the tube until the needle will occupy the centre of the tube when the bracket is attached to the base. The bottom end of the tube has a piece of brass soldered in, with a fine hole drilled in the centre to make the needle a sliding fit.

To suspend the machine, a piece of sheet brass is shaped out as shown by Fig. 7. This is screwed to the top part of the base, a spring or a stout piece of elastic rubber being attached to it.



Figs. 4 & 5.—(Left) How to grind the engraving needle. (Right) The tube and bracket.

The Cover

The cover can be cut from sheet tin. It should be marked out as in Fig. 8, the depth being represented by the outside of the lines *C*. The corners are cut away along the dotted lines *D*, leaving *E* at each corner. These must be turned up first to form a seam at each corner. The sides are then turned up with the covering pieces inside. Solder the joint at each corner, and fit the cover on the base. Where the hanging piece projects file a slot in the cover to pass over. It is secured to the base by means of two screws at each side. Cut a piece to allow the cover to pass over the tube.

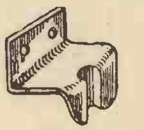


Fig. 6.—The bracket shown in Fig. 5.

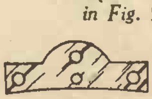


Fig. 7.—The hook to suspend the machine.

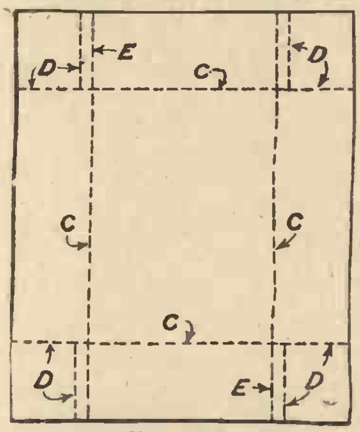


Fig. 8.—How to make the cover.

A stand can be easily fashioned out of wood or metal. It should be adjustable for height, an allowance of 16 in. at least being made for the length of the machine. The spring or rubber suspension is 4 in. long.

In use, three cells will be required, a few experiments being made to get the best effect. Adjust the stand until the point of the needle hangs $\frac{1}{2}$ in. above the work, and grip the tube close to the point, pulling the needle down. It is advisable first to write the inscription faintly with a black lead pencil.

SPRAYING FIREPROOF CEMENT

THE spraying of paint, distemper, and other liquids has been common practice for a number of years, but now the spraying of cement is coming into use.

A particularly useful application is in connection with the refractory lining of certain types of furnaces. It is found desirable to cover the firebrick walls with a smooth lining, and by means of a high-pressure cement gun, a perfect coating can be quickly and easily applied. Not only does the cement penetrate into the interstices of the bricks far more efficiently than when applied by hand, but the cement sets harder and with a more perfect surface.

LUMINOUS PHOTOGRAPHS

Some Practical Methods of Producing Them

A positive photograph on glass backed up with a sheet of card coated with calcium sulphide paint and bound at its edges. It is luminous in the dark.

Coating a fine glass paper with luminous calcium sulphide paint.

PHOTOGRAPHS which appear luminous in the dark are novelties which will appeal to many people, particularly, of course, to those amateur photographers who do their home processing of plates, films and papers. They are readily produced and, although the luminous type of photograph is not suitable for all kinds of subjects, there are many photographic studies, as, for instance, figure subjects, portraits and " broad " subjects generally, which frequently give very pleasing and interesting, not to say out-of-the-ordinary, effects when rendered luminescent by means of one of the methods described in this article.

A " Light Accumulator "

The production of luminous photographs is primarily based upon the well-known luminesence of certain chemicals, notably the sulphides of calcium and zinc. Either of these materials, when exposed for a few seconds to a bright source of light, as, for instance, sunlight, burning magnesium ribbon, an incandescent gas-mantle or a 100 watt electric lamp, will, roughly speaking, act as a " light accumulator." That is to say, it will absorb a quantity of light and will release it again, glowing vividly in the dark. After a few hours, the luminescence of the light-activated calcium or zinc sulphide will have become very feeble, but it can be renewed again by a further exposure to bright light, the process of " reactivation," as it is sometimes called, being capable of being repeated more or less indefinitely.

In passing, it may be noted that it is now possible to obtain zinc sulphide containing a small percentage of radium. This material is permanently luminous in the dark and does not require " reactivation " from time to time by exposure to bright light. Radium containing zinc sulphide, however, is extremely expensive and, as such, will be out of the reach of most amateurs.

Luminous calcium sulphide may be prepared by kneading plaster of Paris into a thick paste with a gum arabic or tragacanth solution, and by heating the resulting mass to an almost white-heat in a closed earthenware crucible. Alternatively, it may be produced by heating ground oyster shells with flowers of sulphur in a similar closed earthenware crucible. In both these cases, the final product will be a dirty yellow or creamy mass, which will powder up readily and which—with a certain amount of luck on the part of the experimenter—will shine satisfactory in the dark after an initial " activation " by exposure to bright light.

It is usually far more satisfactory, however, in addition to being less trouble, to purchase a small quantity of calcium or zinc sulphide from a wholesale firm of chemical and laboratory suppliers. Calcium sulphide is the cheaper of the two, and it shines well in the dark with a soft bluish light. When purchasing this product, it is essential to specify that the luminous calcium sulphide is required, since ordinary calcium sulphide, as commercially supplied, does not luminesce satisfactorily.

Several Methods

Having purchased—or made—a supply of luminescent calcium sulphide, the experimenter will now be ready to undertake the production of luminous photographs. There are several ways of doing this.

In the first place, the worker may take an ordinary lantern slide or positive transparency and convert this into a luminous photograph. To this end, the film side of the lantern slide or transparency must be varnished, otherwise the luminous material would gradually attack the silver of the emulsion and thus destroy the image.

The best varnish to apply to the lantern slide is an ordinary celluloid one, prepared by dissolving scrap celluloid in a mixture of one part of acetone and two parts of amyl acetate. This varnish (which, of course, can be purchased ready made at most oil stores, decorators' and paint-shops) should have a paint-like consistency. It is flowed over the film side of the lantern slide and then allowed to dry and harden.

The celluloid varnish having hardened, a " paint " made by grinding up some of the luminous calcium sulphide in gum water or spirit varnish is applied to the varnished side of the lantern slide. This paint should be applied thinly, and, after it has dried, another layer of it put on. Finally, the lantern slide is backed up with a sheet of good white paper and a piece of cardboard, the whole being bound up passe-partout fashion with gummed strips around its edges.

Time of Exposure

Twenty seconds' exposure of the slide to a strong light will cause the luminous calcium sulphide to glow vividly in the dark, thus giving rise to a luminous photograph of a very interesting, if, perhaps, a somewhat strange, type.

Another way to produce a luminous photograph is to take advantage of the properties of one of the " stripping papers " which are now marketed by photographic firms. These are ordinary bromide papers which are printed in the ordinary way and subsequently allow of their image being transferred to wood and other surfaces.

Let us take, for instance, a sheet of good brown paper, creaseless, of course, or, better still, a sheet of the finest grade of glasspaper. Over this paint a thin and even layer of the luminous " paint " prepared by grinding up the luminous calcium sulphide with glue or gum water, spirit varnish, celluloid varnish or some other suitable medium.

When the paint has dried and hardened, brush over it a warm three per cent. solution of gelatine. This gelatine treatment is absolutely essential, since the gelatine layer forms an adherent surface for the transferred image.

Now prepare the necessary photograph upon the bromide stripping paper and, following the maker's instructions, transfer the image to the paper surface prepared with luminous paint. After exposure to strong light, the photograph so produced will appear in luminous tones.

Suitable Print

Ordinary P.O.P. self-toning, gaslight and other photographic prints can be made luminous to a certain degree by soaking them for some hours in warm olive or castor oil containing a little dissolved wax. The print is then well drained and laid upon a sheet of paper upon which has been painted a layer of luminous calcium sulphide paint. A stiff cardboard backing is provided, the assembly being then bound up at its edges like a lantern slide. Exposed to strong light, the photograph so produced will become luminous, the growing calcium sulphide paint being discernible behind the print made translucent by the oil treatment.

Another interesting mode of producing a luminous photograph and one which obviates the use of luminous backings is the following:

Obtain a sheet of transparent celluloid—an old film, preferably of the thicker "cut-film" variety, with its emulsion cleaned off will do—and coat this with a layer of an emulsion prepared according to the formula below:—

Cooking gelatine . .	12 grams.
Calcium sulphide (luminous) . .	5 „
Potassium bichromate . .	1 „
Water	90 ccs.

The above emulsion is best made up by dissolving the gelatine in half the amount of water by heat, adding the other ingredients and, finally, by making up to the requisite volume with water. The calcium sulphide will not dissolve in the liquid, but will remain "suspended" in it, forming a sort of gelatine paint.

This preparation, being light-sensitive, should be kept in the dark and the celluloid sheet should be coated with it in artificial light only and allowed to dry slowly in the absence of daylight.

Printing

The film is now placed in contact with a *positive* (as, for instance, a lantern slide) in a printing frame and exposed to daylight for about the time it would ordinarily take to print a piece of self-toning paper. After this, the gelatine-coated sheet of celluloid is placed face upwards in a large dish of warm water. Gradually, the portions of the emulsion which have received the least amount of light action will dissolve away, the portions of the emulsion which have had the greatest light action being pratically insoluble in water.

Slowly, therefore, a picture will develop itself up on the celluloid film, a picture which will be a negative one when viewed by transmitted light.

When the semi-automatic development (it may be aided by very gently laving the film with water) has been completed to the satisfaction of the operator, the film should be withdrawn from the water and laid aside, face upwards, in a dust-free place to dry. No attempt must be made to dry the film by heat, otherwise the image will "run" and will be destroyed.

When dry, the film should be backed up with a piece of black paper and bound at the edges in the passe-partout style. Viewed in daylight, a black-and-white positive print will be seen, but, after exposing the picture for a few seconds to a strong light and then examining it in the dark, a well defined luminous picture will be evident.

The above method (based upon the "carbon" process of photography) gives the best type of luminous or phosphorescent pictures and, although it is not too easy to work, it should, at least, be given attention by the enthusiastic photographer and by the amateur who is particularly interested in obtaining these novel and little-known photographic effects.

BOOKS worth READING

"The Woodworker Volume (1937)." Published by Evans Brothers Ltd., Montague House, Russel Square, London, W.C.1. Price 6s. 6d.

CONSISTING of more than 400 pages measuring approximately 7½ in. by 10½ in., this volume contains a very large number of designs for furniture, models, outdoor woodwork, etc. There are also many articles dealing with workshop practice and processes.

Illustrations in both line and half-tone are used liberally throughout, and the book probably represents the best value of any in its field. The book is actually the bound volume of the twelve monthly copies of "The Woodworker Magazine," from January to December, 1937.

It is well and handsomely bound and fit to occupy a proud position on the bookshelves of all readers of PRACTICAL MECHANICS.

"Charles Hayward's Carpentry Book," by Charles H. Hayward. 336 pages. Over 250 illustrations. Large crown 8vo. Published for the English Universities Press by Hodder & Stoughton Ltd. Price 6s. net.

THE author of this well-produced cloth-bound book is Associate Editor of *Woodworker* magazine and author of three other popular books on allied subjects. That he is well conversant with the theory and practice of his subject is evident from a perusal of the present volume. Throughout, the text is clear, concise and interesting, while the illustrations, both line and half-tone, are excellent.

Despite the title, the book deals more with joinery than carpentry and must have a strong appeal to those whose hobby it is to make things in wood. It is written primarily for the woodworker whose main interest lies in making furniture and fittings for the home. The scope is wide, but not too wide to enable every phase of the work to be adequately covered.

Among the items dealt with are the use and making of different kinds of joints, staining and finishing, tool sharpening and preparation of timber. Additionally full and illustrated constructional details for a wide variety of household objects from book ends to a dressing table are given. Information is also included on laying parquet flooring, panelling a room and on the construction of rustic work for the garden.

Right through the 336 pages the author shows his sympathy with and understanding of the requirements of the amateur woodworker who is desirous of producing a "professional" result.

"Notes on Supercharging for Ground Engineers," by C. E. Jones. 33 pages. Published by Sir Isaac Pitman & Sons Ltd. London. Price 3s. net.

STARTING with a short chapter on first principals of supercharging, the author proceeds to give a short dictionary of the principal terms in use, and then with many practical and theoretical details. One chapter is devoted to an explanation of the methods of test, another explains the altitude power curve, while others explain corrections to be observed for power; corrections by A and B factors; airscrews. Then follow eight pages of tabulated data.

The book is in every way in keeping with its title, for it aims at supplying a considerable amount of concise information on most branches of the subject. It is not intended for the casual student of supercharging, but more for the man who is actively engaged as a ground engineer working on modern aero engines. The matter contained in the book is authorised by the Air Ministry although the author states that he "takes full responsibility for all statements made."

"Calverts Mechanics Year Book." Price 6d. 190 pages. Published by Wm. Endsor & Co., Progress House, 75, Wood Street, Manchester, 3.

THIS book which is now in its sixty-third year of publication is remarkable value for a 6*d.* pocket book. This year's edition has been sectionalised, the different subjects and tables can be easily found. Among its new features is a short, but valuable article on "Screw-cutting," Tables for Calculating Wages in Engineering Trades (47-hour week), etc. The hints for mechanics and illustrated notes on Workshop Practice are worth more than the cost of the book.

"How to Excel at Games and Athletics," by A. M. Soldo. Price 2s. 6d., post free 2s. 9d. from A. M. Soldo, Dept. 43, 14, Cursitor Street, London, E.C.4.

PHYSICAL fitness is essential to the sportsman or sportswoman no matter what the sport indulged in. In this book are given usful hints and exercises for improving the body without producing staleness, which is feared by all athletes. Chapters are also included on Running, Jumping, Boxing, Golf, Wrestling, Cycling and Weight-lifting.

"Indicateur Davoine for 1938." 848 pages. Crown 8vo. Price 5 Suisse frs., postage extra. Published by A. Gogler, Publicite Societe Anonyme, La Chaux-de-Fonds.

THIS is a complete directory of the Swiss watch and clock trade. To all those interested in horology, clock-making, instrument-making, engraving and small tool industries, this book will be invaluable.

"Horology," by J. Eric Haswell, F.B.H.I. 12s. 6d. net. Demy 8vo. 288 pages. Published by Chapman & Hall, Ltd. With numerous plates and diagrams.

THIS is a second edition of this very complete work, the first edition of which was published at 25*s.* It very clearly details the principles of Time Measurement and Time Recording, and has special chapters on Pendulums; Clock Escapements; Trains, Motion Works and Gearing; Weight-driven Clocks; Spring-driven Clocks; Striking and Chiming Mechanisms; Calendars, Alarums an Supplementary Devices; Electrical Clocks; Types of Movements; Watch Trains; Balances and Balance-springs; Watch Escapements; Mainspring, Fuses and Going Barrels; Chronograph and Stop Watches; Repeating Mechanisms; Epicyclic Trains; Chronometer Trains, Escapements, Balances and other Data.

The book is very authoritative and illustrated with a great number of practical diagrams. This is an excellent work for everyone interested in clocks and watches, and at 12*s.* 6*d.* it represents excellent value.

MASTERS OF MECHANICS

No. 31—The Story of James Hargreaves and his "Spinning Jenny"

FOR the best invention of a machine that will spin six threads of wool, flax, hemp or cotton at one time, and that will require but one person to work and attend it (cheapness and simplicity in the construction will be considered part of its merits); for the best, FIFTY POUNDS; for the second best, TWENTY-FIVE POUNDS.

IN the year 1761, this notice was posted up in several of the Lancashire towns. It had been drawn up by a special committee of the London "Society of Arts," a body which aimed at fostering trade and invention. Many, indeed, were those Lancashire cotton workers who scanned the announcement time and time again and who, if they were unable to read themselves, had its message explained to them by some individual of greater learning.

Fifty pounds! To the humble cotton weaver of the mid-eighteenth century who worked away at his handloom in his two- or three-roomed cottage for a total wage of about four shillings a week, the sum was a fortune. But although a few poor weavers went away silently with the determination to construct such a machine, the majority of them shook their heads and even laughed, for was it not, they said, an obvious impossibility to make a contrivance which would of itself do the work of half a dozen spinsters.

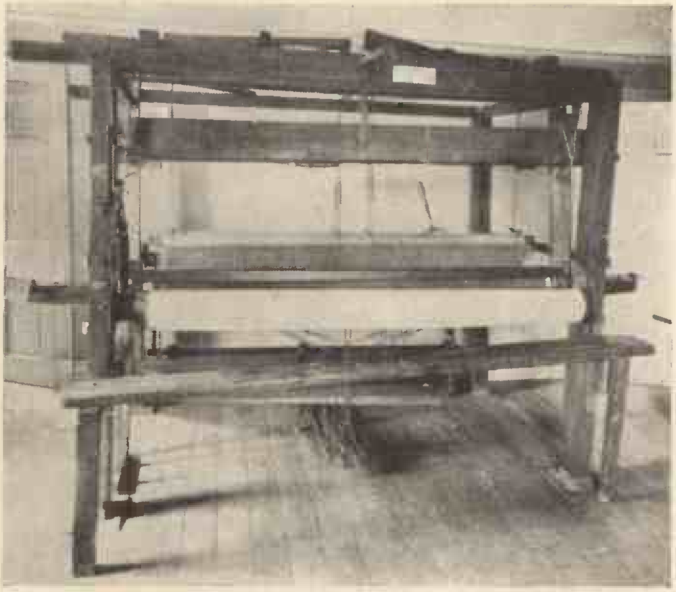
Increasing Demand

Cotton manufacture in those days was just arising in Britain. The demand for Lancashire cotton goods was yearly increasing. But, unfortunately, there seemed to be no means of keeping up with this demand. To a certain extent, a weaver, even a cottage handloom weaver, could, of his own unaided efforts produce a great deal of cloth in a single day. The trouble was that it seemed impossible to speed up the production of cotton thread for weaving into fabric. Often enough, a handloom weaver would, each day, go round to a dozen or more spinners in his district in an endeavour to acquire sufficient thread for his day's weaving. Frequently, he was unable to obtain sufficient of the thread for his needs. Thus the weaver had either to turn spinner himself or to remain content with a very much reduced output of yarn.

The "Spinsters," as they were called, who spun the raw cotton-wool into thread for weaving purposes, were usually the wives of the weavers and, also, the young women of the district. From early morn until sundown many of these spinsters sat at their spinning wheels, drawing between their skilled and nimble fingers coarse cotton thread in an endeavour to satisfy the ever increasing needs of the weavers.

It was into this condition of "cottage industry" that James Hargreaves, the Lancashire weaver, was born. His birthdate is unknown. Indeed, we know little or nothing concerning his earlier days, except that he lived in a small stone cottage at Stanhill, near Blackburn, and that, despite his fine skill at weaving, he experienced the hardest possible fight to maintain himself and his family above the level of utter starvation.

Hargreaves comes into our picture about the year 1765. He is described as a "short man, standing about five feet five inches, broadly built, with stiff black hair." He had been married a few years to a thrifty and industrious young woman whose prowess and skill at the production of cotton thread was such that she had been nicknamed "Spinning Jenny."



A relic of Hargreaves' days. An old handloom of the type used by the Lancashire weaver two centuries ago.

Hardships

Mrs. Hargreaves did her utmost to keep up the supply of thread for her husband's weaving, but with little avail. Illness, the cares of a rapidly increasing family, want of food and other tribulations all took away from her her former ability as a spinster. Matters look grim for the humble Hargreaves family. Their production of woven fabric became less and less and although they were well acquainted with poverty and hardship in its severest forms, the nearly complete destitution to which they were beginning to be reduced further decreased their productivity, thus making bad circumstances worse.

The Hargreaves family was not the only one thus afflicted. Scores of hard-working Lancaster families of weavers and spinsters found themselves down-trodden, starved and ill-treated by the commercial merchants of the time. The age which they lived in was a bad one. Justice, fair-dealing, and the rights of the workers were unthought of. Cruelty abounded, and even the rudiments of humanitarianism were unknown.

It was, perhaps, with such thoughts that the mind of James Hargreaves was occupied—for Hargreaves was naturally of a studious and sober temperament—as he walked one evening over the moor outside Blackburn to a cluster of spinsters' cottages in order to borrow some thread. His wife was ill in bed. For days her spinning wheel had remained unworked and Hargreaves had no material to weave up into yarn.

If only, he thought as he walked along, he could devise some means of combining a number of spinning wheels together so that they could all spin thread at the same time, what a change would come about in his affairs.

He thought of the offer of the Society of Arts. Fifty pounds! Even twenty-five pounds would be wealth untold, were he lucky enough to gain it. And really, despite everything that other weavers said, there seemed to be no reason why a machine to spin six threads at the one time should not be possible.

A Kiss which Made Millions

The journey over the moor took some time. On his way, Hargreaves fell in with two or three acquaintances of his, handloom weavers like himself, but of less serious dispositions. His friends, upon this occasion, had had sufficient ale to render them roisterous and, somehow or other, they prevailed upon Hargreaves to accompany them to a local tavern, there to talk over weaving matters and, no doubt, to drown their sorrows further in capacious pewter tankards.

The party of weavers entered the roadside inn and sat down before the fire of its large kitchen. The innkeeper's daughter, Charlotte Marsden, like all the other young women of the district, occupied her spare time in spinning. But she was noted for her prettiness as well as for her ability at the wheel and when she entered the tavern kitchen one of the weavers, more irresponsible than the rest, rose up and gave the damsel a resounding kiss upon the cheek.

There was a scuffle. The indignant girl wrenched herself away from the semi-drunken embrace and, in so doing, upset her spinning wheel, which was sent careering across the room.

Hargreaves, seated in his corner, witnessed the whole incident, but he was too intent upon the spinning wheel as it slid on its side to the other end of the room to trouble unduly about the offended spinster.

The wheel came to rest on its side, but, curiously enough, perceived Hargreaves, it still continued to revolve more or less freely, its axis being in a vertical position.

Instantly a notion flashed into Hargreaves' mind. Its very nature excited him and he took the first possible opportunity of saying good night to his drunken acquaintances and of leaving the inn.

The "Spinning Jenny"

Arrived at his own home, the first thing which Hargreaves did was to overturn his wife's spinning wheel and to determine whether it behaved in a manner similar to that belonging to the innkeeper's daughter. He found that it did so. When overturned, the wheel still revolved on a vertical axis and if the yarn were suitably pulled by the hands it could be drawn out or spun and wound on the spindle of the machine.

At once Hargreaves saw that the idea which had suddenly occurred to him in the kitchen of the inn was a practicable one. All he required was a frame upon which could be set up a number of vertical spindles. These could be revolved by a single wheel and by devising some substitute for the guiding fingers, it would be possible to draw out or spin at the one time as many threads as there were upright spindles.

All the night through the excited weaver pored over his newly-acquired idea. A stranger peering through the window of the Hargreaves' cottage that memorable night would have seen a poor and half-famished handloom weaver engaged in chalking crude drawings and inscriptions on the stone flags of the kitchen by the light of a solitary candle. A new machine was being born, a novel notion was taking practical form, an idea which was to inaugurate not merely a new process of spinning but, in the fullness of time, entirely new social and industrial era.

There is no doubting the fact that Hargreaves, despite his illiteracy, had within him the germs of mechanical genius. Getting together a quantity of wood and iron, he quickly gave his new invention actual being. Within a few weeks, it was working, and working successfully, within his cottage. In honour of his wife, Jenny Hargreaves, who had helped him so much and as a memento of her earlier days, he called his new machine the "Spinning Jenny," a name which has remained with it ever since.

The Hargreaves, with the jenny in their possession, found that they could spin thread at many times the rate of the hand-spinners. Also, the thread was more regular in diameter and contained less faults than that of the hand-spun variety. At once Hargreaves and his wife became independent of their neighbouring spinsters for their supplies of thread for weaving. Their output of woven material increased by leaps and bounds. Things generally looked better and brighter for the Hargreaves family.

The Invention Kept a Secret

One, perhaps, may wonder why Hargreaves did not claim the prize of fifty pounds offered by the Society of Arts for and invention of this nature. The reason, however, is not difficult to appreciate. For the utterly miserable sum of fifty pounds, Hargreaves' machine would have become public property, or, perhaps, to be more accurate, would have fallen into the hands of an influential clique who would have made a fortune out of it, and left its inventor without claim or title to it.

Hargreaves determined upon secrecy in the matter of his invention. On the northern slope of Stanhill Moor, overlooking Blackburn, Robert Peel, the grandfather of the famous statesman, had a cotton mill and combined with it the then infantile art of calico printing. Peel himself was an inventive man and an acquaintance sprang up between him and Hargreaves.

In a country community it is not easy to keep a secret. Mrs. Hargreaves, the "Jenny" of flesh and blood, chattered and gossiped. She was proud of her husband and of his inventive ability and, no doubt, she felt, too, that her family, no longer having a day to day struggle with the direst poverty, was becoming a little superior to the other families around.

Quickly, therefore, it became known for miles around that "Jim Hargreaves o' Blegburn way" had in his house some marvellous kind of "engine" which enabled him to spin thread at a simply unheard of rate.

Finding that he could not retain his secret altogether, Hargreaves commenced to make jennies for his friends, enjoining upon them the utmost degree of secrecy over the transactions. The profits from the sale of his jennies he devoted to further improvements in his machine.

Very Unpopular

Robert Peel, the cotton manufacturer and calico printer, of Stanhill Moor, bought a number of spinning jennies, set them up in his works and was soon making a good thing out of them.

The invention of the spinning jenny by no means brought prosperity to Hargreaves. The home cotton workers of the district and, in particular, the women spinsters, saw in the mysterious "engine" of Hargreaves the ruin of their livelihoods, for, was it not plain that if Hargreaves' "engine" could spin a dozen or more threads at a time and only require the attention of one individual then eleven spinsters would be put out of employment.

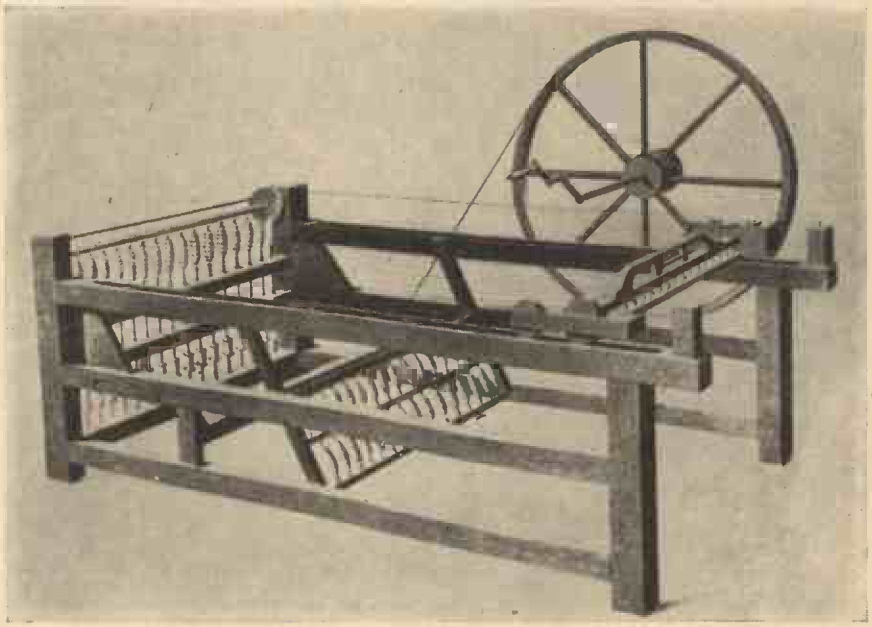
Other cotton workers, too, were opposed to Hargreaves' machine. There was, in fact, a general and widespread prejudice against any machine whatever on the grounds that such "engines" generally contrived to bring about individual unemployment.

Hargreaves, therefore, instead of attaining honour and renown, found himself rapidly becoming the most unpopular individual around Blackburn. Indeed, his unpopularity rose to such a degree that his cottage home up on the Blackburn moors was broken into one night by an infuriated mob, his machinery and jennies smashed to pieces and the cottage razed to the ground.

Poor Hargreaves, his wife and family, finding themselves utterly destitute, had to flee from Blackburn to escape the fury of the mob. They made their way to Manchester, but finding little opportunity there, proceeded to Nottingham, which town was then noted for its manufacture of silk and worsted stockings.

Invention Patented

The flight of Hargreaves to Nottingham took place in 1767 and, arrived in that city, he was given employment by a man named Shipley for whom he constructed some spinning jennies secretly in the back room of a house. Shortly after, Hargreaves was persuaded by a certain Thomas James to leave Shipley's employment and to start up with him as a cotton-spinner. It is probably due to the good offices of James that Hargreaves obtained sufficient money to patent his spinning jenny which, ultimately, he did on 12th July, 1770.



The "Spinning Jenny," the machine which created a vast industry.

As soon, however, as the new machine became known around Nottingham as it had done in his native Blackburn, Hargreaves' troubles commenced afresh. The populace of the town rose up against him. Even the rich manufacturers who appreciated the commercial value of the Hargreaves' jenny combined against the inventor and infringed his patent right and left.

Forced to take legal action, Hargreaves fought his case bitterly against the manufacturers and against others in high places. But he failed to obtain the legal protection which he desired. Owing to a technical flaw, his patent rights were held invalid and manufacturers were given the freedom to put into operation as many jennies as they pleased.

For all that, however, Hargreaves did not, like some other pioneers of cotton manufacture, die in poverty. He carried on in a partnership with jenny-making and cotton spinning until his death, which occurred on 22nd April, 1778, and in his will he left bequests amounting to some £4,000.

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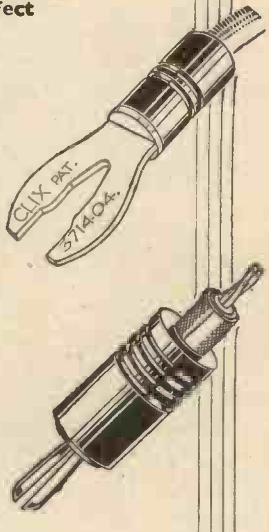

SPADE TERMINALS

An important feature embodied in all models of Clix Spade terminals is the metal shoulder piece which prevents acid creeping up to the leads. The wiring contact is positive metal to metal, and the jaw in all models is designed to give full surface contact.

The Heavy Duty model, as illustrated, is intended for bringing aerial or earth leads direct to set without having to make breaks or joins. Lead-in hole in insulators allows leads up to $\frac{3}{16}$" diameter to be used without stripping insulation tape from wires. Supplied with Red or Black Insulators.

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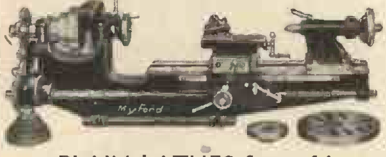

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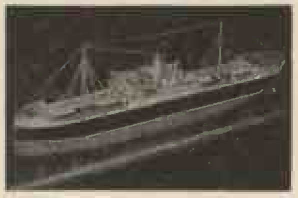

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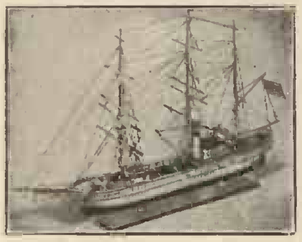

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THE TECHNIQUE OF THE WATCH TRICK

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

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

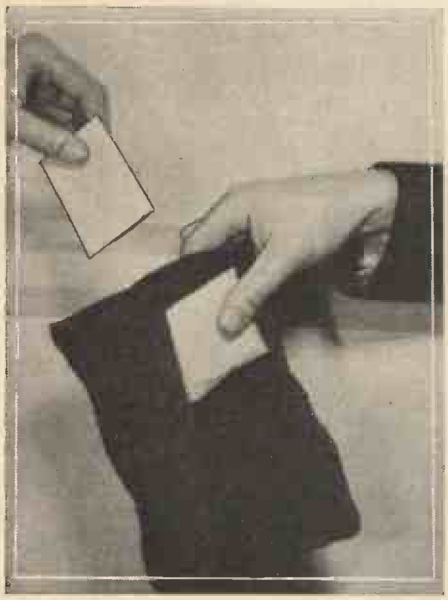


Fig. 1.—Changing a watch. The borrowed watch in the envelope held above the bag is dropped in, and remains hidden behind the partition of the double bag, the dummy watch held behind the bag is simultaneously allowed to fall with a heartrending thud on the floor.

ONE of the most popular tricks in the whole range of conjuring is that in which the performer borrows a watch from some member of the audience and proceeds, apparently, to smash it up, after which the pieces are caused to disappear in some way and eventually the watch, completely restored and none the worse for its adventures, is reproduced from some unexpected place.

This trick takes forms which are many and varied, but generally speaking the broad effect is always the same. And the procedure adopted in every case may be divided into three sections. First there is the means by which the borrowed watch is secretly exchanged for some sort of dummy which can be ill-treated in various amusing ways. Then there is the method for disposing of the pieces, and thirdly, there is the way in which the original watch is to make its appearance again.

Let us take these three parts of the trick in order and see how they can be accomplished.

Exchanging the Watch

The secret exchange of the borrowed watch for a dummy must be managed without arousing suspicion in the minds of the audience that an exchange has been made, or the subsequent comedy effects will lose all point. It must, of course, be evident to anyone who gives the matter a moment's thought that when a borrowed watch is smashed by the performer, it cannot really be the actual watch which he borrowed. But the spectators of a conjuring performance are not normally in a position to give any logical consideration to what is happening. Their minds are so fully occupied watching what is apparently being done that they have no opportunity, during the performance, to reason things out. Consequently as long as the conjurer effects the exchange of the real watch for the smashable dummy in a clean and not readily discernible manner, the destruction will be automatically accepted as happening to the real watch and the audience will be chiefly concerned with wondering how the damage is going to be repaired.

Another Version

In Fig. 1 is illustrated a simple means of exchanging a borrowed watch which at the same time leads naturally on to the smashing up episodes. To begin with the performer asks for the loan of a pocket watch, not a wrist watch in this case. He then asks some other member of the audience to collect the watch for him and place it in an envelope for safe keeping. This done the assistant is requested to drop the watch into a small cloth bag, the performer reminding him that he himself has not touched the watch at all, which is perfectly true of course. The watch is dropped into the bag and instantly, to the apparent horror of the conjurer, goes through the bottom of the bag and lands with a crash on the floor. The conjurer anxiously turns the bag inside out and discovers a large hole in the bottom, then turning to the owner of the watch to apologise, he accidentally treads on the fallen watch, with noisily disastrous results. After that completing the destruction of the timepiece follows as a matter of course.

Most of the method is clearly demonstrated in the photograph. When the conjurer picks up the bag he holds behind it a similar envelope to that in which the watch is to be placed. This envelope contains some odds and ends of cog wheels, bits of spring and other portions of retired watches together with either a couple of lumps of sugar or some nut shells. The bag is held as shown and as the real watch is dropped into the bag the dummy parcel is allowed to fall from behind. The illusion of the

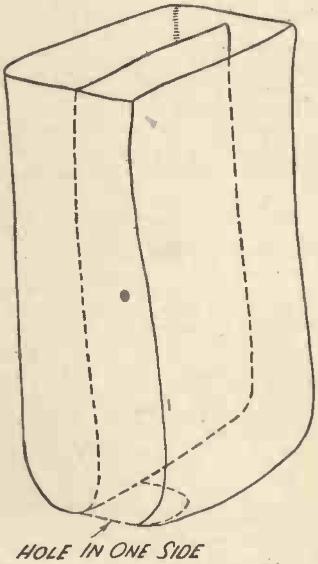
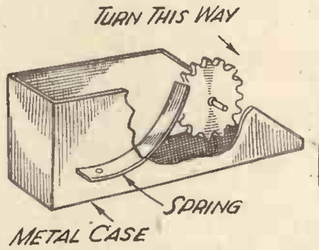
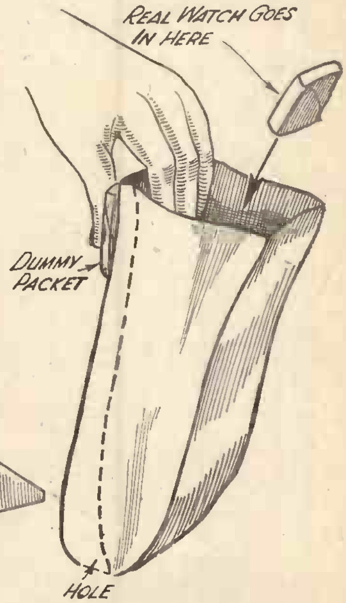


Fig. 2.—(Left) The double bag.

Fig. 3.—(Right) How the watch is changed.

Fig. 5.—(Below) The noisy watch winder.





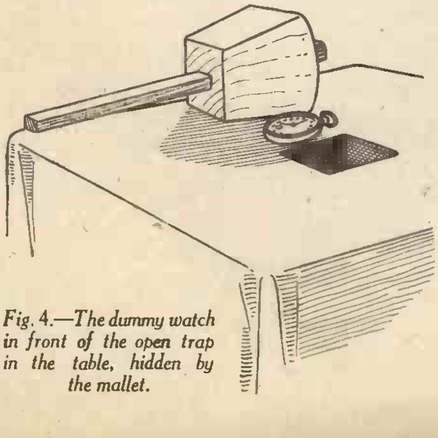


Fig. 4.—The dummy watch in front of the open trap in the table, hidden by the mallet.

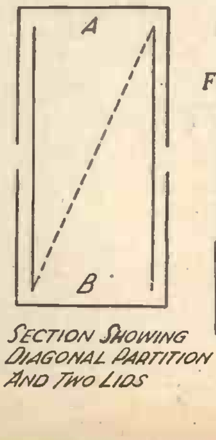
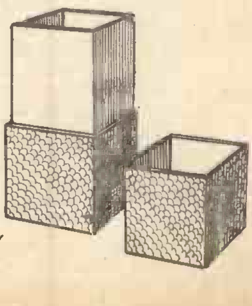


Fig. 6.—The changing canister.



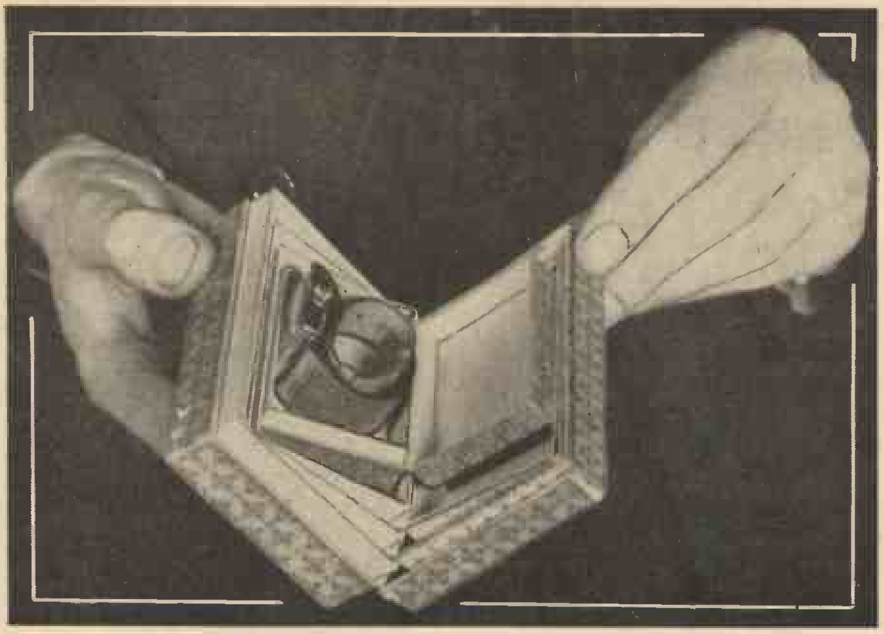


Fig. 7.—A borrowed wrist watch placed into the innermost of a nest of small boxes. The entire nest may be closed together but in opening them each must be opened separately.

watch going through the bag is perfect and the subsequent treading on the packet produces a deliciously horrifying crunch, thanks to the nut shells or sugar.

A Divided Bag

The bag itself is double. That is to say it has a partition from side to side reaching from top to bottom, dividing it vertically into two halves as shown in Fig. 2. One half of this double bag has a hole of fair size, or rather a slit, cut in the bottom. The conjurer takes care when holding the bag that the real watch is dropped into the sound side, by holding the partition against the opposite side as in Fig. 3. When he later shows the hole in the bag he grips the borrowed watch through the cloth and turns the bag inside out via the damaged side. The bag is then laid aside and an assistant carries it off to extract the watch behind the scenes or else the performer, if he is working single handed, lays the bag behind his screen and during subsequent visits to that spot for the purpose of the trick, extracts the watch himself.

Another effective way of changing the borrowed watch for a dummy is to have the dummy watch on a black art table such as I described in an earlier article of this series. The watch is placed just in front of one of the open traps in the table and in front of the watch is laid a wooden mallet. The head of the mallet hides the watch from view. When the borrowed watch is received it is apparently placed on the table and instantly hit with the mallet. What really happens is that the borrowed watch is placed down the open trap and the mallet at once lifted, revealing the dummy, which is promptly given "one on the bean." Fig. 4 makes clear this simple exchange.

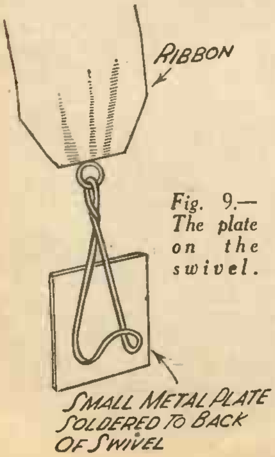


Fig. 9.—The plate on the swivel.

"Vanishing" the Pieces

This same method of exchange can also be used to cause the disappearance of the pieces of a smashed up watch. In this case the pieces are placed in a small paper bag which is then dropped down the trap, a duplicate but empty paper bag, gently puffed out to imitate the full one is then revealed on the table by removing a small square tray of some kind which has been propped up against a candlestick. The empty bag is then put on the tray and set fire to by the candle. It should be noted that a small flat weight, a penny will do, must be put in the empty bag to give it stability, otherwise it will rock about and give away its emptiness.

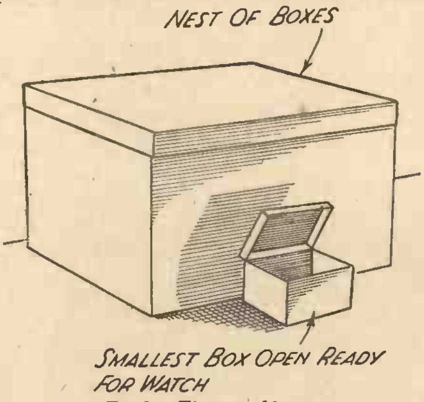


Fig. 8.—The nest of boxes.

This latter exchange could, of course, be used for making the watch vanish without including the smashing up episode if desired. In that case some comedy could be introduced by apparently winding the watch up and making it give out a racket like a rusty mangle being turned. This is managed by a small device illustrated in Fig. 5. This consists of a small flat metal case with an ordinary metal gear wheel running in it and projecting at one end. A piece of flat spring is riveted inside the case to press against the wheel like a ratchet. The device is concealed in the right hand and the wheel pushed round with the thumb, the hand being held against the winding knob of the watch. The effect is very realistic and amusing.

Methods of "Vanishing"

Now we come to methods of vanishing the pieces of damaged watch. These will call for very little explanation as, apart from those already suggested, many different ways of producing the effect will occur to those readers who have seen my previous articles. The pieces can be wrapped in a handkerchief and placed in a drawer box, being left behind in the inner drawer when the box is next opened, or they can be dropped into a hat fitted with a swinging partition and so changed for a similar handkerchief, but empty. Another method is to use a changing canister such as that shown in Fig. 6. The canister is a square tube measuring about three inches wide by six inches high. It has neither bottom nor top but is fitted with a partition running diagonally and dividing the interior into two parts, *A* and *B* in the diagram. There are two push-over lids which fit on at opposite ends and meet in the centre. The pieces of watch are placed in end *A*, that lid being removed for the purpose and lid *B* doing duty as the body of the canister. Lid *A* is then put on and the canister turned upside down in carrying it to another table, after which lid *B* is removed and the pieces of watch have seemingly changed to a handful of confetti, or anything else the performer likes to have inside *B* of the canister.

Reproducing the original watch intact in a striking manner can be managed in several ways. One of the most popular is to find the watch in the smallest of a nest of boxes. There are several methods of producing this effect.

Hinged Lids

Fig. 7 shows a wrist watch lying in the innermost of a nest of cardboard boxes. The boxes have hinged lids and they are prepared for the trick by opening them all and placing them one within the other so that all the lids open the same way. The nest so arranged is placed behind a screen or in a hat, out of sight of the audience. The watch having been disposed of in one of the ways already discussed, the performer secretly gets possession of it and, going to fetch the boxes, he places the watch into the innermost and closes the lot by the simple process of shutting down the lid of the outside box. The nest is then brought on and in due course opened, when, although all the boxes were closed at once, each box must be opened separately. Any reasonable number of boxes may be used, but six or eight is usually sufficient. The time taken to open this number of boxes is of course out of all proportion to the mere second or so needed to put the watch in and close them.

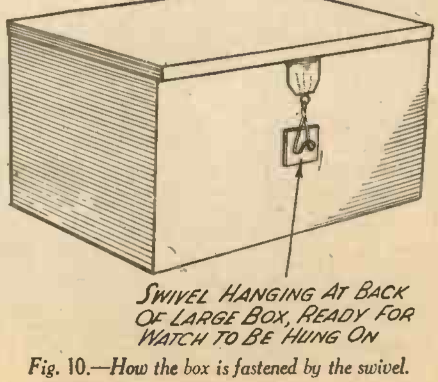


Fig. 10.—How the box is fastened by the swivel.

Another Aspect

This brings me to another important aspect of the watch trick. The borrowed watch, having been exchanged for a dummy, is nearly always secured soon after the exchange, either by the conjurer or his assistant and immediately placed in the apparatus from which it is ultimately to be produced. This enables the article containing the watch to be brought into view before, as far as the audience know, the watch has left their sight. For example in the trick just explained, as soon as the real watch is secured it is slipped into the nest of boxes and the nest given to someone to hold. The dummy watch is still on view so that when it is eventually vanished and the watch caused to appear in the smallest box of the nest the effect is completely baffling because the audience imagine that the nest of boxes was given to the spectator to hold before the borrowed watch had left their sight. This is a most important aspect of the watch trick, and indeed of any trick in which borrowed articles are used.

In another form the boxes forming the nest are of wood and there may be as many as twelve or even more of them. They, or rather the outer box which contains the others, remains in full view throughout the performance, even before the watch is borrowed so that the eventual appearance

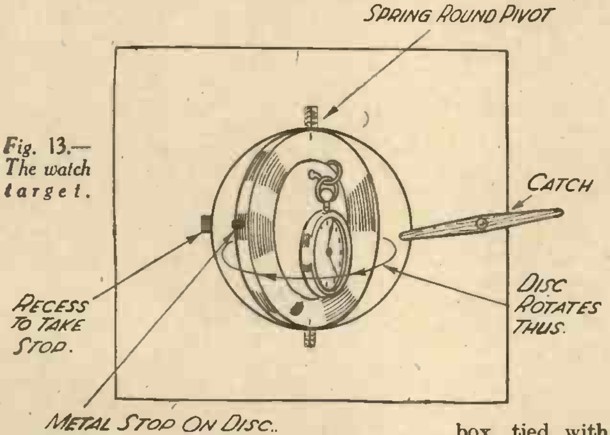


Fig. 13.—The watch target.

of the timepiece from the smallest box becomes almost a miracle. It is, however, a miracle simple to explain.

The smallest box of the nest, lined with a crumpled handkerchief or some wadding is behind the large outer box. The lid of the small box is open, as shown in Fig. 8. The audience see only the large box and, not knowing what is coming, have no reason to suspect the presence of the little one behind it. When the conjurer has secured the borrowed watch he places it into the small box and closes the lid. This may be done quite easily under cover of drawing attention to the large box. Now for another part of the secret. The next smallest box of the nest, which at the beginning of the trick is inside all the other boxes, is bottomless. When the conjurer opens the boxes, he closes the lid of each box as he withdraws those inside and puts the inner box on it. In this way he gradually builds a pyramid of boxes. When he reaches the bottomless box he will have such a pile on the table that it is quite natural for him to put them aside out of the way. He therefore puts the bottomless box down behind the pile and clean over the smallest box. He then takes away the pile of opened boxes, leaving the bottomless one in view. This box in turn he opens and extracts the one now inside it. This of course when opened is found to contain the vanished watch. A pretty and effective piece of conjuring as anyone could wish for.

Fig. 11.—A box with a trap-door bottom and the inner lining which is used to introduce the borrowed watch.

Added Effect

In this version of the trick it adds to the effect considerably if all the boxes are tied with tape, the tape passing lengthways and widthways round each box. This does not make the trick any more difficult as the tape does not cross the under side of the bottomless box, and white hat elastic is substituted for tape in the smallest box, permitting the lid to be propped open for the reception of the watch.

Another variation of the last effect can be performed by producing the vanished watch from the smallest box, tied with a ribbon round the neck of a teddy-bear or stuffed toy of similar type. In this case the preparations are even simpler. The toy has a ribbon round its neck and to the end of the ribbon is attached a swivel hook. The swivel hook should have a small piece of metal soldered to the non-opening side so that when it is suspended against the side of the box it will not turn round. See Fig. 9.

To set the trick, place the toy in the smallest box and tie up the box, leaving the ribbon hanging out. Place this box in the next larger and seal this with cord, again leaving the ribbon hanging out. Continue in this way until all the boxes are fastened and the swivel hangs out at the side of the largest as shown in Fig. 10. Place the nest on a table with the hinged sides to the front and the swivel hanging therefore at the back, out of sight.

Borrow a watch, change it as already described and in due course get possession

Fig. 14.—Shooting a watch. The centre of the target is spring pivoted and flics round when released, to reveal the watch previously hung at the back.

of it. Holding the watch in your right hand, pick up the nest of boxes to show it and in doing so hook the watch to the swivel. A pocket watch should be used for this trick, not a wrist watch. Put the boxes down and proceed with the vanishing of the watch. When you want to reproduce the watch you have only to open the boxes, withdrawing in turn the ones inside and the watch will be drawn up with each succeeding box, remaining dangling out of sight behind the boxes. When you finally reach the smallest box and take out the teddy-bear, the watch, coming from the back of the box,

(Continued on page 354)

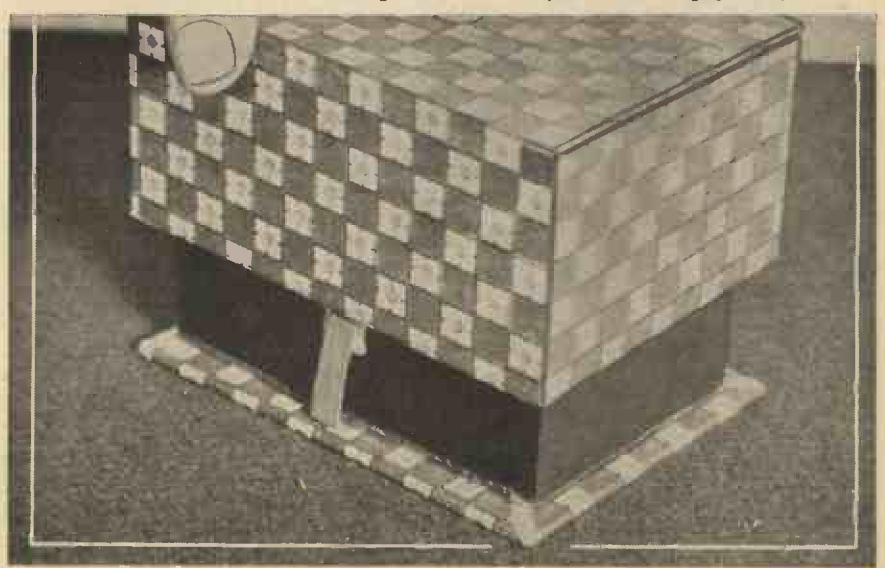


Fig. 12.—The lining of the box shown in Fig. 11 being introduced into the closed box via the trap-door bottom of the latter.

Televisio

THE RECENT ACTIVITIES AND DEMONSTRATIONS IN CONNECTION WITH TELEVISION PICTURES PORTRAYED ON BIG SCREENS HAS BROUGHT CINEMA TELEVISION TO THE FORE ONCE MORE. A BRIEF SURVEY OF THE DEVELOPMENTS LEADING UP TO THIS IS MADE IN THIS ARTICLE.

TELEVISION pictures received by cable or radio and reproduced on some form of screen large enough for audiences of several hundred to witness the results in complete comfort, has been one aspect of the developments of television which has engaged the services of engineers for the past few years. Although existing in the imagination some ten years ago, the events of the past few months have made it clear that equipment giving satisfactory results for the cinema or theatre is on the verge of real commercialisation. In reaching this point big screen television has passed through many vicissitudes, and many and diverse have been the schemes tried in an effort to achieve results capable of providing sustained entertainment with sufficient brightness and freedom from flicker to prevent eyestrain.

Over Seven Years Ago

Before dealing with the more modern ideas, therefore, it will be instructive to review briefly how some of these earlier methods attempted to give satisfactory large pictures. In 1930, when low-definition television transmissions were the only signals available, the lamp screen was demonstrated by Mr. Baird. This consisted of a 7 ft. by 3 ft. honeycomb frame of 2,100 ordinary filament lamps, each being joined to a bar in a 2,100 segmented commutator. The lamps were lit in turn at high speed (25,000 contacts were made by the brushes as they swept over the commutator surface), and the degree of brilliance exhibited by each individual lamp was governed by the received television signal. Part of the original equipment used for this purpose is shown in Fig. 1, and since the lamps had inherent luminous inertia the effect was not that of a single travelling light spot, but rather a semi-permanent picture remaining on the screen with persistence of illumination supplementing persistence of vision. The pictures shown were quite brilliant and represented an important step forward over other methods, but since the degree of definition was only 30 lines they fell short of sustained entertainment value when judged by present day standards.

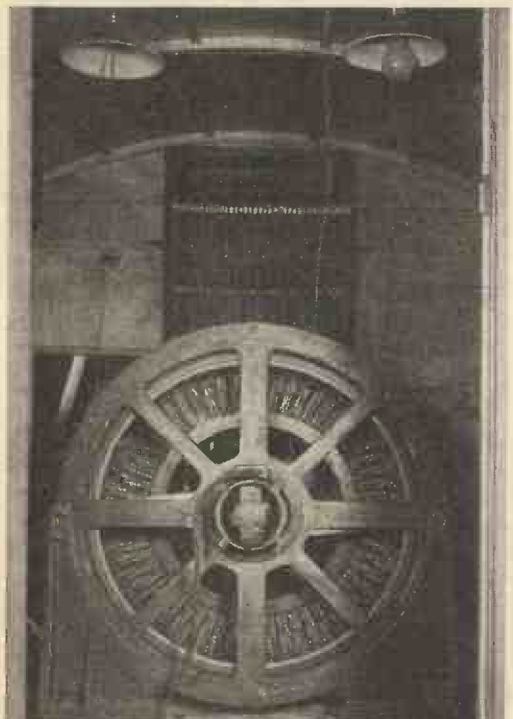


Fig. 1.—The commutator and back of the lamp screen used for the big screen demonstration in 1930

Multi-zone Schemes

It was known at that time that the question of screen brilliance would become more acute as the quality of the transmission channel improved, since the light spot becomes proportionately smaller in relation to the screen as the number of elemental areas embodied in the picture increases. In an attempt to meet this situation pictures transmitted in a plurality of zones were developed and these were featured for the first time in January, 1931, by both the Marconi and Baird Companies. The former showed a fibe zone film transmission by television and the latter a three zone direct pick-up scheme Land lines were employed in both cases and an idea of the arrangement is shown in Fig. 2. Revolving mirror drums served as the mechanical analysing and reconstituting methods, and providing the zones were properly matched the pictures were satisfactory within the limits of definition then available.

At the same time another method was demonstrated, still with the idea of big pictures with adequate illumination. This consisted of directly modulating the current passing through an arc lamp without the assistance of subsidiary modulating apparatus. Fig. 3 shows the idea in simple pictorial fashion, and there is no doubt that the picture brilliance achieved was outstandingly good. Unfortunately it has not been found possible to maintain this direct arc modulation at the frequencies required for high-definition television, but there is no doubt that the idea was a real step forward towards the goal of entertainment for large audiences in cinemas or theatres.

An Ambitious Effort

Following on this was the first attempt by Baird at showing scenes from the Epsom race-course on Derby Day to a cinema audience by television. This was undertaken in 1932, the receiving equipment being of the three zone type giving a picture 10 ft. by 8 ft., with a 90 line definition. It was accommodated on the back of the stage of the Metropole Cinema, London. Fig. 4 illustrates the apparatus which was built up from three arc lamp beams whose light intensities were modulated by Kerr Cells, which in turn were operated by the incoming television signals. The emerging beams were focussed on to a mirror drum kept in synchronism with the scanning equipment at the transmitting end, and from the drum passed to a reflecting mirror to be back projected finally on to the translucent screen. Bearing in mind the difficulties associated with an initial experiment of this nature, the results were most creditable, for in addition to the crowds the horses were seen flashing past the winning post.

A single zone of this same equipment was subsequently exhibited in other parts of this country and on the continent in conjunction with portable television transmitting apparatus, and the interest shown left no doubt as to the keenness of the public for big screen pictures.

The Intermediate Film Method

Quiet apart from these mechanical methods of reproducing television pictures, another quite distinct scheme was developed both in this country and abroad, and is, in fact, still being employed for demonstration purposes in Germany. This is the intermediate film method, which is characterised by the fact that there is a few seconds delay between the time of receiving the broadcast television

Fig. 4.—Part of the receiving ... of the Metropole Cinema, ... with the first big screen te...

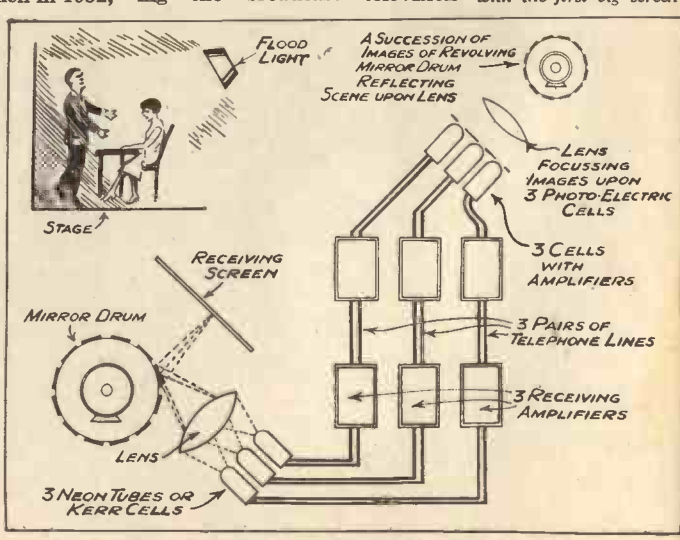


Fig. 2.—A simple schematic representation of multi-zone television used to give larger and brighter pictures.

on *in the* Cinema

equipment on the back stage 'ictoria, used in connection levising of the Derby race.

signals and their ultimate reproduction on the screen. In one scheme a continuous loop of film is employed, while in the other the film with the recorded television pictures is wound up on a spool for use on subsequent occasions. The first idea is shown in simple pictorial fashion in Fig. 5. The incoming television signals are made to modulate a Kerr Cell or cathode ray tube in conjunction with scanning equipment, and these results are recorded photographically on a film negative fed through a camera. This film is subsequently developed, washed, fixed and dried and then passed through a standard form of cinema projector so that the recorded pictures can be thrown on to a theatre screen in the normal manner with the same degree of brilliance. The film is then led through chambers, the emulsion and picture is removed, new emulsion coated on, and, after drying, passed through the recording camera again to repeat the whole process once more.

In the second scheme the method of recording and subsequent picture projection on to the screen is the same, but new film is fed continuously into the recording camera and no attempt is made to use the film over and over again. The complete apparatus can be built up into quite a compact form, and an excellent example of a German version is produced by the Fernseh Company. On the left is the cathode ray tube and recording film camera. The processing tanks are contained in the rectangular base on which the apparatus is accommodated, and on the right hand side is the cinema projector similar in most respects to a standard model except that the top film spool chamber is missing owing to the film being fed directly from the final drying tank.

Modern Mechanical Schemes

Yet another scheme for big screen working is that represented by the permanent installation used by Baird at the Dominion Theatre, London. This now gives a large television picture in colour, interlaced scanning by mechanical methods being employed in association with red, blue and green filters. The installation was demonstrated to the public over a year ago, the pictures then being monochromatic and regarded somewhat in the light of a television public address system.

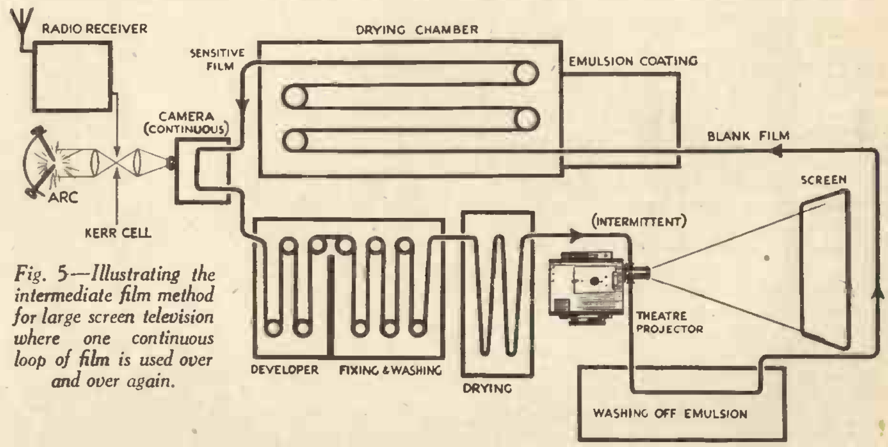


Fig. 5—Illustrating the intermediate film method for large screen television where one continuous loop of film is used over and over again.

One of the latest forms of mechanically reconstituted television pictures is that featured recently by Scophony, by showing pictures received from the standard B.B.C. television transmissions from Alexandra Palace. The apparatus is capable of portraying pictures 6 ft. by 5ft., and for this purpose modulates the light beam from a 100 ampère arc. The incoming television signals are applied to a quartz crystal control to which is fed a supersonic frequency to set up waves in the liquid forming part of the unit. This device enables the degree of light emerging to be in direct proportion to the intensity of the television signal so that when passed to a combined mirror polygon scanner it is possible to back project the reconstituted pictures on to a screen to conform to the present 405 line interlaced picture standards of the B.B.C. The pictures shown so far are quite bright and steady and represent a new line of development in so far as mechanical optical television is concerned.

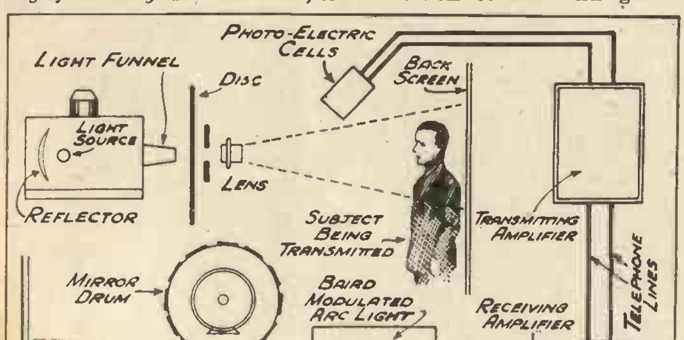


Fig. 3.—A pictorial idea of how an arc lamp was directly modulated to give brilliant low-definition pictures on a big screen.

Using Projection C.R. Tubes

For some time research has been directed towards the development of cathode ray tubes of small size capable of reproducing an intensely brilliant picture on a screen diameter of approximately 4 to 6 inches. This miniature picture is then so bright and well defined that it can be projected by means of a suitable lens system on to a remote screen for observation purposes instead of being watched as a picture on the tube screen itself, as in commercial home receivers. The success which has crowned the engineers' efforts in this connection was made manifest recently by the demonstration given to newspaper press representatives by the Baird Company at the Palais Cinema, Bromley. Brilliant and steady pictures with ample contrast were shown to a size of 8 ft. by 6 ft. 6 ins. under conditions simulating those which must operate when cinemas ultimately incorporate television receivers for showing pictures to their patrons. High anode voltages are necessary for projection tubes of this type, and quite naturally precautions must be taken to ensure that the power dissipated at the screen surface does not in any way cause disintegration. Pictures of this type are controlled quite easily, while the scanning and focussing are carried out in a manner similar to that for a home receiver. A proper balance between the brightness and contrast controls ensures that the picture is clearly visible in any seat of the cinema. Electro-optical equipment of this nature has the advantage of being able to be set up on site very readily and needs only normal supervision to give pictures of sustained entertainment value.

There is no gainsaying the fact that technically big screen television suitable for cinemas and conforming to the modern high standards of definition has now arrived, and the next point to settle concerns the right of cinema exhibitors to show the broadcast pictures to their patrons. At present the B.B.C. hold a monopoly for a public television service, but it is certain that the points at issue and the rights involved will be capable of adjustment so that cinema and theatre audiences can enjoy to the full the fruits of the labour of television engineers engaged on this important branch of big screen television development.

Mr. S. J. Crouch's modified "Dragon" petrol model. Inset: the model in the air.

A model ski-plane made by Mr. A. H. Cutts and modified from the designs for a Five-minute Flyer, given in our issue dated September, 1936.

MODEL AERO TOPICS

CURRENT NEWS FROM THE WORLD OF MODEL AVIATION

BY F. J. C.

N.M.A.C. Model Exhibition

THE North Hants Model Aero Club (Kettering Section) held a model exhibition during February, which was well attended. This section is composed of keen aero modellists, and I reproduce below a photograph of the petrol model built by the Brothers Cragg.

I should like to see more of these local exhibitions, especially in districts where club membership is small. Nothing awakens interest or rekindles it so much as a show of work done. It is always possible to find a local hall where models can be exhibited, and a small entrance fee will add a useful sum to club funds.

A Ski-plane

Mr. A. H. Cutts sends me two photographs of his model ski-plane which he has adapted from designs for the Five-minute Flyer described in our issue dated September, 1936. The modifications include an uncambered wing section, a streamline built-up tail and rudder, a trimming tab, a free-wheel, and, of course, a different undercarriage. The wheels were removed and bamboo skis fitted to the undercarriage with an additional pair of rear supports. The skis were made long enough to support the plane, in flying position, and eliminate the need for a tail skid. The total extra weight was under ½ oz., and duration was well up to standard. On hard snow the take-off run from a standing start was only 4 ft. and the landing run up to 60 ft. On soft snow, however, the take-off distance was over 60 ft. and flights were very steady, no doubt due to the lower centre of gravity.

Blue Prints

Mention of the Five-minute Flyer reminds me that we stock blue prints of model aeroplanes, including this very successful model. Readers will find the blue print very convenient as a template when building the wings, fuselage, etc. On the next page I reproduce a photograph of a model of the Five-minute Flyer, made by Mr. G. M. Gale, who states that the performance of the 'plane in every way justifies the claims made for it. The only departure he made from the original design he says, was to dope the Japanese tissue, although I cannot quite understand what he means by this, since the original instructions did recommend doping.

S.M.A.E. Handbook

A valuable and most interesting handbook, as noted in last month's issue, has been compiled by the S.M.A.E. It contains no less than forty pages of valuable data, and as it has been produced by the controlling body, the authenticity of the matter is beyond question. It is a small textbook and competitor's guide combined. Copies can be obtained from Mr. York, of the Model Aircraft Supplies, 171 New Kent Road, London, S.E.1, and from other members of the S.M.A.E.

The Competition Season

The competition season will shortly start, and I am hopeful that this year someone will organise a gigantic national rally and model flying meetings, so that the hobby of model aeronautics can take its rightful place as the leading mechanical and scientific pastime of the age. In a book which I wrote in 1919, Mr. Handley Page states in the foreword: "In the ensuing years, aircraft is going to play an important part in the commercial and national interests of all nations, and only those competent in aeronautics can acquire the positions eventually to be had. No more certain way of acquainting oneself with the alpha and omega exists than the making and flying of model aeroplanes. These are within the means of everybody to make, and there is no reason why the subject should not become part of the curriculum of our technical schools and colleges." Those remarks, made nineteen years ago, were really prophetic, and Mr. Handley Page has seen his words come true. The time has come when our schools should not devote in their

Mr. L. Cragg with the petrol model built by himself and brother, J. W. Cragg.

Another view of Mr. Cutts' model ski-plane.

Mr. G. M. Gale's model of our Five-minute Flyer.

practical instruction too much or all of their time to practical crafts such as woodwork; they should encourage hobbies of a scientific nature. I hope my schoolmaster and schoolteacher friends will do their best to form model aircraft clubs among their scholars. Several schools have already founded very successful model aero clubs; some even build full-size aeroplanes and gliders.

IGNITION HINTS FOR BEGINNERS

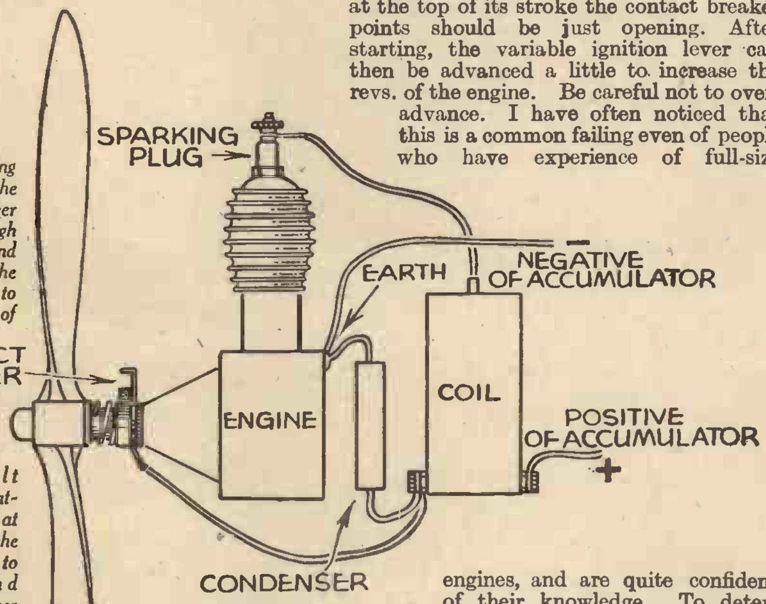
TESTING OUT A NEW MINIATURE PETROL ENGINE

THE following remarks will help quite a number of newcomers to petrol work, in what often seems to give them trouble, the ignition gear.

On receipt of the new engine after purchase a number of people fail to get it going because simple knowledge is lacking. I suggest they first of all check over the ignition gear in the following order:

1. Clean contact breaker points by closing and then pulling a piece of stiff paper between the points.

2. Check ignition timing and set correctly, if not already set correctly to get a start.



Start tracing wiring from the contact breaker points, through the coil and one end of the condenser to positive side of the 4-volt starting battery. Start at negative of the accumulator to earth and through other end of condenser.

A Common Failing

Except where otherwise specified by manufacturers when the piston is exactly at the top of its stroke the contact breaker points should be just opening. After starting, the variable ignition lever can then be advanced a little to increase the revs. of the engine. Be careful not to over-advance. I have often noticed that this is a common failing even of people who have experience of full-size engines, and are quite confident of their knowledge. To determine that the piston is at the top of its stroke take out the sparking plug and the piston can be seen as the engine is rotated. On many engines the piston position can be seen by looking through the exhaust port. If the points are not opening as suggested at top dead centre, the contact breaker gear should be rotated until the points just begin to open. This opening, of course, is caused by the cam behind the propeller boss.

Ignition Timing

This question of ignition timing must be grasped by the model engine owners.

3. Trace wiring as shown in the diagram, and see that all wires are connected. Assuming that all wires are connected correctly this tracing of the wiring will teach the novice to understand his wiring system for the future.

4. See that the starting battery is a large one with plenty of capacity. A 4-volt accumulator of not less than 40 amps. is advisable, or if not obtainable, 3 large bell batteries can be wired together. But these dry batteries do not always last at full strength for long, and are really nothing like so satisfactory as a well-charged accumulator, and in the long run are far more expensive. I use 4 volts for starting and warming up. I have not included the small flashlamp battery for flight in my diagram, as I am only concerned for the moment with getting the novice to run his engine up on its skids when first received. Later he will master the inclusion of the flashlamp battery for flight and the time switch for controlling duration of flight.

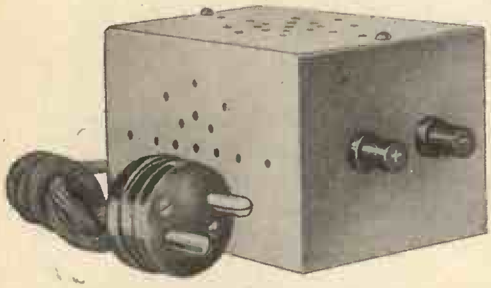
5. Be careful to see that the "petrol" mixture as used on most model two-strokes is really well shaken up and properly mixed. Unless otherwise specified, use 1 part good heavy motor-cycle oil to 3 parts of any No. 1 grade petrol for running in the engine. Later a mixture of 1 part oil to 4 parts petrol can be used.

6. Test that there is a fat and hot spark being given *every time the engine is being turned over.* It is well to take the sparking plug out and see that this spark occurs regularly at the points by laying the plug on the cylinder and turning the engine over. Sometimes the plug is at fault. *Generally the contact breaker points are the trouble. They become dirty by creeping oil. Clean them frequently, as suggested in paragraph one.* Manufacturers should mark their coils for correct connection.

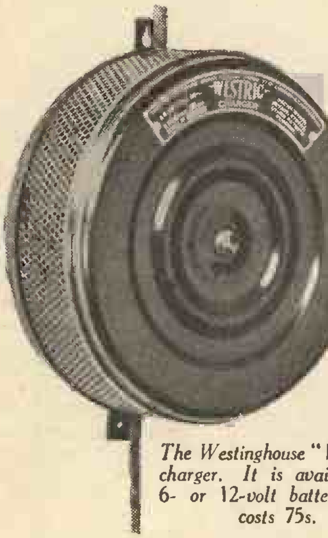
C. E. B.

Battery Trickle Chargers

Chargers are Now Available at Prices from 12s. 6d. Upward. They are Perfectly Safe, Have a Wide Field of Utility and Use a Negligible Amount of Current in Normal Circumstances, so that Running Costs are Rarely More than a Penny for Fifty Hours; in Many Cases, they are Much Lower than this



One of the lowest-priced chargers made. It is the Heaberd "Tom Thumb," and charges 2-volt batteries at ·5 amp. The price is 12s. 6d.



The Westinghouse "Westric" charger. It is available for 6- or 12-volt batteries and costs 75s.

THE popularity of accumulator trickle charging has increased very rapidly during the past two years. So much so that a very large percentage of motorists who have a mains supply in their garage now use a charger in order to keep the battery in a fully charged state. Those who use battery-operated wireless receivers have been users of trickle chargers for a number of years, but it is only during the present winter that the number of chargers in use has increased so rapidly.

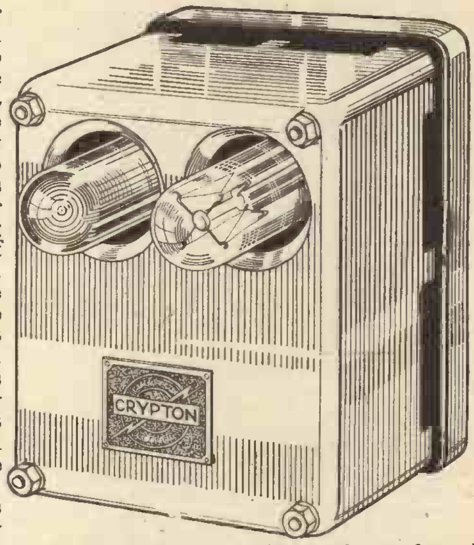
There are various reasons for the rapid growth in the use of trickle chargers, the first of which is that prices are now extremely modest. Additionally, however, the public has come to realise that a charger is perfectly safe and very easy to use correctly. What is more important, it is now understood that the cost of current for operating the charger is negligible.

The object of the trickle charger is, as the name implies, to charge at a very low rate—a "trickle" of current. Thus, the current taken out of the battery during the daytime, for example, can be replaced during the night. Suppose that an accumulator is used to feed a battery-fed wireless set or electric model taking ·5 amp. for six hours a day. This means that the consumption is 3 amp. hours a day, which is the drain on the battery.

That current could be replaced by charging the battery at 1 amp. for three hours, or at ·5 amp. for six hours, or at ·25 amp. for 12 hours. Using the last-mentioned charging rate, the battery could be kept "full" by leaving it on trickle charge over-night.

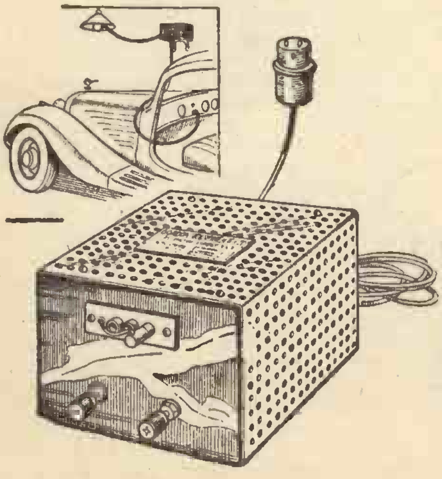
Not only does regular charging prevent the battery from becoming "flat," but prolongs its useful life.

Besides their use for battery charging, small trickle charges are extremely useful for operating directly small D.C. electric models and other apparatus. A number of typical chargers is illustrated on this page. As can be seen, prices range from 12*s.* 6*d.* upwards.

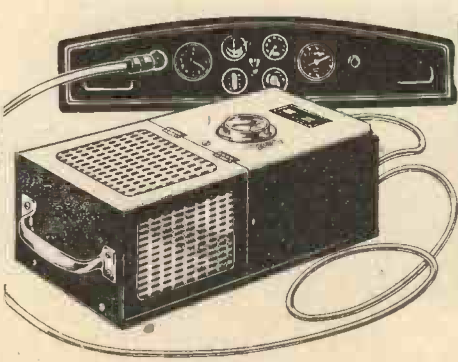


This Crypton charger employs a valve rectifier and gives a constant charging current of 1·3 amp. at 6 or 12 volts. It costs £4 complete with Philips valve.

Neatness is a feature of the Philips Home Charger. It uses a valve rectifier, and is obtainable with output of 6 or 12 volts at 42s. 6d., or for both 4 and 6 volts, at 65s.



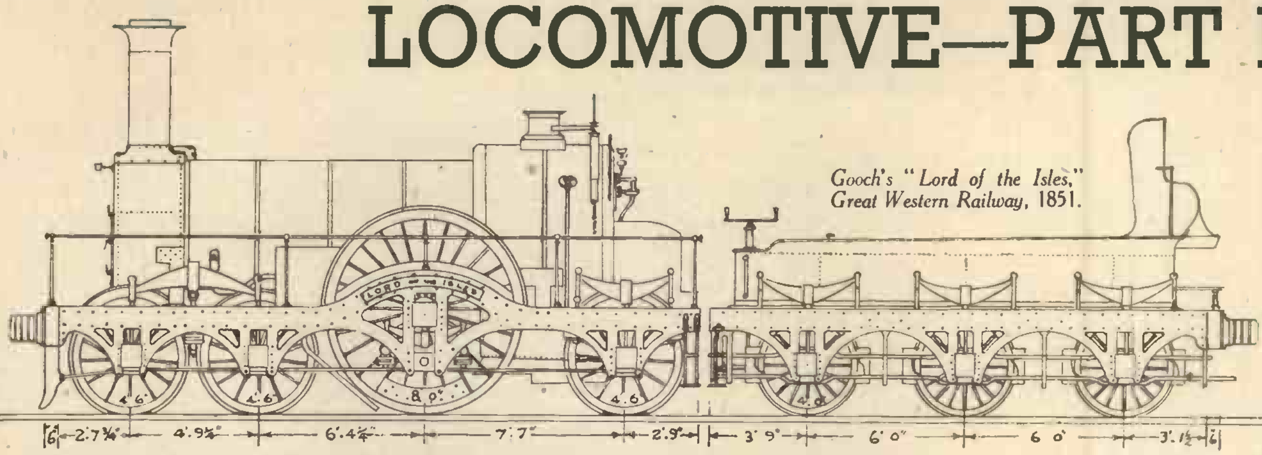
This is the Gordon 1-amp. charger, for 2-, 6- or 12-volt batteries. It is listed at £2 15s.



One of the many "Davenset" chargers.

The Heaberd type A.O.9 charger costs £5 5s., has an output of 1 to 3 amp. at 2, 6 or 12 volts.

PROGRESS OF THE BRITISH STEAM LOCOMOTIVE—PART II



Gooch's "Lord of the Isles," Great Western Railway, 1851.

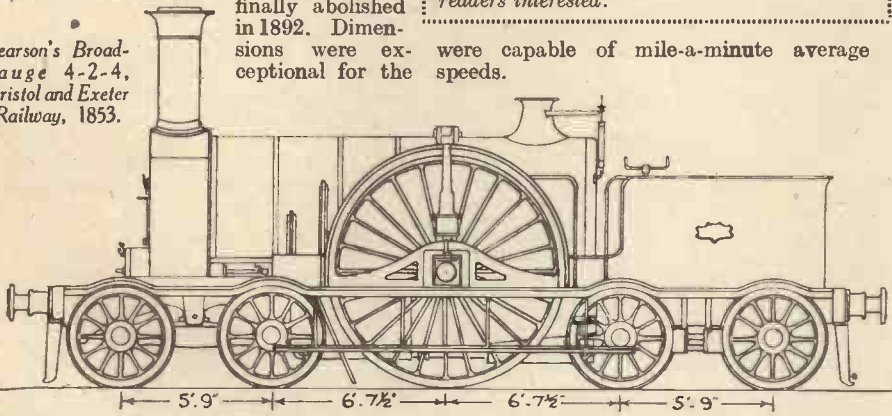
By W. J. Bassett-Lowke, M.I.Loco.E.

Gooch's "Lord of the Isles," Great Western Railway, 1851—

THE contention was that the broad gauge would be of the utmost service in the development of rolling stock and Gooch proceeded to prove it by building engines in power nearly half a century ahead of their time, and Brunel's specially designed longitudinal sleeper track capable of carrying their weight, gave the G.W.R. a reputation for wonderfully smooth travel. His earlier engines of the "Great Western" type were based on the "North Star." In 1847, however, he produced the much larger 4-2-2 "Iron Duke," from which developed the "Lord of the Isles" class in 1851. This was the principal express type of the Great Western until broad gauge was finally abolished in 1892. Dimensions were exceptional for the period, including the 4 ft. 9 in. diameter boiler, the 1,790 sq. ft. of heating surface, the 25 sq. ft. of fire grate and engine weight of 38 tons. Remarkable speeds too were attributed to these engines. There is no doubt they were capable of mile-a-minute average speeds.

We appreciate the interest that has been taken in the first instalment of our "Milestones" series and anticipate that when we get to more modern times we shall receive a certain amount of criticism regarding our selection. The selection has been made in collaboration with two well-known railway students and writers, Mr. E. W. Twining, who has provided me with the drawings, and Mr. Cecil J. Allen, whose assistance in railway matters has been invaluable.

The elevations which illustrate this article are all to the same scale, 3½ mm. to the foot and are suitable for 16 mm. gauge railways. Detailed drawings are available for those readers interested.



Pearson's Broad-gauge 4-2-4, Bristol and Exeter Railway, 1853.

Stirling's "Eight-footers," Great Northern Railway, 1870

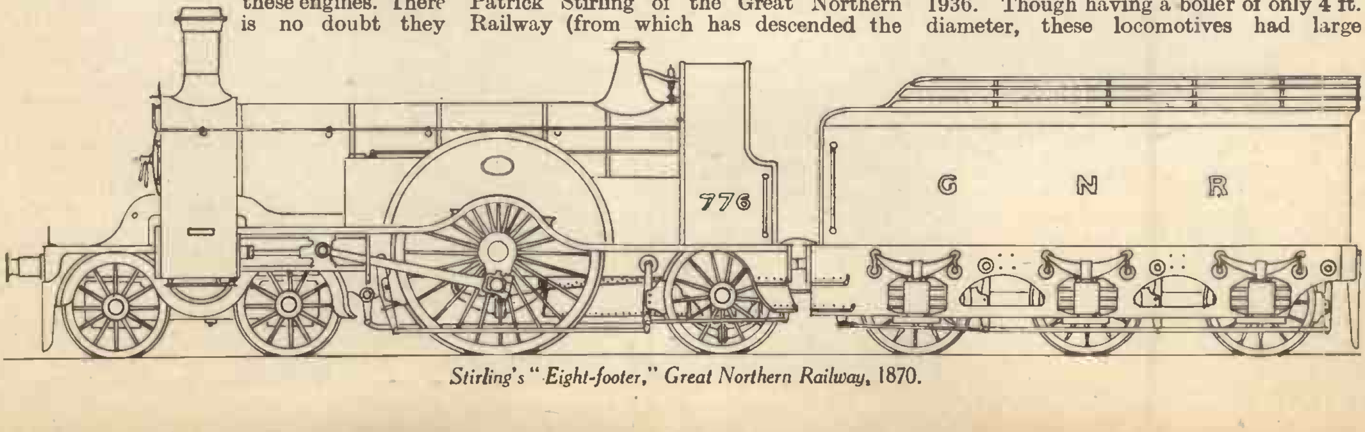
Throughout British history the G.N.R. had been the speed rival of the G.W.R., and Patrick Stirling of the Great Northern Railway (from which has descended the present-day London and North Eastern), like Gooch, favoured large driving wheels; the 8 ft. 1½ in. wheels of his engines gave them the familiar name of the "Stirling Eight-footers." Also like Gooch the Stirlings refused to have anything to do with domes, so that their engines have the characteristically unbroken line on the boiler from chimney to safety valves. Steam was collected from the boiler by a perforated pipe in the upper part of the barrel, and the designer thus avoided weakening the boiler shell by cutting a hole in the dome. Stirling drivers took part prominently in the Race to Edinburgh of 1888 and the Race to Aberdeen in 1895, and few more beautiful locomotives have been designed than these. They were the embodiment of grace in motion.

We now come to the high-spot locomotives of later railways, the London & North-Western Railway, London, Brighton & South Coast Railway, and the Midland and Caledonian Railways, as well as outstanding engines of those railways I have previously mentioned.

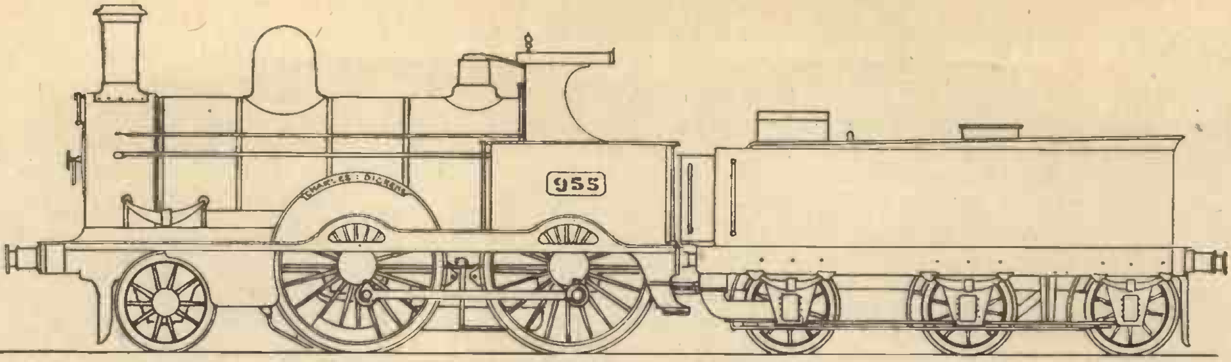
Webb's 2-4-0 "Charles Dickens," London & North-Western Railway, 1874

The London & North-Western Railway, by comparison with its neighbours, seems to have used the smallest engines possible for its passenger work, and this fact accounts for the large number of double-headed trains running on its lines.

Most popular were the "Precedents," or "Jumbos" as they were called, and the first of these neat little engines, designed by Francis William Webb, appeared in 1874, while the last survivor was at work until 1936. Though having a boiler of only 4 ft. diameter, these locomotives had large



Stirling's "Eight-footer," Great Northern Railway, 1870.



Webb's 2-4-0 " Charles Dickens," London & North-Western Railway, 1874.

cylinder ports, evacuating the steam quickly, and the secret of their high speed capacity.

The " Precedent "

The " Precedent " " Hardwicke " in the race to Aberdeen in 1895, covered the 141 miles from Crewe over Shap Summit to Carlisle in 126 minutes, at an average of 68 miles an hour, which is faster than the streamlined " Coronation Scot's " present schedule.

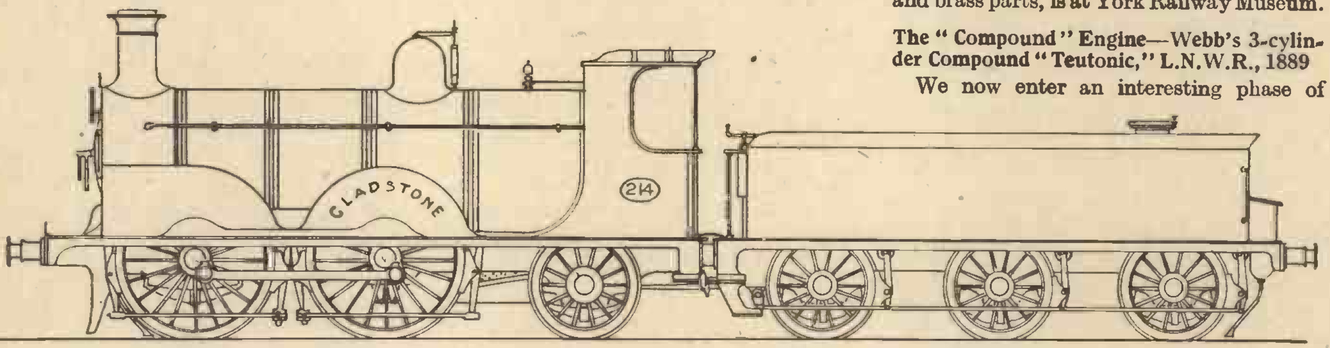
Illustrated is the most celebrated of the " Precedent " class 2-4-0, " Charles Dickens." Built in 1882, it ran daily from Manchester to Euston and back, and in 1902 was stated to have completed 2 million miles. It would be interesting to know how much of the original engine remained to be scrapped in 1912, when another quarter of a million miles had been added !

Stroudley's 0-4-2 " Gladstone," London, Brighton & South Coast Railway, 1884

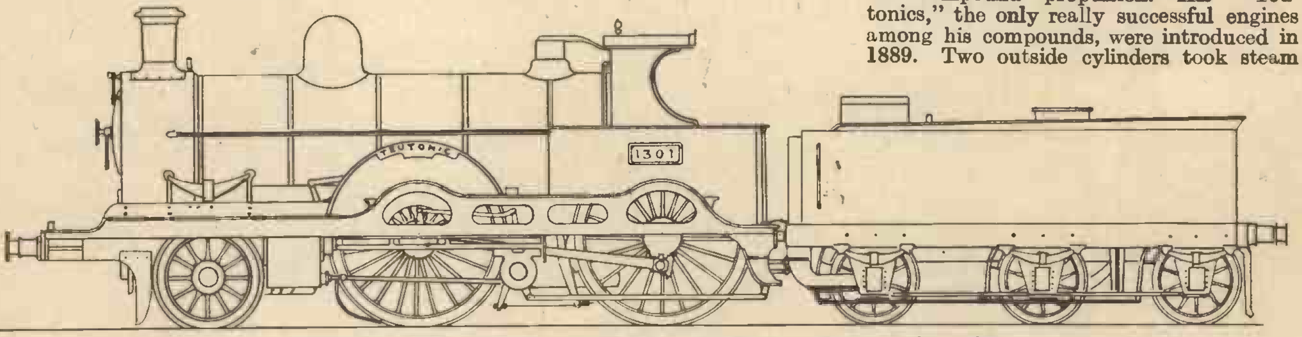
Webb did not provide his " Precedents " with a 4-wheeled bogie at the leading end of the engine, to carry it smoothly round the curves ; but William Stroudley of the London, Brighton & South Coast Railway turned his wheel-base round, and put his driving wheels at the leading end of the engine. The 0-4-2 wheel arrangement had been previously tried for small-wheeled mixed traffic or slow passenger engines, but never before in Britain for express passenger engines. The first of these engines appeared in 1878, followed in 1882 by the larger series, in which the model illustrated is included. Stroudley's 0-4-2 " Gladstone " of the London, Brighton & South Coast Railway has been chosen. The original, with its gay gamboge yellow colouring, red lining, and copper and brass parts, is at York Railway Museum.

The " Compound " Engine—Webb's 3-cylinder Compound " Teutonic," L.N.W.R., 1889

We now enter an interesting phase of locomotive history, the development of the " Compound " engine. Webb, who designed the " Charles Dickens," thought that better use could be made of steam if two successive stages of expansion were used, i.e. compound propulsion. His " Teutonics," the only really successful engines among his compounds, were introduced in 1889. Two outside cylinders took steam direct from the boiler, and drove the rear pair of driving wheels. After use in these, the steam was led to a receiver, and from there to one large single cylinder between the frames, driving the front pair of wheels. This method of propulsion caused a slow and measured exhaust, for there were only two puffs instead of four to each revolution of the driving wheels. The pairs of wheels also could slip independently of each other, for there were no coupling rods. The compounding principle was right—now proved by successful continental designs—but Webb applied it faultily. His successors completely reversed his policy. Only one really efficient compound design has ever been introduced in Great Britain—the 4-4-0 Midland compound of 1902. 235 of these locomotives are still at work on L.M.S. metals.



Stroudley's 0-4-2 " Gladstone," London, Brighton & South Coast Railway, 1884.

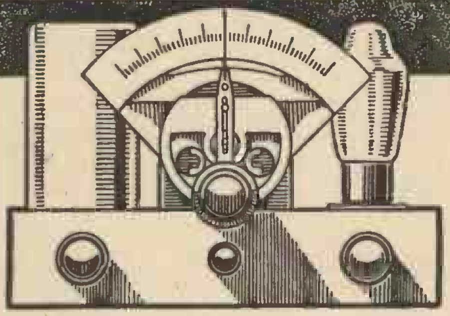


Webb's Three-cylinder Compound " Teutonic," London & North-Western Railway, 1889.

Lloyd's Register Scholarship

THE General Committee of Lloyd's Register of Shipping offer a scholarship, valued at £100 per annum, and tenable for three years, to be awarded on the results of the Studentship Examination of the Institute of Marine Engineers in May next. The Scholarship is intended to assist marine engineering students to take an advanced course of instruction in engineering subjects. The age limit is 18 years to 23 years. The closing date for entries is April 16th, 1938. Further particulars, entrance forms, and copies of previous papers may be obtained on application to the Secretary of the Institute of Marine Engineers, 85, The Minories, London, E.C.3. The entrance form for the Scholarship is distinct from the entrance form for the Studentship Examination, and a candidate for the Studentship who wishes also to compete for the Scholarship must complete and return both forms by the dates specified.

The PRACTICAL MECHANICS WIRELESS EXPERIMENTER



MAKING ALL-WAVE A-I AERIAL SYSTEMS

THE increasing use of all-wave receivers has resulted in an increase in the interest of aerial design, as it is now found that the standard single-wire aerial does not afford maximum results on all wavebands covered by the modern receiver. Even in a modern two-band (medium and long-wave) receiver, a single horizontal wire is necessarily a compromise, and is generally erected to provide maximum resonance on the wave-length which is found to be most difficult to cover with the particular receiver in use. Of course, many listeners simply erect any length of wire which can be accommodated in the garden space which is available, and then devote their energies to designing or modifying the receiver to give the desired results. There, however, serious interference is experienced, either from passing motor traffic, or from electrical signs erected on buildings adjacent to that in which the receiver is installed, the listener is forced to adopt some form of anti-interference aerial and is thus brought face to face with this important section of radio technique.

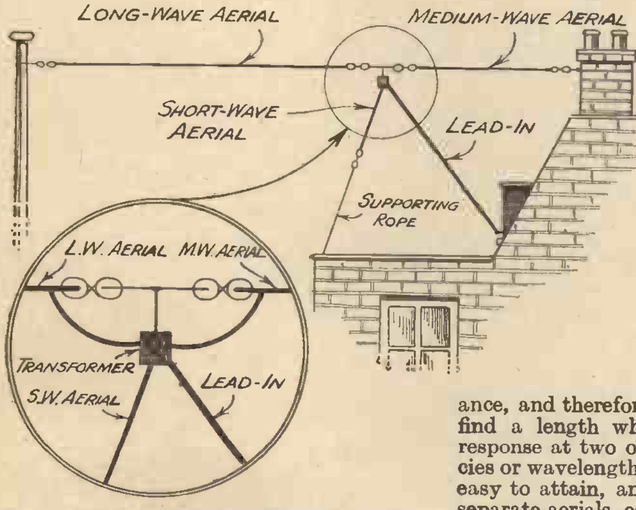


Fig. 1.—The general arrangement of an all-wave aerial such as is adopted in the H.M.V. and Marconi system.

All-wave Aerials

A modern all-wave receiver may be said to cover one short-wave band in addition to the two normal broadcast bands, and thus a short aerial is found very useful in providing maximum response on the short-wave band. Where two short-wave bands are included even two short-wave aerials may be found desirable, although not essential. For medium waves an aerial of about 30 ft. is generally found most useful. whilst for long waves from 60 to 100 ft, provides maximum results. The longer aerial often only introduces difficulty on the medium waves, due to the fact that it decreases selectivity due to the larger amount of energy which it picks up, as distinct from its resonant frequency. It should be understood, of course, that the aerial system (which includes the aerial, lead-in wire, earth wire, and the coil connected between aerial and earth terminals) will resonate at a particular frequency dependent upon its inductance and capacity. When the grid circuit to which this is coupled is tuned, the aerial is also tuned, due to the coupling between the aerial and grid coils, but the resonance is most pronounced at the natural frequency of the aerial system. At harmonics of that frequency it will also provide strong resonance, and therefore it should be possible to find a length which will give maximum response at two or three different frequencies or wavelengths. In practice this is not easy to attain, and it is preferable to use separate aerials, each chosen to resonate at a frequency roughly in the centre of the waveband covered by the tuning coil being used. Thus for a three-band receiver three separate aerials are desirable a short wire say 10 ft. or so in length, being included in addition to the 30 ft. and long wire previously mentioned. These may be arranged in many ways, and one of the most convenient for the amateur is depicted in Fig. 1. There the two broadcast aerials are joined end to end (insulated at the junction) and the shortwave aerial is suspended from the point at which they are joined.

A Complication

If the performance to be obtained from the receiver has to reach a very high level it may be necessary to use even more than these three aerials, including other lengths to resonate at some other part of the wavebands covered. Such an aerial is very popular at the moment in America and is known as the spider-web aerial, a diagram of it being given at Fig. 6. It will be seen here, however, that the aerials each consist of a dipole, or half-wave aerial, each built up from two quarter-wave aerials, and this necessitates twin feeder wires from the centre point. The advantage of an aerial of this type is that the feeder wire (or lead-in) will not pick up any energy, as it is either screened or transposed throughout its length. This is the arrangement which has to be adopted if local interference is experienced, as the aerial array may be placed well away from the building (out of the area of interference) and the lead-in will play no active part in picking up the signals. If a very long feeder is needed it will be necessary to include two transformers in the aerial system, one at each end of the lead-in, to balance out losses. This is carried out by using a stepdown transformer at the aerial end and a step-up transformer at the receiver. The two sections of the transformers which are connected together form a low-impedance circuit and consequently the capacity between the feeders will not have such a marked effect upon the signals which would otherwise be seriously interfered with.

Transposed feeders, generally do not need the inclusion of the transformer, provided the transposition blocks give adequate spacing between the two wires. The twin feeder consisting of two wires will require the transformer, and the usual way of arranging such a feeder is to use parallel-laid insulation wires in a heavy rubber cable. An alternative scheme is to use a single wire laid inside an insulated cable with a braided metal screen surrounding it,

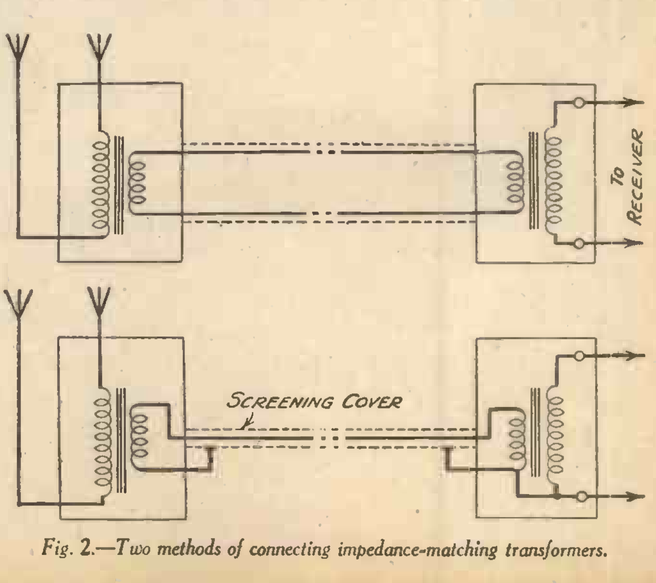


Fig. 2.—Two methods of connecting impedance-matching transformers.

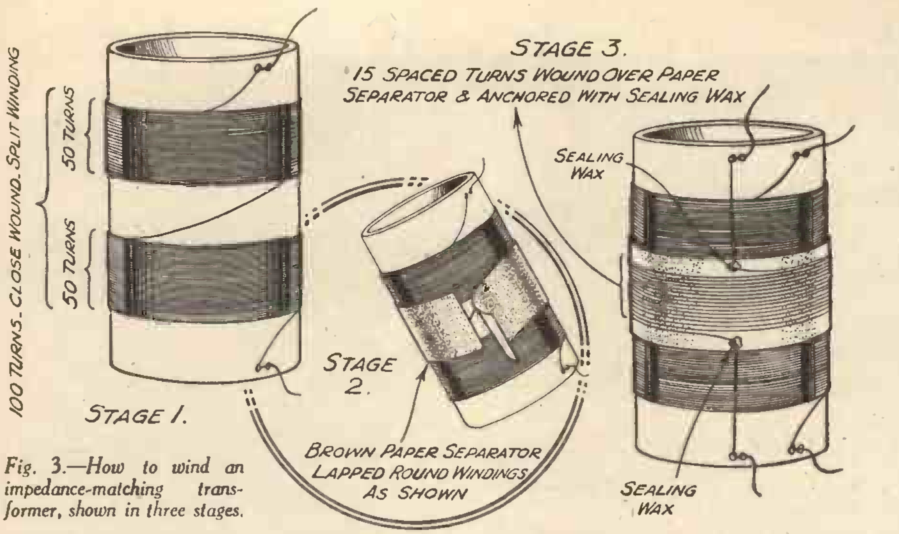


Fig. 3.—How to wind an impedance-matching transformer, shown in three stages.

and this screen may form one of the feeder wires by being connected to one side of both transformers. The separate schemes are shown in Fig. 2. In place of a simple transformer an auto transformer or tapped coil may be used, or a tuned transformer incorporating fixed condensers, such as is used in the B.T.S. system (Fig. 7), may be employed. The capacities will depend upon the coil windings, and it may be desirable for the amateur to experiment to find the most suitable values for his particular aerial and receiver system.

Fig. 5.—A commercial kit supplied by the New London Electron Works.

Incorrect Matching

One important point which must not be overlooked is that at the receiver end the tuning circuit may be such that the maximum effect is not obtained from the impedance-matching transformer, and this fact should not be lost sight of when a commercial all-wave anti-interference system is purchased. Generally these are designed by the makers primarily for use with their receivers, and although they may not necessarily fail to give satisfactory results on other makes, the aerial circuit may require modification in order to provide the maximum effect. An existing aerial circuit may easily be modified by winding a small coupling coil over the present grid coil (the number of turns and the spacing again having to be found by experiment) and connecting each end of this to the aerial and earth terminals for subsequent connection to the impedance-matching transformer.

Transformer Design

The majority of modern impedance-matching transformers employ iron-cored coils, providing a high inductance-capacity ratio, and are accordingly beyond the scope of the average amateur to build. Alternative designs may be wound on small diameter formers, however, and a small low-loss switch employed on the secondary for wave-change purposes. It will be appreciated, of course, that no switching is required at the aerial end to separate the individual wires, as these automatically resonate to the frequency to which the receiver is tuned, by reason of the tight coupling existing between the aerial and the tuned circuit. A design which has been found to offer good results from an aerial transformer (that is the one joined directly to the multi-aerial system) with a primary of 100 turns of 28 D.C.C. wire on a 1-in. diameter former, and to split this into two equal sections, separated by ½ in. Over the centre space three or four layers of thick brown paper are wound, and in the centre of this 15 turns of a similar gauge of wire are wound for the secondary. The ends of this winding should be anchored with sealing-wax or Chatterton's Compound, and taken straight across the primary at right angles before being lead through anchoring holes in the former for connecting purposes.

This coil should be mounted inside a small aluminium screening can, and the bottom of this should be sealed with a disc of waxed wood or ebonite. Chatterton's compound or some similar wax will make it waterproof, and the holes through which the ends of the aerial and lead-in are passed should also be sealed.

The receiver transformer will be wound in exactly the same manner, but the larger winding (which is in this case the secondary) must be tapped to provide the necessary wave-change selection points. The ideal system is to use a two-point switch so that equal tappings are selected from each end of the secondary, although in many cases it is quite sufficient simply to transfer one connection by stages down the secondary, leaving the earthed end permanently connected. Figs. 3 and 4 show these arrangements.

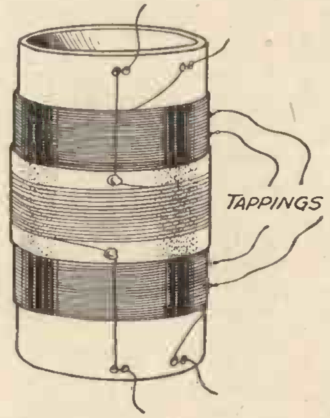


Fig. 4.—The receiver transformer design, provided with tappings.

The receiver transformer should be mounted as close as possible to the aerial and earth terminals of the receiver, and the leads to these terminals should also be screened.

It must be emphasised that these details will not apply to every set, and therefore the constructor must be prepared to carry out some experiments as previously mentioned.

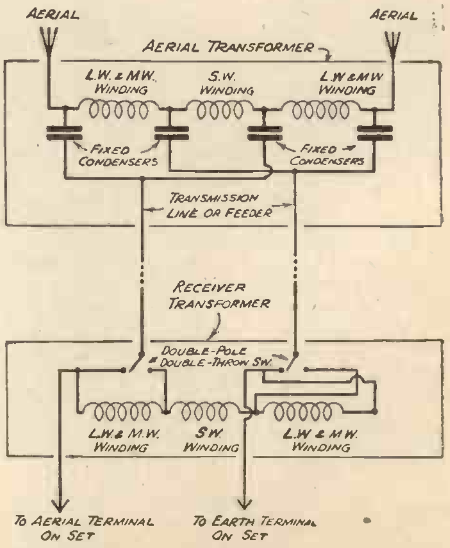


Fig. 7.—The circuit arrangement employed in the B.T.S. anti-interference all-wave aerial system.

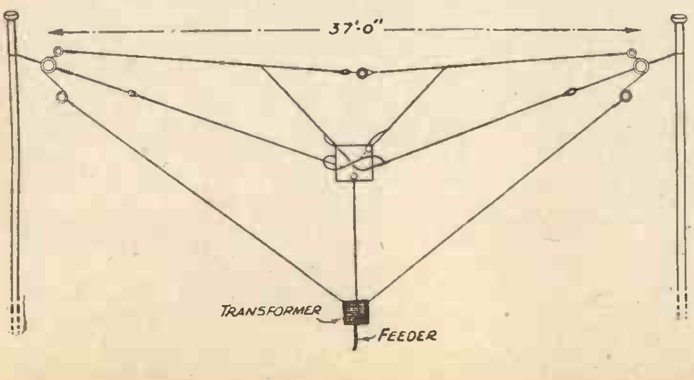


Fig. 6.—This is the arrangement employed in the American spider-web aerial. Note that each aerial is a dipole.

STARGAZING FOR AMATEURS

A NEW SERIES

By N. de Nuffy

A GUIDE FOR MARCH

THE Sun will enter the zodiacal sign Aries at 7 o'clock on the morning of the 21st, thus marking the Spring Equinox, the conventional commencement of that season and the beginning of the Tropical Year. On that date, moreover, the days and nights will be of equal duration all over the world.

Increasing solar disturbances, manifested recently by an unusually large "spot" followed by a striking display of the aurora borealis, an intense "electric storm" and excessive fading of wireless short waves all point to the approach of actual culmination of the present about 11-year cycle.

The Planets

Though Mercury will not reach greatest elongation until April 2nd, there may be an opportunity of glimpsing this elusive world in the evening twilight at the end of this month. At 7 o'clock on the 23rd, Mercury will be slightly north of west, about five degrees (ten Moons widths) above the horizon and three degrees above Venus. At the same hour on the following few nights the two planets will be in nearly the same relative positions but somewhat higher in the sky; both are immersed in the glare of sunset. Mars continues to be visible in the south-west after dusk, setting at half-past nine. Jupiter and Saturn are practically out of sight. The remote planet Neptune—the outermost of the solar retinue—will be "in opposition," and consequently at its nearest to us this year, viz., 2,714,350,000 miles, on the 11th. It rises due east at 6 p.m. and will be above the horizon throughout the night. Its position is R.A. XI hrs. 25 min. N. Dec. 5 deg., in a barren region between β (Beta) Virginis and σ (Sigma) Leonis. Under favourable atmospheric conditions it may be seen through good glasses or quite a small telescope. Identification may not be easy, though with adequate power it will be recognisable as a pale green speck. It is a ponderous globe 33,000 miles in diameter and has but one minute satellite named Triton. The planet's period of axial rotaton is inferred, from the variability of its light, to be 7½ hours; but spectroscopic observations indicate double that length. Owing to its immense distance and cloud-wrapped surface little can be ascertained of its physical character, even by means of giant telescopes.

The Stars

Since the issue of the last PRACTICAL MECHANICS, several further interesting telescopic objects have come into sight in the east and north-east quarters of the sky. The moonless evenings at the beginning and end of this month will be the best times to view them. Later on they will be somewhat dimmed by the light nights. The little constellation Canes Venatici includes not only the magnificent star cluster illustrated in the March number last year, but also a wonderful spiral nebula designated M. 51. Although an ordinary telescope will show only two very small hazy patches of unequal size, mammoth instruments reveal a "Catherine-wheel" structure with clots of condensation strung like beads along the curving wreaths of luminous matter. The photograph reproduced on this page was taken with the 60-in. reflector at the Mt. Wilson Observatory, California, after an exposure of four hours. M. 51, though not strictly in the Great Bear, is situated near the star ζ (Zeta) of that group at the end of the "handle" of the Plough; or, to be more correct, the Bear's "tail." The constellation Ursa Major is now high in the north-east, and ζ (Zeta)

Spiral nebula in the constellation Canes Venatici.

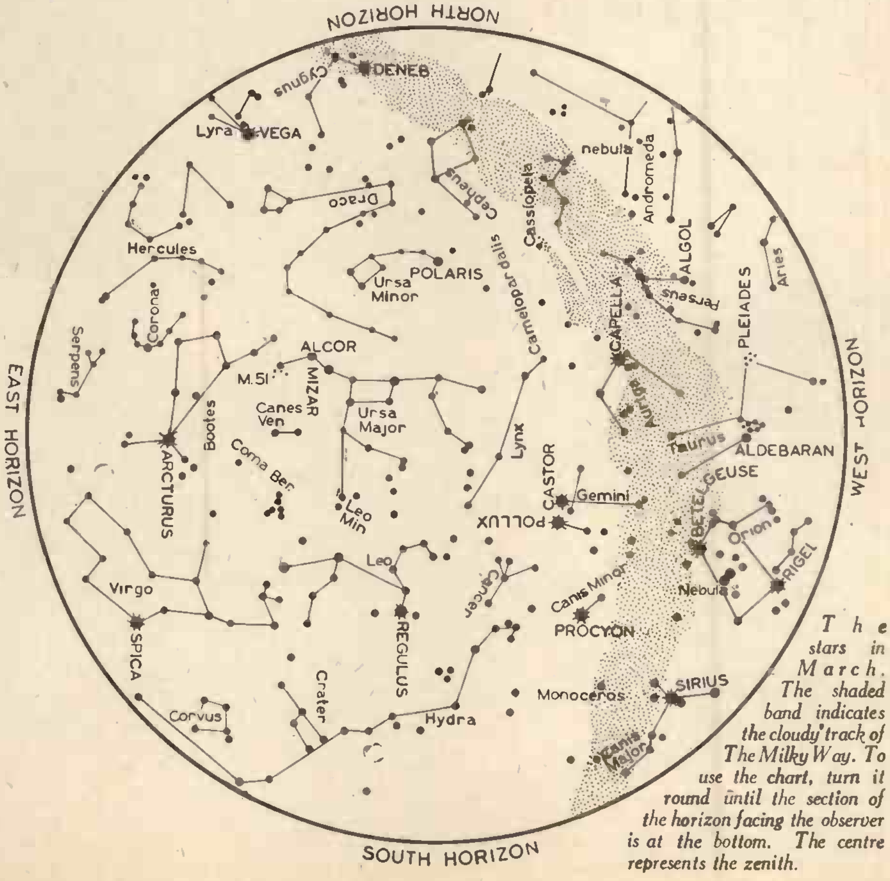
Ursæ Majoris—also called Mizar—is a fine double, forming a quartette with the inconspicuous adjacent star Alcor, itself a spectroscopic twin. The "Owl" Nebula is yet another interesting object in Ursa Major. It is slightly below the star β (Beta), and was given its name by Lord Rosse, owing to its two dark thinly veiled circular patches, each of which has a small star glittering in the centre; thus suggesting the staring eyes of the familiar nocturnal bird.

Boötes, the group high in the east with its brilliant leader Arcturus, offers an attractive field for exploration. ε (Epsilon) Boötes is one of the most beautiful coloured double stars in the heavens. The hues are golden yellow and sapphire blue. On clear nights they can be easily seen with a refractor of 2½ in. aperture, or a slightly larger reflector. Still nearer the horizon but somewhat to the south, stretches Virgo, remarkable for having a greater number of nebulæ within its confines than any other constellation. They are mostly situated in the area bounded by the stars ε, δ, γ, η, and β Virginis and β Leonis: i.e. between R.A. XII and XIII and N. Dec. 5 and 15 degrees. Some of these will be found marked on the majority of star atlases. Virgo's chief member, Spica, consists of a very close pair of suns; in fact they are almost inseparable, being practically in contact. γ (Gamma) Virginis, another double, can, however, be readily divided into its two almost equal components. Since they revolve around each other in about 180 years and were "closed-up" in 1836, they are now at approximately their widest distance apart.

Astronomical Notes

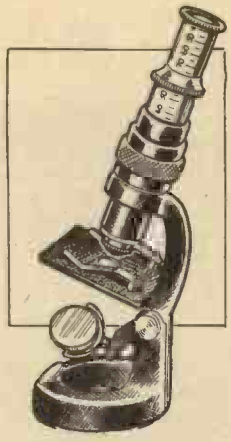
The variable "pulsating" star ε

(Continued on page 350)



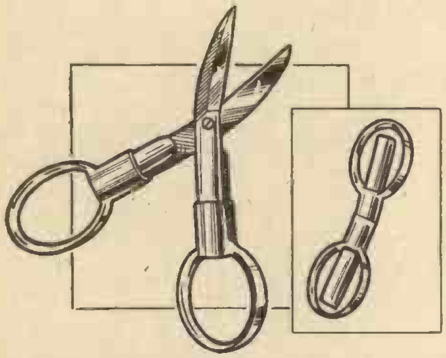
The stars in March. The shaded band indicates the cloudy track of The Milky Way. To use the chart, turn it round until the section of the horizon facing the observer is at the bottom. The centre represents the zenith.

INTERESTING ITEMS NOW ON THE MARKET

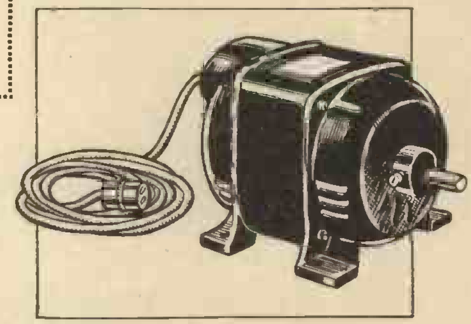


A cheap and efficient microscope.

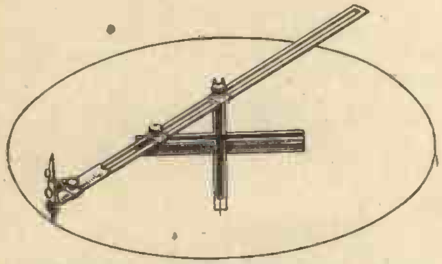
The address of the makers of any device described below will be sent on application to the Editor, PRACTICAL MECHANICS, Tower House, Southampton Street, Strand, W.C.2



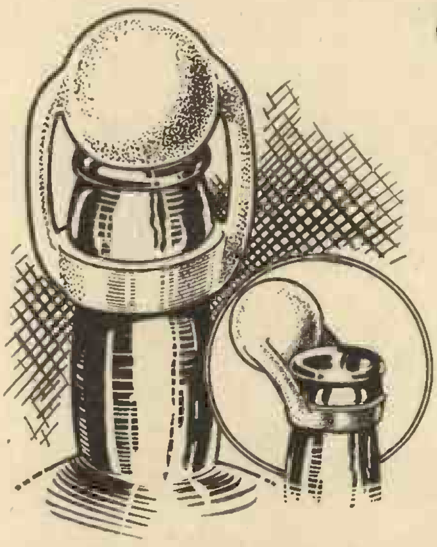
Pocket scissors are always handy and these prove no exception, as they can be folded into the compact arrangement shown on the right.



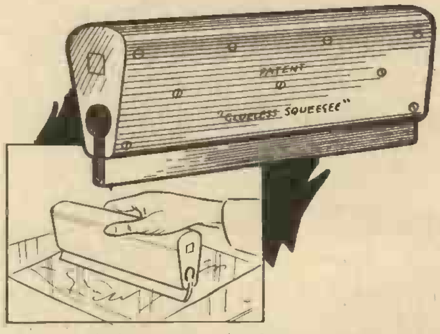
A ½-h.p. split-phase electric motor which will work on 220/230 volts 50 cycles. It is sold complete with flex lead.



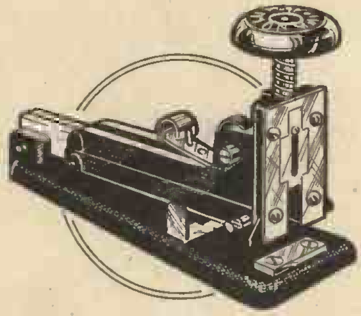
An elliptic trammel with ink and pencil points for drawing ellipses of not less than 4 in. minor axis.



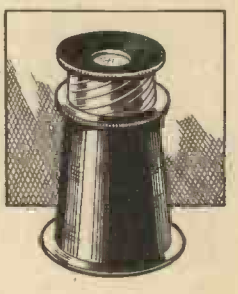
A universal bottle stopper which will effectively seal the contents of a bottle.



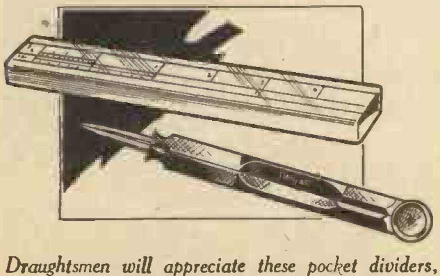
A glueless squeegee for draining prints.



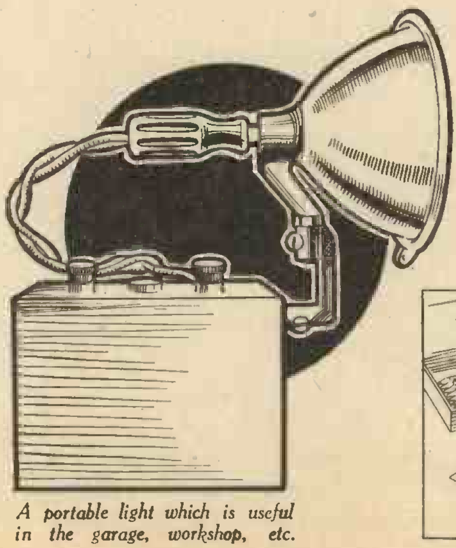
The Vanguard staple press which has many uses.



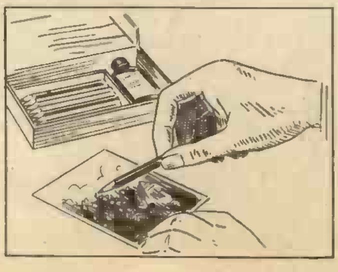
A useful focusing magnifier.



Draughtsmen will appreciate these pocket dividers, the case for which can be used as a ruler.



A portable light which is useful in the garage, workshop, etc.



A soluble crayon outfit for colouring photographs.

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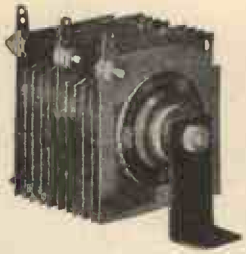
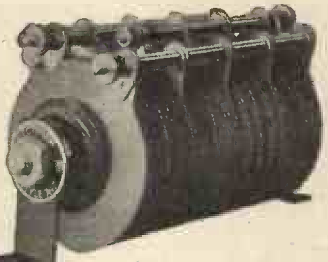
of obtaining direct current from A.C. mains for battery charging, high-tension supplies for radio and television, or for running model railways, etc.,



Type H.T. 14 & 15



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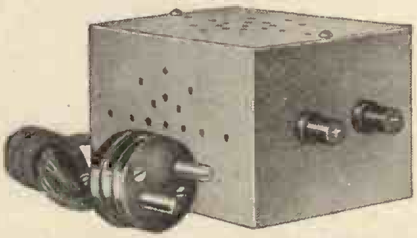

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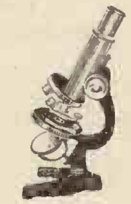

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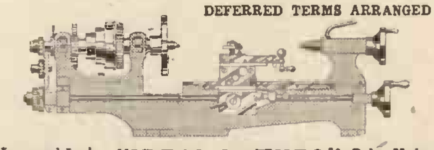

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BUILDING THE "LUTON MINOR" LIGHT AEROPLANE

PART VI. Final Assembly

THE top bay is braced by plates, M10, whilst additional supports, M8, attach to the cylinder heads at the socket supports.

Engine controls of the motor-cycle handle-bar type are not recommended, and push-pull cables, consisting of a single high-tensile wire encased in a flexible steel casing, should be substituted. The air control in the carburettor, if fitted, should be removed, leaving only the one carburettor control and one magneto control.

The ignition should be coupled to the throttle so that the ignition is fully retarded when the throttle is closed and so that opening of the latter automatically advances the spark. Full ignition advance should be arranged for when the throttle is about one-quarter or one-third open.

The following note applies to the fuselage construction dealt with in the (January) issue of PRACTICAL MECHANICS :

Owing to possible slight variation in the fuselage plan shape, the dimensions of the decking supports, included in Fig. 1, should not be rigidly adhered to. The shape of frames 1A and 5 may first be made from the given dimensions, checking the widths with the actual fuselage, after which the intermediates may be made to suit. In each case the radius R should be equal to the height of the decking above the top longeron at the position considered.

The front fuselage bulkhead, to which the engine mounting is attached, should be made fireproof by means of a sheet of tinned steel. This should preferably be fixed before the top engine bracing fittings are set in position.

Engine Controls

It has already been mentioned that the carburetter air control, if fitted, should be removed, and that the ignition and throttle controls should be interconnected.

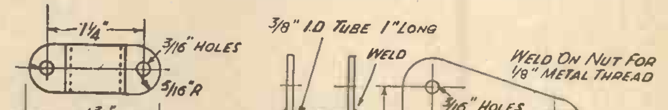
Fig. 1 shows the throttle arrangement and details for use with the Anzani engine, though they will probably be suitable with a little modification for other types of engine. Separate levers are employed for throttle and magneto, but the latter is arranged to be fully advanced when the former is roughly one-third open. The throttle lever then continues on alone. When the throttle is closed, a small projecting lug on the lever retards the ignition automatically.

Transmission is by means of solid high-tension steel wire within a flexible casing. The wire is held fast to the fork-end (15C) by means of a set screw, whilst the casing is similarly fixed to the support fitting (13C and 14C).

Adjustment may be made by careful positioning of the casing. First make sure that the throttle is fully open in the "open" position of the lever, and closed when the lever is fully back. Then note that the ignition is fully retarded when the throttle is closed, and fully opened when the throttle is approximately one-third open. The proper adjustment of the controls is essential for economical and correct running of the engine.

Petrol and Oil Tanks

The capacity of the petrol tank considered sufficient for all normal purposes is six gallons. This gives a supply of at least three hours for most light engines, and provided the engine is throttled back reasonably for cruising, the supply should be sufficient for a flight of almost four hours.



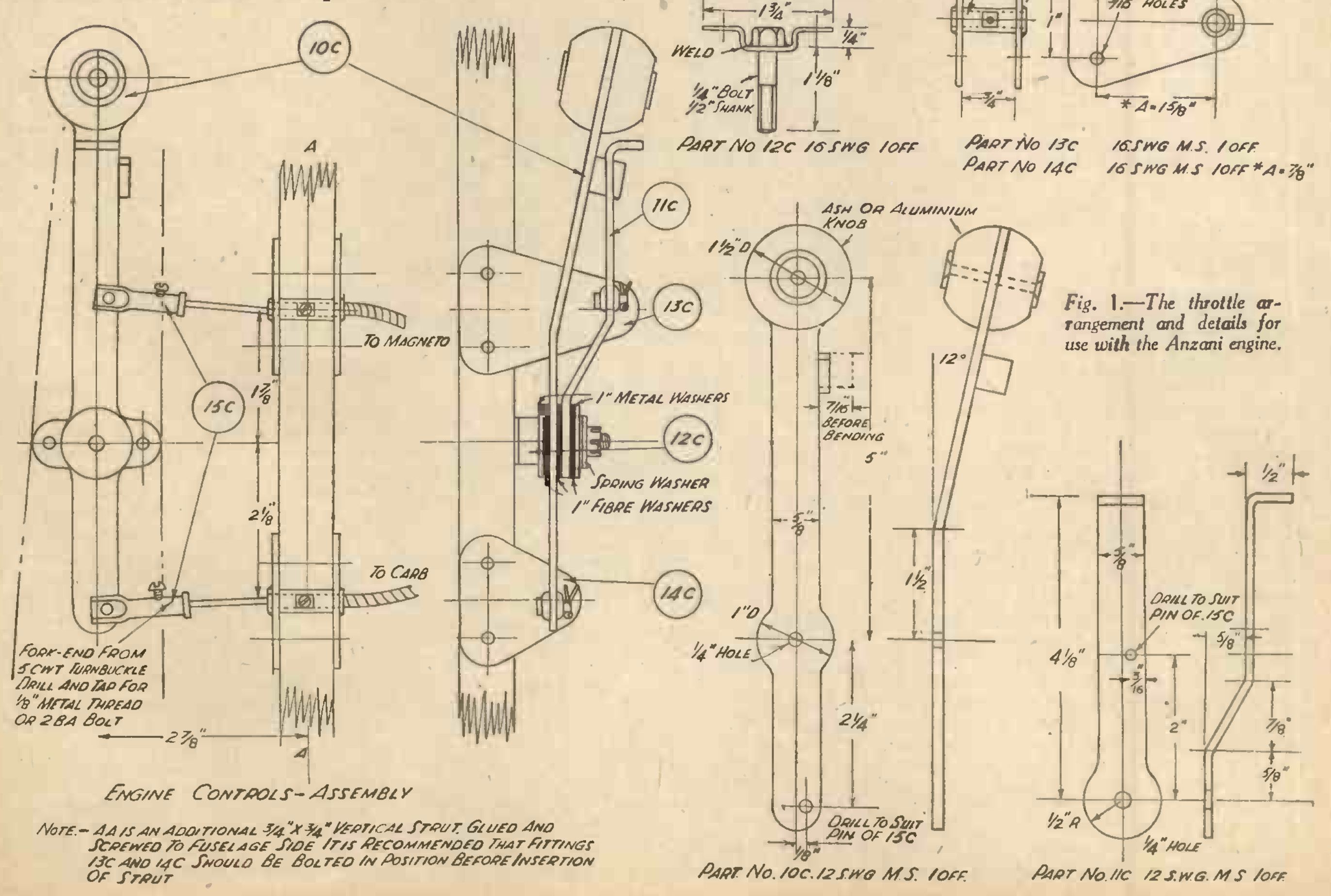


Fig. 1.—The throttle arrangement and details for use with the Anzani engine.

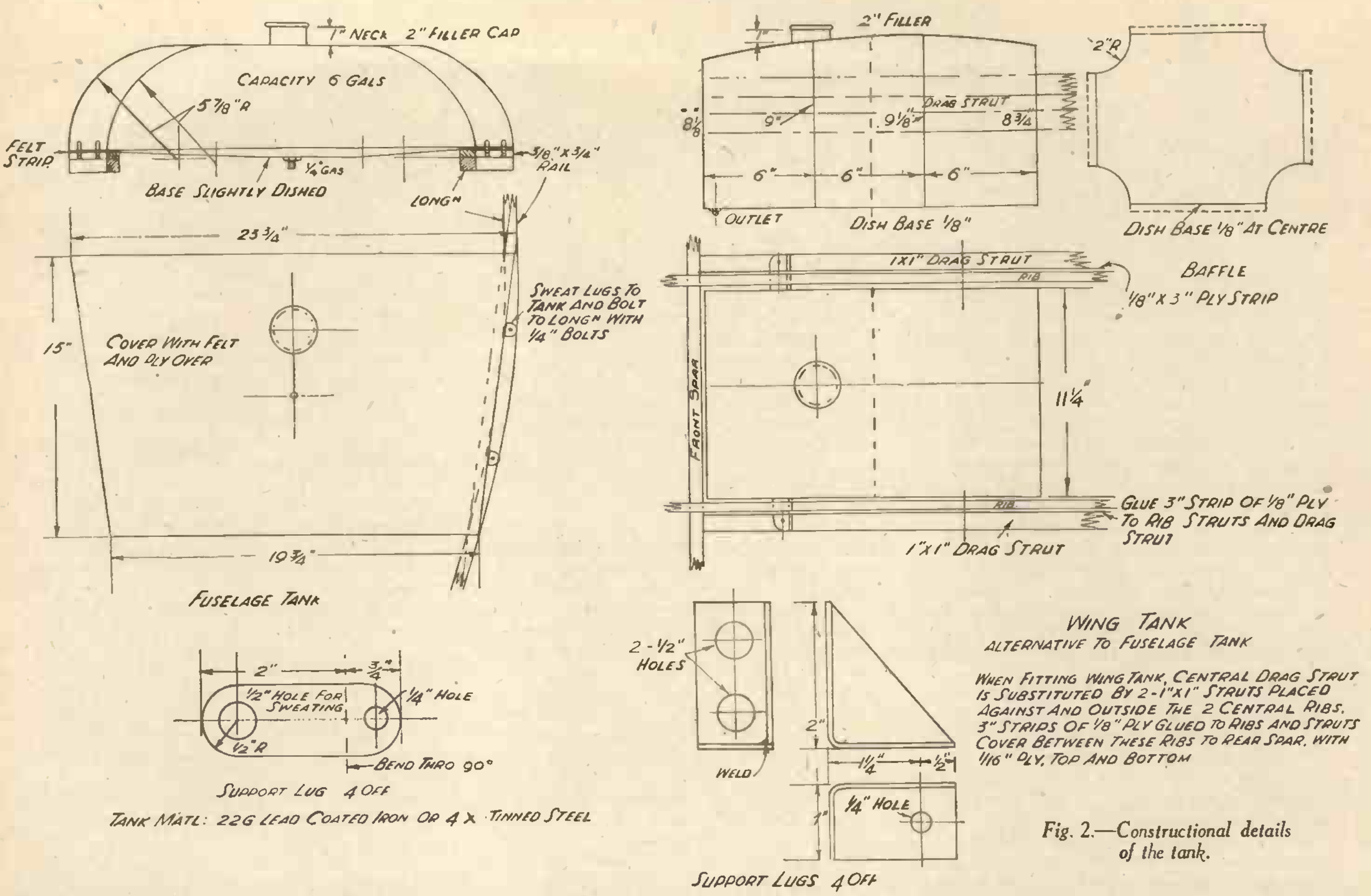


Fig. 2.—Constructional details of the tank.

Normally the petrol tank is fitted in the fuselage, in the top decking forward of the cockpit. The tank is shown in Fig. 2, and rests on two spruce runners, ⅜ in. by ¾ in. The tank is placed with its front face just clear of the centre section drag bracing strut, and in this position leaves just sufficient space for the instrument panel and instruments. The actual fitting of the tank might be left until almost the last, as the wing pylons may have to be adjusted slightly to give the correct wing position.

The tank is held in place by 4 lugs, which bolt to the longerons, but the fixing of these lugs to the tank should be left until later.

If, for reasons of balance, due to the fitting of a heavy power unit or other causes, it becomes necessary to install a wing tank, this should be made and fitted as shown in the alternative design. In this case the central wing drag strut is substituted by two drag struts, 1 in. × 1 in. each, situated just outboard of the two central ribs. Between the ribs and drag struts strips of ⅛-in. ply, 3 in. deep, are inserted and glued to ribs and struts. These considerably strengthen the structure. Four support lugs are sweated to the tank and bolt to the drag struts, on which the tank rests. Parts of the adjacent ribs will have to be cut away for this purpose.

Insert felt, or rubber, packing between the support lugs and the members to which they affix. The space between the ribs, and between the spars, is covered top and bottom with $\frac{1}{16}$-in. plywood; the top covering not being fitted until the tank is in position. A piece of fabric should be cut to fit round the filler neck and on to the top plywood covering. This is doped in position to prevent spilt petrol from gaining entrance to the wing.

The tanks may be made of 22 s.w.g. lead-coated iron, or good quality tinned steel (4X). The former is rather more expensive and is heavier, but it is non-corrodable.

The oil tank may be placed ahead of the petrol tank, but to one side of the centre section drag strut. It should be about 6 in. high, 6 in. wide and 5 in. deep, but the exact shape must be dictated by the space available. It is fitted with filler, and outlet at the bottom of the front face. If the engine fitted has an oil return system (the Anzani has not) a return pipe connection will be required near the tank top.

Pipe Connections

The pipes connecting the petrol and oil tanks with the engine should not be of copper piping without some form of flexible insertions, or failure due to vibration is certain to be experienced. They may be of any good brand of flexible tubing, although very good petrol- and oil-resisting rubber tubing is now available and a short length of this, say 4 in., inserted in each length of copper piping, and held in position by " Jubilee " clips is recommended as being eminently suitable for the purpose.

No long length of piping should be left unsupported, but should be held by means of a clip to any convenient point.

Balancing for Flight

The proper balancing of an aeroplane for flight is most important. It is necessary both for satisfactory flight and particularly for considerations of stability. In slow speed flight the centre of lift on the wings is in its most forward position, approximately at 0·3 chord from the leading-edge or about 18 to 19 in. in the case of the " Minor." The centre of gravity (C.G.) of the complete aircraft, loaded, that is the point through which the weight acts, should be vertically below the centre of lift, or slightly in front. The limiting positions may be taken as 4½ in. in front and 1½ in. behind, greater diversion than this resulting in an unsafe machine.

When the fuselage is in rigging position, with the top longerons horizontal, the base of the landing wheels should be roughly 12 in. in front of the C.G.

Normally, the " Minor " is balanced for flight with an engine weighing about 110 lb. and a 6 gal. fuselage fuel tank. If a heavier engine is installed, balance may be obtained by fitting the wing tank, or by moving the pilot back about 3 in., or both. Alternatively an engine may be used of the correct weight, but having the carburetters situated too high to allow a sufficient head of petrol for gravity feed, when the aircraft is in the climbing attitude with the fuel tank about empty. In such a case the wing tank must be used and balance may be obtained by shifting the engine about 7 in. forward.

When making the C.G. check, someone should sit in the pilot's seat, or a weight of about 150 lb. should be placed 12 in. from the seat back. A weight of 24 lb., representing half the petrol weight, should be rested on the tank and a weight of about 5 lb. placed above the oil tank. The tail unit should be in position, as also should the wheels, engine cowling, etc., but not the main plane.

The fuselage should be rested on a large plank of timber, which in turn rests on a steel tube, or other available circular rod. A few nails driven into the underside of the plank will retain the tube in position. The tube is then placed on top of any large rectangular block which is of sufficient height to raise the wheels just clear of the

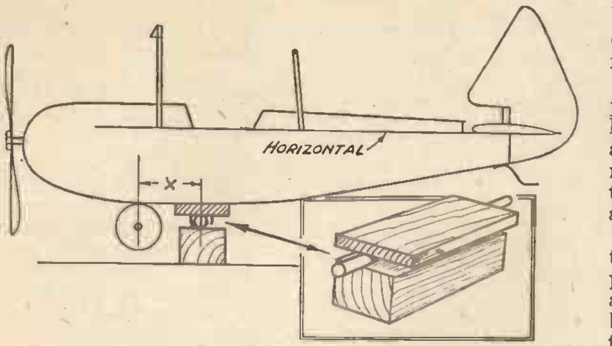


Fig. 3.—Method of checking for centre of gravity.

ground. This is shown diagrammatically in Fig. 3.

The position of the rocking tube should be adjusted so that the fuselage just balances, care being taken to see that the tube is equidistant from the axles on both sides.

The distance, x of Fig. 3, should be about 11 in. without the wing being in position, and certainly not more than, say, 2 in. either way.

The wing may next be supported above the fuselage by means of two trestles to which extensions have been clamped, Fig. 4. The wing should be so placed that the undersurface at the front spar is 2 ft. above the fuselage top longeron, and the wing incidence (obtained by setting the extension rails on the trestles) should be 3 degrees.

Set the leading-edge of the wing 18 in. in front of the C.G. as ascertained. (*Note.*—The wing weight will cause the C.G. of the complete aircraft to move 1 in. to the rear and so coincide with the wing C.P.)

Check the fuselage setting by means of a spirit level placed longitudinally and laterally. Check the wing incidence at both trestle supports. Check the lateral setting of the wings with a spirit level and check that the wing is at right angles to the fuselage axis by measuring with thread from, say, each wing-tip at the front spar to the centre line of the stern part. A plumb-bob dropped from the wing centre should be vertically over the plan centre line drawn along the fuselage top.

Keeping the wing in this position relative to the fuselage, the front pylon struts, and the fitting, 6F (Fig. 5), may be fitted, together with the drag strut, the rear pylon and the rear fitting, 7F.

Holes may be cut in the top of the decking for the pylon struts to pass through and some cutting away will be necessary at the strut attachment.

The front end of the centre drag strut attaches to the fittings 4F and 4FA, which should have been bolted in position before finishing off the top decking.

There now remains only the fitting of the main lift struts and bracing.

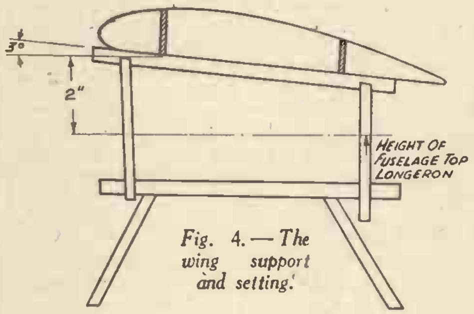


Fig. 4.—The wing support and setting.

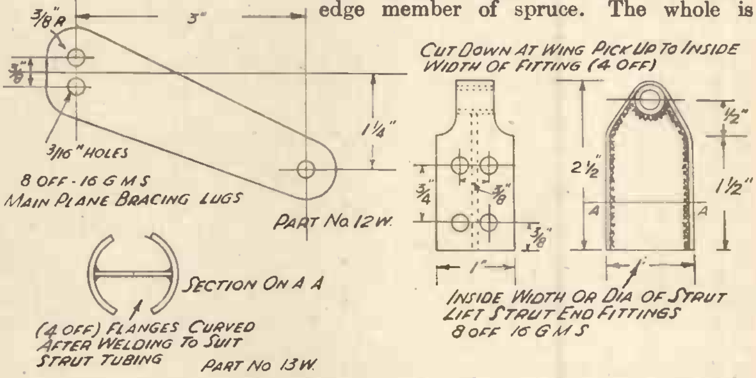


Fig. 6.—The main lift struts.

Main Lift Struts and Bracing

The struts are made of 1⅜-in. × 22 s.w.g. M.S. tubing. The end fittings, 13W, are shown in Fig. 6. The length of the struts is approximately 6 ft. 2 in. Bolt one end fitting in position, offer the strut up and cut to the required length. Slip the other end fitting in the tube, pin temporarily to the fuselage and wing fittings, and drill for the 2 B.A. bolts, taking care that the wing setting remains unaltered throughout.

The performance and appearance are improved by the fitting of plywood fairings to the main struts. Streamline shaped formers may be cut from ⅜-in. spruce and are slipped over the tube, at about 2 ft. centres. The fairing may be of 1 mm. or $\frac{1}{16}$-in. plywood. Leading and trailing edge members, ½-in. × ¼-in. may be inserted, as shown in Fig. 7, though these are not essential. If they are omitted the trailing edge should be finished off as shown in the alternative diagram.

Alternatively the lift struts may be made from streamline tubing of section 2·5 in. × 1·156 in. × 22 s.w.g. This provides a much superior job, with less head resistance and less work is entailed, but streamline steel tubing is rather expensive to purchase.

The centre section pylons may also be faired off to improve the appearance. This may be done by means of two strips of $\frac{1}{16}$-in. plywood, 2 in. wide, feathered down each edge and a light wedge-shaped trailing-edge member of spruce. The whole is bound tightly with strip fabric or tape and doped. (Fig. 8.)

After fixing the four main lift struts in position, and checking again for rigging, the drag and anti-drag cables should be inserted. They run from the base of one strut to the outer end of the other and vice versa.

Fittings, 12W, (Fig. 6), bolt to the inner pairs of bolts in 13W, and care should be taken to ensure correct matching up. Ten cwt. cable is used for the bracing, and 10 cwt. turnbuckles are inserted for adjustment.

Cockpit Flap Fastener

Details of this are given in Fig. 9. It consists of two steel plate arms, flanged at the lower edge for stiffness. They are

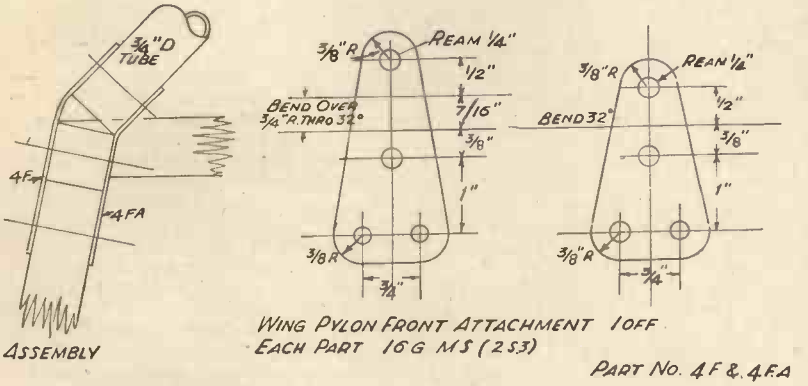
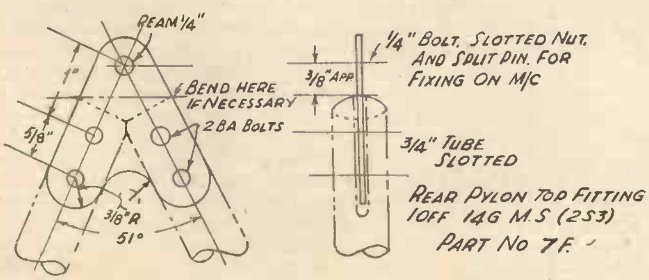
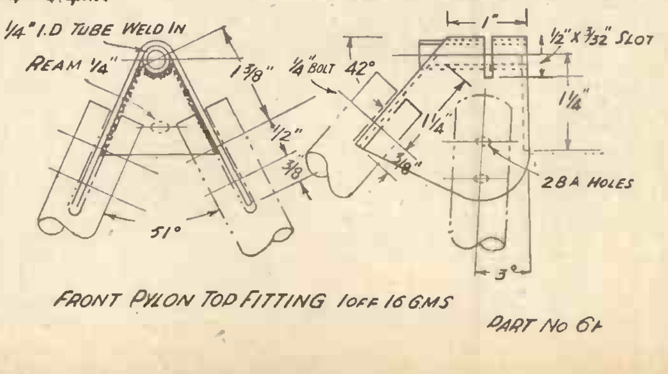


Fig. 5.—Details of the pylons.





joined at the centre by a ¼-in. bolt, brazed to one arm, and an ash, or other suitable knob attaches here. The arms pivot about bolts 4 in. to either side so that when the knob is raised the outer ends come free from bolts attached to the longeron. Some sliding motion of the arms is permitted by an ⅛-in. elongation of the pivoting hole. A small piece of M.S. plate may be let into the plywood on the fuselage side where the bolt head at the knob position rubs, and may be held in position by two small screws.

Fabric Covering

The usual method of wing covering is to make a " bag " which fits reasonably tight on the wing. This is then stretched over the wing, and sewn to all ribs, top and bottom, the stitching passing through the depth of the wing.

For light aircraft such elaborate work is not essential, though it may be mentioned that if the aeroplane is required for tropical regions it is recommended that the whole wing, tail unit, and even fuselage, should be entirely fabric covered to withstand the extreme heat.

A light, strong material, such as airship fabric, is better than the ordinary aeroplane fabric for light work, but it may be noted that many fabrics do not react favourably to dope and do not therefore give a satisfactory finish.

The fabric is cut into strips running from leading-edge to trailing-edge, the strip being sewn together along their edges with an ordinary (double) seam. It may be attached to the wing by dope, the substance used being applied to all wood surfaces that will come in contact with the fabric (ribs, leading and trailing-edges, etc.).

The fixing should be done in sections, for if too large an area is dealt with at once the adhesive will be dry before the fabric is properly positioned.

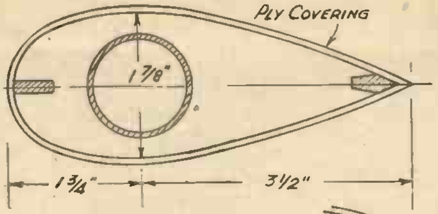
If the whole wing is to be covered, attach the fabric to the trailing-edge, pass it over the undersurface, round the leading-edge and back to the rear, finishing it off on the underside of the trailing edge. It is not necessary, however, to cover the forward ply-covered nose, and in this case the fabric may be attached first just above the front spar, passed round the trailing-edge and finished off below the front spar, the surplus material at the edge being trimmed off with scissors or a safety-razor blade after fixing.

The general tendency when fixing fabric is to concentrate the tightening in the fore and aft direction, but this in fact helps to produce sagging between ribs, giving that " lean " appearance. A better job is obtained when the fabric is pulled more in the spanwise direction.

A good finish is obtained by doping strips of fabric, or, preferably, frayed tape, or again 2-in. notched tape, along all edges of the fabric. The same procedure is employed for covering the tail unit.

An important point to bear in mind before covering wings, etc., is the secure locking-up of all bolts within the structure. See also that the cables are properly in position and working smoothly over their pulleys.

Strips of fabric should be doped on to close the gaps between the wing and ailerons, and between the tail plane and



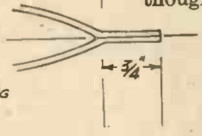


Fig. 7.—The lift strut fairing.

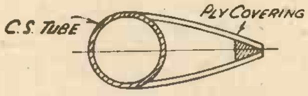


Fig. 8.—The pylon tube fairing.

elevator. These strips should be attached to the top surface of the wing, passing down through the gap and doped again on to the undersurfaces of the aileron, thus effectively closing the gap without upsetting the working of the control surface. Holes are cut in the fabric at the hinge positions (see Fig. 10).

Doping

There are two suitable doping schemes for light aircraft. The first, and most orthodox, is to apply at least two coats of red oxide tightening dope, followed by two coats of aluminium finishing dope. The second and probably better scheme for this type of work, is to apply four coats of tightening dope containing aluminium. Coloured finishing dopes may be used if desired, but they are roughly half as expensive again and do not allow of opening up and repairs so readily as the aluminium dope. It is recommended that colour should be confined to the fuselage, struts, and the ply-covered wing nose.

Most amateurs will have to apply the dope by hand, but a good finish can be obtained by following the simple rules as given, and even when a spray plant is available the first coat must be applied by hand to ensure its being brushed well into the interstices of the fabric.

The enemies of dope are dampness and cold, but more especially the former. For this reason the middle of the day is generally superior for doping operations, and a warm, sunny day should be chosen for preference. Damp and cold tend to chill the dope, when the appearance becomes milky. The tightening qualities are impaired, as also is the finished appearance. The minimum doping temperature recommended is 60° F., though preferably 70° F., and obviously humid weather should be avoided.

Well stir the dope several times during the period of application. Pour out small quantities for use, keeping the drum or main container closed. A 2-in. flat, stiff bristle brush is suitable, and should be cleaned in "thinners" immediately after use. If the brush should become solid, it can generally be made fit for use again by soaking in thinners.

Apply the dope liberally in patches of, say, 2 ft. by 2 ft., brushing first laterally and smoothing over in the fore and aft direction, working from one wing-tip towards the other. A period of 30 minutes or more should be allowed between coats. The fabric will no doubt go very " soggy " after the first coat, but there is no need for alarm, provided the fabric was reasonably tight to begin with, and all will be well at the finish.

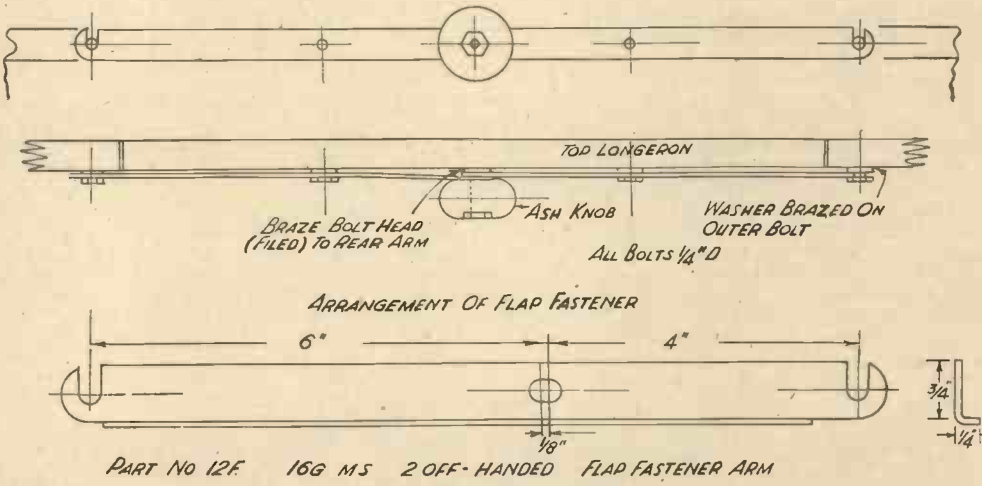


Fig. 9.—The cockpit flap fastener.

If spraying is resorted to, it will probably be necessary to obtain suitable thinners for mixing with each dope used, or difficulty may be experienced in getting the spray gun to function correctly.

Painting

Before preparing for painting, go carefully over all bolts and make sure that they are properly and securely locked.

The fuselage, and the wing ply nosing if not covered with fabric and doped, should be painted both for protection and for appearance. Before commencing, the plywood should be well rubbed down with glasspaper, medium and fine, particularly at the scarfed joints. Any holes or indentations may be filled with stoppers, the surface being rubbed smooth when dry.

Best results are obtained if the plywood is first given a coat of primer, followed by at least two of undercoat and finally one or two coats of finishing paint, though the primer may be deleted if required for economy. Rub down after each coat with " wet and dry." Use plenty of clean, cold water, as this prevents the paper from becoming clogged and ineffective.

A good quality synthetic paint, suitable

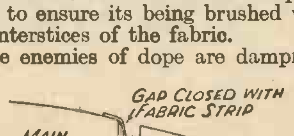


Fig. 10.—A strip of fabric connecting the top surface of the wing and the undersurface of the aileron.

MATERIALS REQUIRED FOR WING SUPPORT

12 ft. M.S. tubing, ¾-in. o/d. × 17 s.w.g.
25 ft. M.S. tubing, 1⅜-in. o/d. × 22 s.w.g.
or
25 ft. streamline tubing, 2·5 in. × 1·156 in. × 22 s.w.g.
30 ft. steel cable, 10 cwt.
4 turnbuckles, 10 cwt.
M.S. sheet, 16 s.w.g. 1 sq. ft.

PRICES OF WING SUPPORTS, ETC.

	£	s.	d.
Front and rear pylons, with fittings	1	0	0
M.S. tubing for pylons, 12 ft.		12	0
M.S. tubing for lift struts, 25 ft.	1	7	6
Streamline tubing for lift struts, 25 ft.	2	15	0
Strut end fittings, 8	1	16	0
Drag cable fittings, 8		12	0
Drag cable, 10 cwt. 30 ft.		6	0
Turnbuckle for drag cable, 4		2	8
Lift struts, fittings, drag cables, etc., made up	5	5	0
or with streamline tubing	6	10	0
Engine controls, complete with 13C and 14C		18	6
Petrol tank, fuselage or wing	2	5	0
Oil tank	1	5	0

for outdoor use, is recommended, there being a proper undercoat for use with each particular finishing paint.

Where the paintwork adjoins a doped surface, or another colour paint, the edge should be outlined with masking paper which may be cleaned off afterwards.

The inside of the cockpit should be painted also. The undercoating may be used here as it will give a matt finish. If possible the seat should be upholstered before painting.

Flight Adjustment

If every care has been taken to ensure proper setting of the wings relative to the C.G. the aircraft should be capable of steady horizontal flight with no force necessary on the control column. If, however, it is found that it is necessary to exert a continuous push or pull on the stick, then it is advisable to change slightly the setting of the tail plane, by respectively increasing or decreasing the incidence. To do this it will be necessary to make up a fresh pair of front tail fittings with the bolt holes raised or lowered by, say, ¼-in.

If this is insufficient to rectify the balance in flight, the fault is most probably to be found in the incorrect adjustment of the C.G. and this should be carefully re-checked.

In concluding this series of articles on the construction of the "Luton Minor" Messrs. Luton Aircraft Ltd. wish to point out the need for the employment of materials of the correct quality—inferior material will lead to accidents—and to the importance of careful workmanship. For a small fee, plus travelling expenses, Luton Aircraft will send an inspector to examine the work in progress and the importance is particularly stressed of having the airframe examined by a competent inspector before covering.

Those constructors who would like to be kept advised of developments in connection with this design, and to receive details of modifications, etc., are asked to send their names and addresses, together with a remittance of five shillings, to Luton Aircraft Ltd., Phœnix Works, Gerrards Cross, Bucks. For their own benefit *all* private constructors are asked to forward their names to Luton Aircraft and they will then receive notification of any structural or aerodynamic modification that may appear desirable from the point of view of safety. It is hoped that a "Minor" club will be formed shortly for the mutual assistance of all "Minor" builders and pilots.

MATERIALS REQUIRED FOR COVERING, DOPING AND PAINTING

Airship fabric, 40 in. wide, 30 yards.
Frayed tape, or notched strip, 100 yds.
Aluminium tightening dope, 4 or 5 gals.
or Red Oxide tightening dope, 2 gals.
and Aluminium, or Coloured, finishing dope, 1 gal.
Primer for painting, 1 gal.
Synthetic paint, undercoat, 2 gals.
Synthetic paint, finishing, 1 gal.

	£	s.	d.
30 yds. airship fabric, 40 in.	2	0	0
100 yds. frayed tape,		7	6
or 100 yds. notched strip, 2 in.		12	6
5 gal. drum Aluminium tightening dope	3	19	6
4 single gal. tins Aluminium tightening dope	3	12	0
2 gal. Red Oxide tightening dope	1	12	0
1 gal. Aluminium finishing dope		17	0
Coloured finishing dopes, per gal.	1	0	0
Primer, for painting, per gal.			
Synthetic paint, undercoat per gal.	1	5	6
Synthetic paint, finishing, per gal.	1	6	6

Manufacturing Rights

Messrs. Luton Aircraft Ltd. have granted to each reader of PRACTICAL MECHANICS the right to construct one aeroplane of the Luton "Minor" type for his own use. All design and manufacturing rights are, however, retained by Luton Aircraft Ltd., and must not be infringed.

REMOTE ELECTRIC SHUTTER CONTROL

By "Handyman"

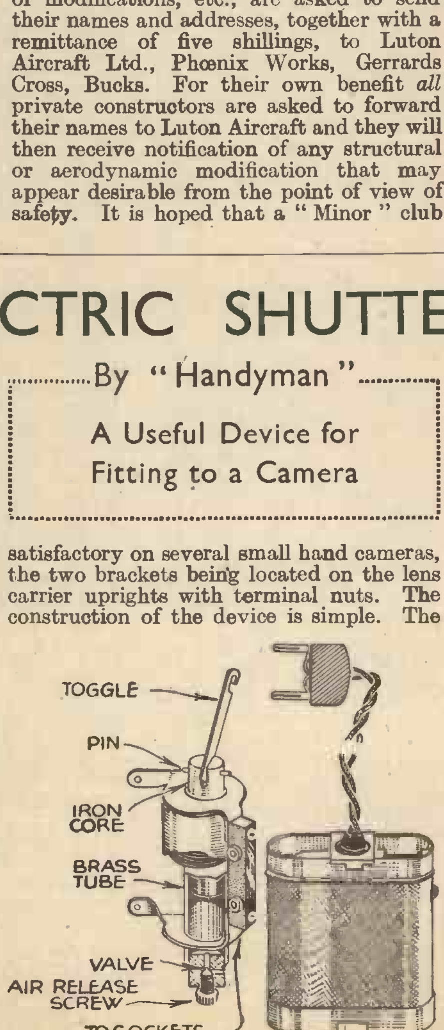
A Useful Device for Fitting to a Camera

THE ability to operate the shutter of a camera at a distance has several advantages. It enables one to take a group of people of which oneself is a member, and is practically an essential for self-portraiture. There are a number of ways in which this can be done, from the time-operated delay shutters which are on the market or by a simple pull arrangement with a piece of cotton. But a really satisfactory solution is an electrically-operated device.

Essentially the equipment consists of a solenoid-iron core movement fixed to the camera, working on the shutter control, a length of twin flexible wire and an ordinary torch case, with a battery.

For ease of fitting when required and of compactness for portability, the solenoid is fitted with two sockets into which can be inserted a miniature two-pin plug. The battery end of the leads terminate in a miniature screw cap adapter, or the base of a dud bulb can be used, which is screwed into the torch case when required, the switch on the side of the case being suitable for the operating switch, providing a really good connection is made between the case and the switch with a short loop of flexible copper wire.

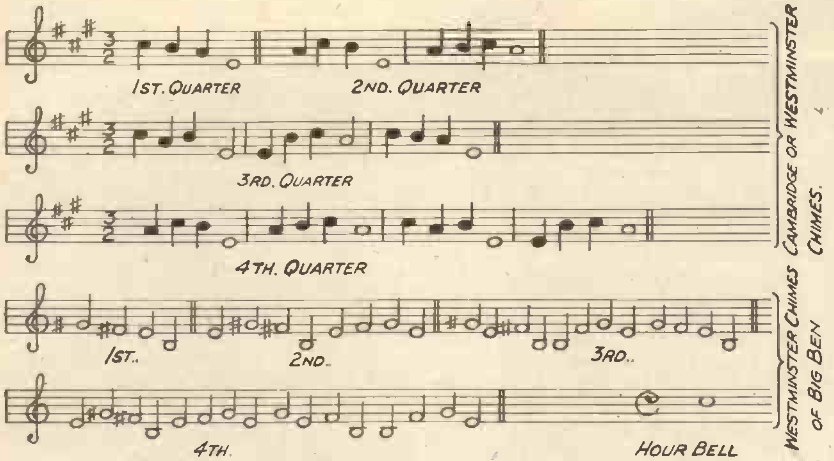
The actual design of the solenoid movement is rather dependent on the type of camera on which it is to be used, the sketch illustrating a type which has been found satisfactory on several small hand cameras, the two brackets being located on the lens carrier uprights with terminal nuts. The construction of the device is simple. The centre tube, which may be about $\frac{5}{16}$ in. inside diameter, has soldered to its ends the two brass cheeks, which also form the supporting brackets and the two lugs for securing the socket panel. The lugs should not be bent until after the solenoid has been wound. The tube is insulated with a layer or two of thick paper, and further insulation is provided at the ends with discs of paper. The solenoid should be about ¾ in. in diameter and filled with No. 28 S.W.G. D.S.C. wire, the whole being covered with a sheet of leatherette paper, etc. The lugs can then be bent down and the wires soldered up to the two sockets.



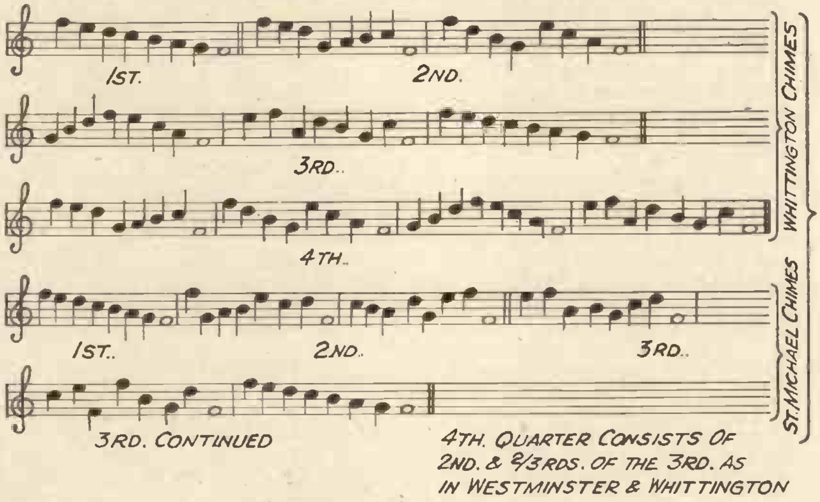
Details of the device.

The core is of soft iron and should be a good sliding fit inside the tube, preferably ground in, and a smear of vaseline on the core, will provide a good air seal. The top of the core is slotted and pinned to carry a link to connect up with the camera trigger, the actual design of this varying considerably with different types of shutters.

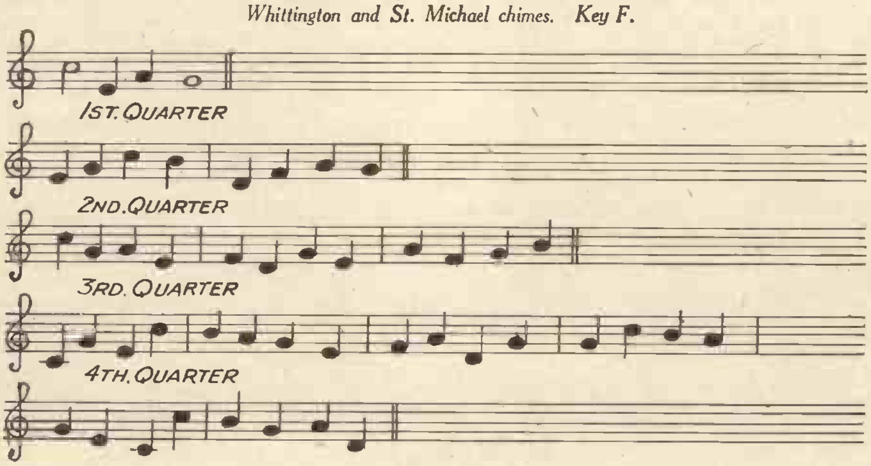
The air release valve in the lower end of the tube prevents, to a large extent, a jar being given to the camera when the current is switched on, and can also be adjusted to give a second or more delay. If an immediate return of the trigger is necessary, the top of the valve block may be countersunk and a brass ball fitted to make a non-return valve, but the air hole for this must be separate from the adjustable screw.



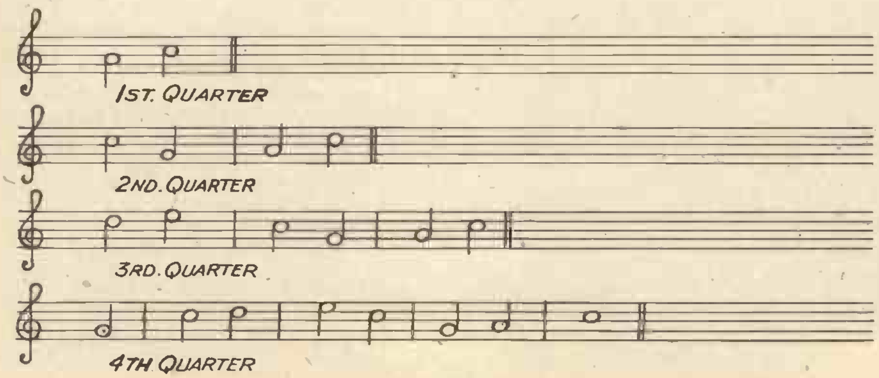
The Cambridge and Westminster chimes of "Big Ben."



Whittington and St. Michael chimes. Key F.



Guildford chimes.



Caius chimes.

Clock Chimes

OWING to the number of enquiries we have received regarding this subject, we reproduce the score of six of the most popular chimes. They are the Cambridge or Westminster Chimes, the Westminster Chimes of "Big Ben," St. Michael, Whittington, Caius, and Guildford.

Building a I-c.c. Engine

(*Continued from page* 318)

After hardening and lightly tempering, the face of the washer is polished up on a flat oil stone. It should be noted that the face of the washer when in position is slightly higher than both the pin and end of the bush.

The Crank Pin

This part is made from nickel-chrome steel, and as only a short piece is required, it may, without involving a lot of extra turning, be conveniently made from $\frac{7}{8}$ in. diameter material. The ·187 in. diameter works in a $\frac{3}{16}$ in. diameter hole and should be finished with a high polish. This portion should be made ·200 in. in length, not ·220 in. as shown on the drawing.) Screw the No. 4 B.A. thread to fit tightly in the crank plate.

The $\frac{1}{8}$ in. diameter hole is for lightening purposes, and also serves as an oil feeder for the big-end bearing of the connecting rod via the $\frac{1}{16}$ in. diameter drilled hole. As seen in Fig. 30 the slots in the head are to take a key for assembly purposes.

The Cylinder

There is more work on this part than is at first apparent. The bore is very important, and although the material specified does not tend to "tear" during machining no great loss of labour will be incurred if the hole produced in the roughed out blank proves unsatisfactory. This will of course mean scrapping the partly made piece if the hole is imperfect. By the way, the writer presumes that no means of fine finish-grinding the bore is available, otherwise omit the reaming operation and grind and lap finally. As previously stated, the material from which it is made is $\frac{7}{8}$ in. diameter nickel chrome steel.

First Operation

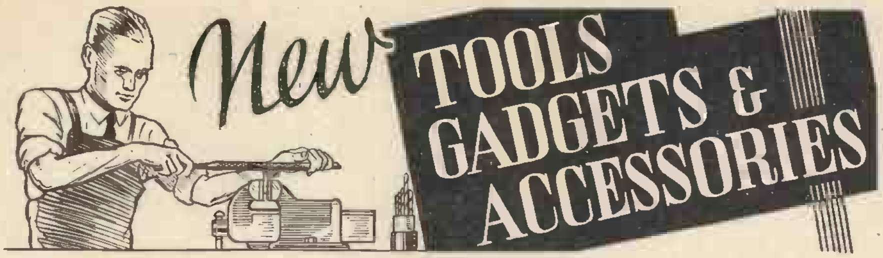
Chuck the material, leaving a sufficient length projecting to make the part plus a parting allowance. Face the front and centre-drill. Rough down to the dimensions given in Fig. 32. Drill a true $\frac{13}{32}$ in. diameter hole to a depth of $1\frac{1}{4}$ in. to the lips of the drill and part off to leave the blank $1\frac{15}{64}$ in. overall length.

Second Operation

Chuck truly on the fin blank diameter and face to the overall length given in Fig. 34, also turn the boss as shown. Open out the drilled hole by boring to ·432 in. in diameter, using a fine feed and well lubricating to leave a clean finish.

Third Operation

Ream the bore with a reamer that has been lapped to about ·001 in. under $\frac{7}{16}$ in. diameter. When used with plenty of lubricant a reamer that has been so treated will not scratch or score the metal, providing the amount to be removed is not excessive. The blank is now ready to mount on a centred mandrel for finished turning.



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.*

A Multi-purpose Tool

KNOWN as the "Versa-Vice," the tool shown on this page is of robust construction, incorporating a precision-machined housing, expertly designed and made by engineers. It has many advantages over the ordinary vice, as it dispenses with parallel bars, vee blocks, temporary fixtures and all clamping devices. Valuable time was lost by engineers in the past, as when work was raised for tooling in a vice it necessitated the use of parallel bars and packing pieces.

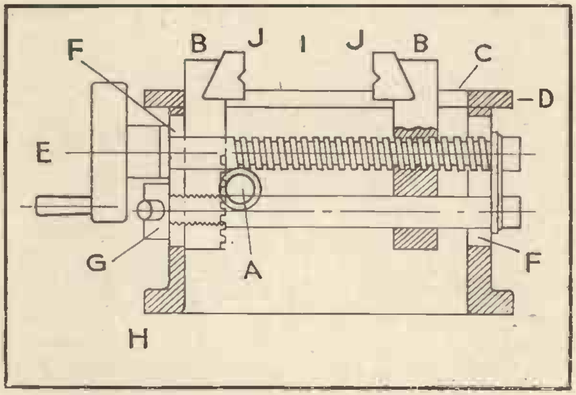
With the "Versa-Vice," however, setting up becomes a simple task, as the operator merely heightens or lowers the jaws to the desired position. Another advantage is that it is possible for the operator to check his work as he goes along by means of the surface table which is parallel to the base.

The vice has many uses, being suitable for tool-making, template and gauge-making, fitting, surface grinding, shaping, pressing, punching, nulling, jig building and machine and hand engraving.

The "Versa-Vice" is housed in an exceptionally high-grade all-steel body H, incorporating a precision-machined surface ground table D. The table has a central oblong slot C permitting of the horizontal and vertical (independent) motions of the jaws BB fitted with specially hardened steel gripping faces J, in which transverse and vertical V grooves are recessed.

The height, or projection of the top of the jaws BB above the surface of the face plate D, can instantly be determined by relaxing the locking lever G and turning hand-wheel A, which causes the whole of the incorporated internal mechanism to "rise" or "fall" by means of an efficient rack and pinion device. The two vertical ends of the body are slotted FF to permit this. The vertical jaw setting is instantly and securely locked at both ends by pressure on locking lever G.

An important feature of the vice is that the work is supported by the surface table D irrespective of thickness and weight, whereas with most vices the work is held by suspension and compression. Thus the operator was liable to distort and damage the work by excessive compression, whereas this is impossible with the vice shown as it supports the work independently of the jaw grips.



A side-elevation sectional view of the "Versa-Vice."

When carrying out a job lay the work across the slot C in the gap I. A bridge piece of suitable size should be laid below the "work," if the job is too narrow. Relax the locking lever G and lower or raise the jaws BB to permit the top surface of the work to project sufficiently above them for the required tooling operation. By relocking G the jaws are (vertically) "fixed" at the set position. The work is held against lateral and rotary movement by bringing forward the back jaw B. Only the slightest screw pressure is needed, as the work is supported.

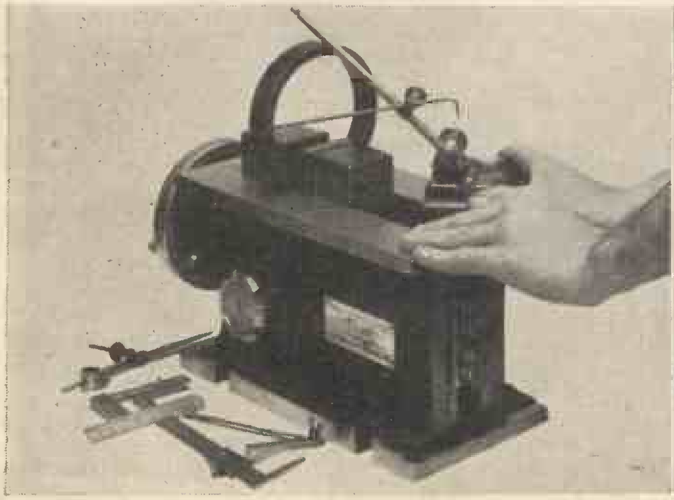
For carrying out repetitive work the "Versa-Vice" acts as a universal jib as well as a holding tool.

It is as good as another pair of hands to the engineer, and is made in three sizes. Size 1 (mini) costs £2 3*s.* 6*d.*, size 2 (medi) costs £5 7*s.* 6*d.* and size 3 (maxi) costs £8 2*s.* 6*d.*

The "Gilbert" junior electric hand drill.

A Serviceable Electric Drill

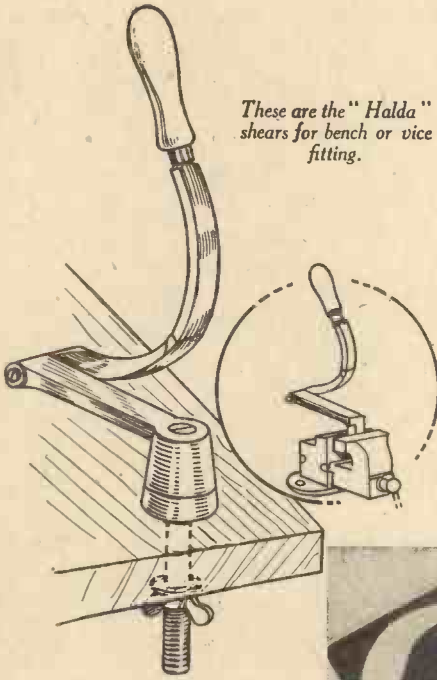
THE Gilbert "Junior" electric hand drill shown on this page is sturdily built both electrically and mechanically and will give years of thoroughly dependable service. Accurate drilling is ensured, which is essential when fitting dowels. It drills wood or metal and will take drills up to ¼ in., as well as being useful for sandpapering, burnishing, buffing, etc. The drill is obtainable in voltages ranging from 105/110, 200/220, 230/250 volts A.C. or D.C., 60 cycles or less. It is guaranteed for twelve months against faulty material or workmanship and is sold



Showing work being scribed in position with every accuracy on the "Versa-Vice."

Showing one of the many uses this tool has to the motor engineer.

complete with switch, chuck and flex. Current consumption when not under load is between 40 and 50 watts. The gross weight of the tool when packed for dispatch is $4\frac{1}{2}$ lb. and its overall length is $7\frac{1}{2}$ in. At the moderate price of 35*s.* it is extremely good value for money.



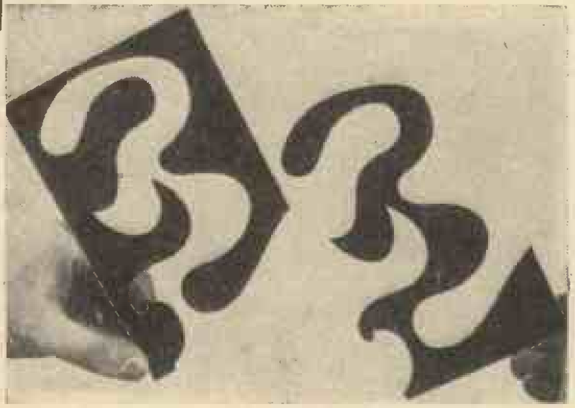
These are the "Halda" shears for bench or vice fitting.

Metal-cutting Shears

METAL-CUTTING shears are an essential tool in any workshop and those shown on this page, owing to their novel design simplify the job considerably. Known as the "Halda" shears, they effectively cut through sheet iron, aluminium, brass and zinc, as well as through soft materials such as paper and cardboard. They are made from high-quality alloy, and owing to their novel design, cut intricate shapes with ease, without distorting or damaging the edges of the work.

The "Halda" shears are made in two sizes. The smaller size, No. 1, is for use with a vice and will cut $\frac{1}{32}$-in. stuff, whilst the larger size, No. 2, can be fastened to the bench by means of a cast-iron swivel as can be seen in the diagram. It will cut $\frac{3}{64}$-in. iron. No. 1 size costs £2, and No. 2 size £2 6*s.*

The makers of the shears have also marketed electric-operated shears known as the "Pullomax" and the "Shearomax" driven by small A.C. electric motors. The "Shearomax," which is light and portable, is a nibbling machine 1 ft. $6\frac{5}{8}$ in. high and roughly a foot in diameter. It costs £40.



A shape cut out of a $\frac{1}{32}$-in. stainless steel plate. As no chipping occurs the cut and cut-out shapes fit exactly. The edges are not deformed. This was done on a "Pullomax" shearing machine.

The Batwin Flexible Shaft Unit.

The "Pullomax" is a de luxe model costing from £100 to £160.

A Useful Tool

AN interesting device for the workshop is the Batwin Flexible Shaft Unit, which has a hundred and one uses. Polishing, sanding, buffing, and drilling are just a few of the time-saving jobs the unit will do for you—and there are many others. It is of robust construction and is reasonably priced.

The power unit is a powerful, specially tested, heavy duty, $\frac{1}{3}$rd h.p. capacitor start induction-run type motor, not the usual split-phase motor which, although suitable for light service is undesirable where frequent starting is required. The over-shaft centre height is 1 ft. 9 in. from the floor and the cast iron pedestal on which it stands is fitted with a 12 in. tool tray.

The machine, complete with 10 ft. 3-core flex, wrenches, drill chuck and arbor, costs £15. Extra equipment is obtainable consisting of a 3 in. by 3 in. sanding drum costing £1 7*s.* 6*d.* and a $5\frac{1}{4}$-in. wheel guards in polished aluminium costing 17*s.* 6*d.*

STARGAZING FOR AMATEURS

(*Continued from page* 339)

(Epsilon) Aurigæ appears to be abnormally dilated. Measures taken recently at the Yerkes Observatory indicate an unexpected expansion to 2,000,000,000 miles diameter, or more than 3,000 times that of our Sun. Hitherto, nothing larger than 400,000,000 miles has been anywhere definitely determined. If, however, the star really proves to have now become a double (as was initially announced), it is possible that an exceedingly close contact may have caused the measurements to include both of the components. In any case, the change is of considerable astronomical importance and further information (not available at the time of writing) is awaited.

* * *

At the Royal Astronomical Society's last meeting the Astronomer Royal drew attention to the curious fact that, although the star α (Alpha) Ursæ Majoris, had been identified as a binary system so long ago as 1889 and was seen as such for several years thereafter, the "companion" ceased to be visible in large telescopes. In 1933, however, it was again observed through the 36-in. refractor of the Lick Observatory and its position, magnitude and separation were then much the same as in 1889. Notwithstanding that the period of revolution of 44 years corresponds with the interval between these observations, the disappearance of the smaller object is not considered to be due to an interim alignment of the two. The little "companion" has again been discernible in the Greenwich 28-in. refractor; but, paradoxically enough, it is more clearly seen when the great lens is stopped down to 9 inches. This remarkable anomaly seems to confirm the experiences of numerous amateur stargazers possessing only modest instruments that under certain circumstances and in spite of seemingly logical arguments to the contrary, features imperceptible in big telescopes can sometimes be seen in small ones! The "canals" of Mars and faint shadowy markings on Venus and Mercury are cases in point.

* * *

A super Nova has lately been discovered in an extra-galactic spiral nebula in one of the Virgo clusters. These super novæ are the brightest objects of which astronomy has any knowledge: and this particular one attained a maximum luminosity approximating ten million times that of the Sun! It nevertheless fluctuated considerably before finally fading out. The velocity of expansion of the outpouring gases was estimated at 4,000 miles per second against a general maximum of 2,000 miles.

* * *

An eruptive solar prominence on May 29 last, rose with exceptional violence in a few hours to a height of nearly 300,000 miles (one third the Sun's diameter). At its commencement the protuberance had the appearance of a plume of feathers. A few minutes later it divided into two parts, of which the upper portion became detached and rapidly disappeared. Short-wave fans who keep daily records of reception conditions may find an interesting note against that date.

* * *

It is calculated that the distance from the Sun to the centre of the Galaxy (i.e. our own particular universe) is 30,000 "light years." Each revolution around that centre of the solar system and its attendant planets and neighbouring stars takes about 210,000,000 years. Half of the total mass of the Galaxy is concentrated in a region extending 3,000 light years from the middle; and our situation is placed at two thirds of the way towards the edge.

QUERIES and ENQUIRIES

A stamped addressed envelope, three penny stamps, and the query coupon from the current issue, which appears on page 355, must be enclosed with every letter containing a query. Every query and drawing which is sent must bear the name and address of the sender. Send your queries to the Editor, PRACTICAL MECHANICS, Geo. Newnes Ltd., Tower House, Southampton Street, Strand, London, W.C.2.

A POWDER FOR SOLDERING

"I ENCLOSE a sample of powder which is used in Germany, England and America to solder or weld fine chain made of nickel and gilding-metal.

"This powder is made up into a paste with trichlorethylene and castor-oil before being applied to the chain, afterwards the chain is covered with fine graphite before applying a fierce heat.

"I would like to make this stuff myself as the cost is fairly high, but cannot get to know the composition." (A. L. Heesterman, Birmingham.)

THE sample of powder which you sent for examination consists of a mixture of finely-powdered red phosphorus and zinc dust. It is impossible through our ordinary Query Service to make a quantitative analysis of your powder in view of the time and expense involved. From various considerations, however, we should say that the powder contains about 90 per cent. of zinc dust and ten per cent. of red phosphorus. At any rate, in preparing such powder, you will not go far wrong if you begin experiments with material of the above approximate composition.

The red phosphorus and the graphite with which the metal articles are covered, act simply as protective agents which prevent the zinc dust from becoming oxidised when it is subjected to great heat. Thus the zinc dust melts and acts as a sort of solder for the fine metalwork.

STAINING WOOD

"I AM working on a piece of woodwork which was originally sized and varnished.

"I wish to remove the present finish and work up spirit or water stain and french polish. At present I have been unable to remove the size and the stain.

"Can you suggest a suitable agent for removing the size and restoring the wood to its natural state (both sandpapering and hot water have been ineffective), or can you suggest a stain which will penetrate the size?" (G. Rudgley, Southampton.)

IT is a pity that you have not informed us of the dimensions and, in particular, of the nature of the wood in question, since some woods are more easily subjected to treatment than others.

We presume that you have removed all the varnish from the woodwork. The size will have penetrated the pores of the wood, from which it will only be removed with difficulty. You might try scrubbing the woodwork over with a hot strong solution of caustic soda. This is, perhaps, a drastic treatment, and, for a delicate piece of woodwork, we should hesitate to recommend it.

Your best plan, therefore, presuming the woodwork to be valuable, is to soak it in hot water containing about two or three per cent. of ordinary washing soda. Give the woodwork several of these treatments and, eventually, you will find that the size will dissolve out of the woodwork pores. Finally, the woodwork should be thoroughly well rinsed in several changes of clean water and allowed to dry *slowly and without heat.*

You should remember, of course, that many soft woods, such as birch, do not take a stain evenly when they are in the unsized condition. In your case, however, assuming that you can get rid of the size satisfactorily, we would advise the use of a spirit stain, followed by a light sandpapering and a final application of the stain. This should provide a satisfactory and enduring base for your polishing operations.

DISTINGUISHING TESTS

"CAN you tell me the distinguishing test for a 'fluoride' with all equations concerned in the reactions. Also the test for a tartrate and an acetate, also with equations." (H. M. Kent, Lincs.)

FLUORIDES are mostly insoluble, the chief soluble fluorides being those of potassium, sodium, ammonium, and silver.

Barium nitrate solution when added to a solution of a soluble fluoride produces a white precipitate of barium fluoride, soluble in an excess of dilute nitric acid. Calcium chloride solution when added to a solution of a fluoride gives a white precipitate of calcium fluoride which is only soluble with difficulty in dilute nitric and is almost insoluble in acetic acid.

Insoluble fluorides when heated with concentrated sulphuric acid, evolve hydrofluoric acid:

$$CaF_2 + H_2SO_4 = CaSO_4 + 2HF$$

(Calcium fluoride) (Calcium sulphate) (Hydrofluoric acid.)

Hydrofluoric acid etches and corrodes glass when a piece of the latter material is exposed to it. This action enables a fluoride to be distinguished readily.

(2) A tartrate can be distinguished by adding to a solution of it a solution of potassium chloride acidified with acetic acid. A white crystalline precipitate of potassium hydrogen tartrate will be formed:

$$Na_2C_4H_4O_6 + KCL + HO.CH_3CO =$$
$$KHC_4H_4O_6 + NaCl + NaO.CH_3CO.$$

(sodium tartrate + pot.-chloride + acetic acid = pot.-hydrogen tartrate + sodium-chloride + sodium acetate.)

Solid tartrates, when heated dry, evolve dense fumes smelling of burnt sugar.

When a small quantity of a solid tartrate is heated with twice its weight of resorcinol and a little concentrated sulphuric acid a red coloration is slowly developed.

Dilute hydrochloric or sulphuric acid, when added to a solution of an acetate and warmed, liberates acetic acid, which can be recognised by its characteristic "vinegary" smell.

$$KO.CH_3CO + HCl = HCl + HO.CH_3CO.$$

(Potassium acetate + hydrochloric acid = pot.-chloride + acetic acid.)

A UTILITY HOOK AND HOLDER

"I WOULD like your advice upon an article, of which I enclose a blueprint.

"I have secured a British patent upon the device.

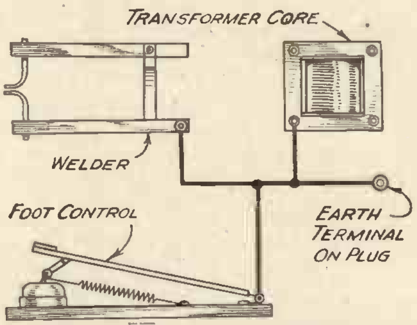
"It might be described as a utility hook and holder, and could be made in a malleable casting or perhaps aluminium.

"Do you think it would be advisable to try to place the hook upon the market myself—my finances are limited—or to try to sell the patent to a manufacturer?

"If you think the former course feasible, would you give me the name and address of a manufacturer who could make me a sample, and give me an estimate of their cost?

"If you advise selling the patent, could you give me any information as to where I might dispose of it?" (L. F., Surrey.)

AS the patentee of the improved hook and holder is not a manufacturer of similar goods, you are not advised to try to market the invention yourself; for one reason the profit on each article must of necessity be extremely small, so that it is necessary to sell a very great number to make the proposition a commercial success, and to do this requires a widespread selling organisation which is impracticable for a single article of this description. You would be better advised to place the invention before manufacturers of such classes of goods and be willing to accept a small royalty.



In our issue for December, 1937, we published an article on "A Spot Welder for Use on A.C." The above sketch shows the connections for earthing the welder and the foot pedal.

ANTICIPATING A PATENT

"IN 1932 I patented an invention which was renewed in 1936 and has not since been revoked.

"I was unable to dispose of or market the invention, but have recently found it on sale and in use.

"On taking the matter up with the makers, I was informed of two registered designs by which they suggested anticipation.

"One registered in 1930 was somewhat similar but had not the advantages of the patent, and the other design registered in 1934 and coupled to the previous design was identical to my patent.

"It was pointed out to them that neither design would invalidate the patent, and they produced another model similar in some respects to the 1930 model and also similar to the patent.

"This model was more efficient than the 1930 model, and was alleged to have been produced in 1927 and to have been sold and used.

"They were requested to give proof, but refused.

"Could application for cancellation of the 1934 design on the grounds of publication (i.e. Patent 1932) be made, or can you advise me how to ascertain the validity or otherwise of the patent?" (C. R., Dover.)

UNFORTUNATELY you have not given sufficient material particulars to enable any worthwhile advice to be given.

It is possible for the use of an article forming the subject-matter of a registered design to anticipate a subsequent patent, but not usual or probable. If a patent be granted for an invention, and such invention be published prior to the date of a subsequent design for the shape or configuration of the article appearing in the specification of said patent, then the design is invalid and the registration can be cancelled by an interested party on making application in proper form. You are advised to obtain professional assistance, since the matter appears to be somewhat involved.

A DIRECTION INDICATOR

"I HAVE designed a direction indicator suitable for cycles, which works in the following manner:

"The thumb is pressed down on a projecting rod fixed to the end of the indicator, which is of the usual shape. It is lifted up by this action, and, by a system of wires connected to the cycle lamp, is lit up.

"I have a pair in use on my cycle, and find them completely satisfactory.

"I should be grateful if you would advise me on the practicability of my idea, and if it is worth patenting." (P. P., Beds.)

AS you give no details of your direction indicator for cycles, it is not possible to give any advice on the invention which would be of any value. As the invention has apparently been in use on your cycle, it would appear to be a practical construction, but through such use which it is presumed has been in public, it may not now be possible to obtain a valid patent on the invention, since an invention to be patented must, among other things, be novel and not have been publicly used before the date of filing the application for patent.

NEW TYPE OF WHEELBARROW

"I ENCLOSE herewith a drawing of a new type of wheelbarrow which I have devised, and would be obliged if you would kindly advise me as to the possibility, marketing it as a patented device.

"I am an engineer of over 35 years' experience and have retired here, where I am the only white man in a district in the Himalayas, having an elevation of 9,000 ft., and situated at a distance of 33 miles from Simla.

"I know from bitter experience that it is not so easy to 'cash in' on an invention (I have five patents in the Calcutta Patent Office, from which I have drawn the sum of nil!), but I am sure I can depend on you for sound advice in manipulating my invention." (F. K., Simla Hills.)

THE improved wheelbarrow is thought to be novel, and forms fit subject-matter for protection by patent. For certain purposes the invention appears to have certain advantages over existing wheelbarrows, and if properly marketed should be a commercial success, since it is not thought that the cost of manufacture should greatly exceed the present type of metal barrow. The drawback for contractors' use resides in the fact that it has two wheels or requires a double track.

A CAR TRAILER

"I AM marketing a car trailer which is fitted with a patent axleless springing (Pat. No. 432291).

"I am proposing to advertise the sale of these parts for the trailer with drawings for the home constructor.

"Will you be good enough to inform me if this would in any way affect the validity of my patent in allowing others to make these trailers?" (G. K., Colchester.)

THE sale of parts to purchasers to allow them to make or assemble a car trailer, including a patented spring suspension, will not affect the validity of a patent (No. 432291) granted to the manufacturer, seller, and proprietor of the patented spring suspension. For your protection it would be advisable to not only mark the spring suspension with the number of the patent, but also to mark them with a private mark to enable you to keep track of the patented articles which you have sold.

MAKING A REFRIGERATOR

"I AM constructing a refrigerator, and am in doubt as to what system to use.

"For simplicity, I would like to use brine. I thought of building a tank at the top of the refrigerator, and using a pump on the compression and decompression principle. What pressure do I need?

"Do you advise a different system?" (C. M., Balham.)

IT is really impossible to give you detailed advice concerning the construction of your refrigerator, since you do not supply us with the necessary details and particulars of the apparatus you propose building.

It is not within the bounds of amateur practice to imitate the construction of the well-known commercial domestic refrigerators, for such articles are precision-made and have extremely delicate conditions of equilibrium.

We take it, however, that your proposed system of refrigeration is to cool brine by means of compressed ammonia or sulphur-dioxide gas. For this you will require a gas pump operated by a small motor. You will need an internal pressure of about 100 lbs. per sq. in. or thereabouts, the exact figure depending upon the size and constructional features of your refrigerator.

It will be found an exceedingly difficult matter for an amateur to make a refrigerator operated by gaseous compression and decompression, and if the refrigerator is only to be of small dimensions we would advise the consideration of some type of ice-box in its place.

If, however, you have determined to go ahead with the making of a mechanical refrigerator, you will find various systems outlined in any of the following volumes which are available in most reference libraries:

J. A. Moyes and R. U. Fittz: *Refrigeration.*

A. M. Greene: *Elements of Refrigeration.*

H. B. Hull: *Household Refrigeration.*

F. E. Matthews: *Elementary Mechanical Refrigeration.*

J. A. Ewing: *Mechanical Production of Cold.*

VANISHING INK

"CAN you tell me of a solution that will make an ink or dark stain disappear (for conjuring purposes)? I shall also be glad if you could send me a list of suitable stains and solutions. It is not necessary that the action should be instantaneous. If the stain is used on glass, would the use of the solution, if sprayed on, leave the glass clear? Please state which solutions are suitable." (J. D., Essex.)

ALMOST any aniline dyestuff can be removed from paper or fabric by washing it over with a strong solution of bleaching powder (or, better still, sodium hypochlorite) which has been acidified with a few drops of dilute hydrochloric acid. If, for instance, you write on paper with an ink or colouring medium composed of a solution of methyl violet, congo red, or brilliant green and subsequently rub the writing over with a rag charged with the above fluid, it will more or less quickly disappear. Ink stains containing iron cannot be bleached away in this manner. For their removal you must use a strong solution (preferably hot) of oxalic acid or ammonium oxalate. Since many of the iron inks are "coloured" by admixture with aniline-dye solutions, it follows that to be sure of removing the ink stain completely, it would be better to employ the oxalate solution mixed with the bleaching powder or hypochlorite solution previously mentioned.

If you intend to produce the coloured stains on glass, it will be advisable to mix the inks with a 2 or 3 % solution of cooking gelatine. This will render the stains capable of adhering well to the glass and if, subsequently, the colour-removing solution is brushed or sprayed on to the glass, it will leave the latter clear.

All acid solutions are, of course, corrosive to paper and cloth (but not to glass), as are also, to a certain extent, bleaching-powder solutions and solutions of sodium hypochlorite. If, however, such solutions are only allowed to act upon the fabric for a few minutes, no harm will be done by them. It is the prolonged action of such solutions which harms fabrics.

BOOK RECEIVED

"Noral Paste for Paint." 56 pages. Published by the Northern Aluminium Company, Limited, Bush House, Strand, W.C.2.

THE book is, in effect, a survey of many of the present and potential uses of aluminium paint manufactured from paste. The general benefits of an aluminium paint are discussed and test results are quoted to indicate the reasons for the rapid replacement of aluminium powder as a metallic paint pigment by the new paste.

The booklet is divided into about twelve main sections dealing with the use of aluminium paste paint for the protection of wood and metal, its value in painting storage tanks and pipes, for the repservation of steelwork, cement finishes, etc. Another section of the book deals with aluminium ink made from paste.

A useful concluding chapter contains a list of recommended media for use with the new paste. Practical guidance on the application of the product under the various categories is also given in easily read tabulated form.

THE TECHNIQUE OF THE WATCH TRICK

(*Continued from page* 329)

will appear to have come from inside it; the illusion being completed by the fact of its being tied round the neck of the toy.

For this trick half a dozen boxes are ample, as too many would mean having so much ribbon to stretch across them all that it would allow the watch to dangle below the smallest box. The boxes, too, should be of good size and fairly deep to give plenty of cover. Their size is, of course, accounted for by the presence of the teddy-bear in the smallest box, which it completely fills.

Finally, here is a method of producing the watch from the innermost of a nest of boxes, all of which have first of all been shown empty.

Fig. 11 illustrates the main part of the secret. The smallest box of the nest has the bottom divided and hinged to fold up inside the box. There is a lining fitting easily but closely into this box as shown in Fig. 12. A small piece of flat clock spring attached to one side of the lining ensures its remaining in place and not falling out.

The boxes are stacked one upon the other, the largest at the bottom. The false lining rests inside the second or middle box of the three. The watch having been secured and hidden in the hand, the top box is picked up and the lid of the next one opened. While the smallest box is being shown empty the watch is allowed to drop into the lining concealed in the second box. The small box is then closed and placed inside the next larger box, when it goes over the lining as shown in Fig. 12. The other boxes are omitted from this photograph to make the working clearer.

The lid of the second box is now closed and fastened and the boxes placed into the largest box. In doing this the large box may be allowed to be seen empty, but it is not wise to draw direct attention to the fact or someone may wonder why you did not show the second box empty.

At the end of the trick it is only necessary to open the boxes and lift out the ones inside until you come to the smallest box. This will, of course, bring its lining with it and inside this lining will be the borrowed watch.

Last of all is a rather sensational production of a borrowed watch. The smashed-up pieces of watch are stuffed into the mouth of a tin cone fitted to the barrel of a cap pistol and fired at a small target held by an assistant. As the shot is heard the borrowed watch is seen swinging on a hook attached to the bull's-eye of the target.

The metal cone on the cap pistol is simply a piece of tin soldered up into a funnel to take the pieces of watch. There is no trick about it and the pieces just stay where they are as after the appearance of the watch no more interest will attach to them or to the pistol. The target is of wood and the centre is cut out. This centre disc is pivoted at the sides, and a small but powerful spring is attached to make the disc spin round when released. There is a stop on the disc and a catch to release it, all of which are clearly shown in Fig. 13. The watch, having been passed off to the assistant, by giving it to him under cover of taking some other article from him, he hangs it on the hook at the top of the pivoted disc. In due course he brings on the target, holding it facing flatly to the audience. As the pistol is fired he presses down the release catch, the bull's-eye spins round so rapidly that its movement is unnoticed and there is the watch hanging on the target. Reference to Fig. 14 will show the watch in the act of making its appearance.

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Machine Vice 11/-

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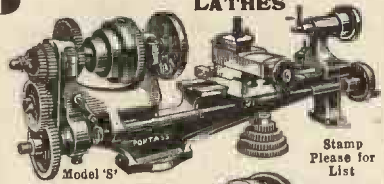

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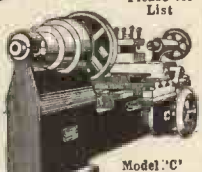

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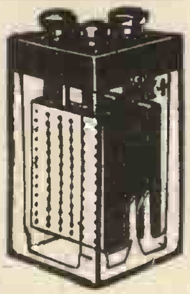

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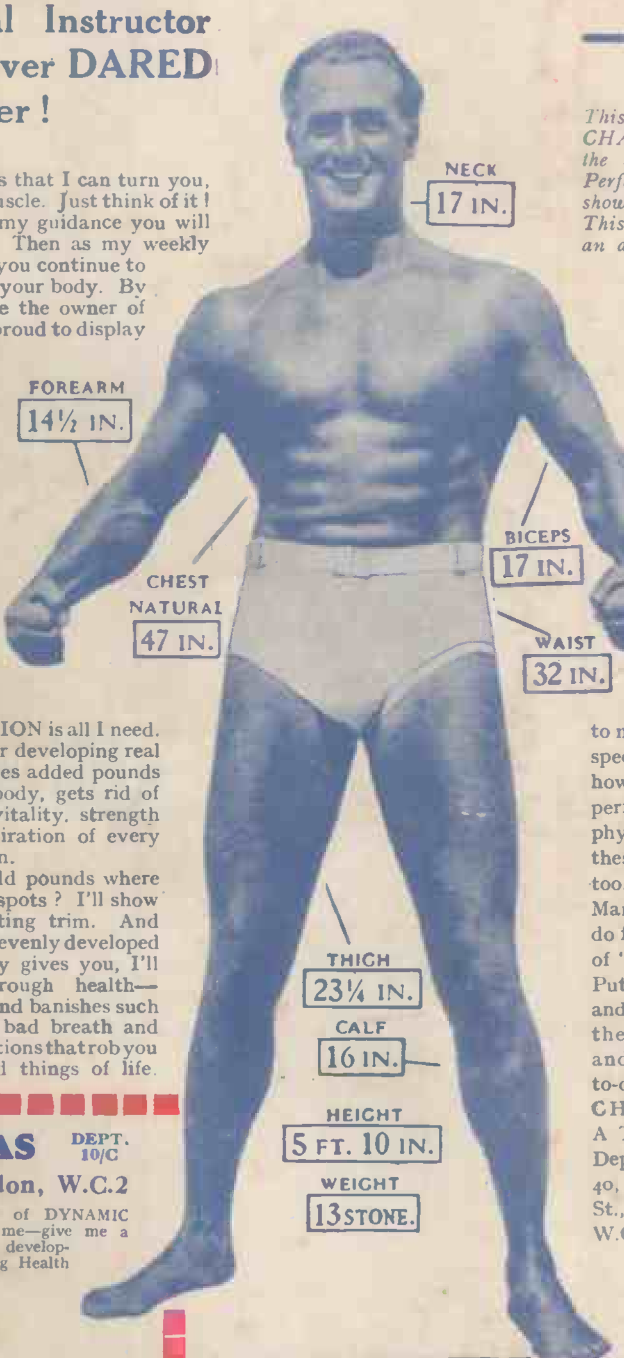

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