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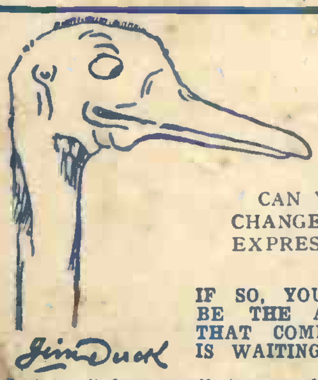

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Notes, News and Views

"Tom Thumb" Valves

THE introduction of a "Tom Thumb" type by a well-known manufacturer of wireless valves may mean that before very long most of the police throughout the country will carry miniature wireless receiving sets in which these valves are incorporated. As these valves are only about 2 in. long, with a circumference not much larger than that of a shilling, it is obvious that they can be installed in a set of very small dimensions, particularly as they can be associated with the more compact coils and condensers, of a highly efficient character, which are now available.

In the various provincial towns where the police have been equipped with wireless sets, it has been found that such sets have put a powerful new weapon in the hands of the police. The results of what was regarded at first as only an experiment, have, in fact, been so impressive that the issue of wireless sets to the police as part of their standard equipment is not a remote contingency. With the new miniature valves, and the smaller compass of the sets which they presage, the prospect of this police equipment is brought very much nearer.

Jolts Test for Watches

A NOVEL device for reproducing the various jolts and jars which watches receive in service has recently been brought into use by the Great Western Railway Company for testing watches prior to their issue to the staff. Every watch is subjected to a fifteen-minutes test, during which time it receives over 1,000 shocks. If, at the end of this time, the watch works correctly, it is passed for service. The device consists of a small wooden tray holding a dozen watches, one end of which is fixed, while the other is rapidly jerked up and down by an electric motor.

Electrically-driven Paddle Ferry Boats

THE first of their class in this country, the two Diesel-electric ferry boats, *Robert the Bruce* and *Queen Margaret*, recently built for passenger and motor traffic between North and South Queensferry, on the Firth of Forth, have just completed their trials. The two paddles are driven by separate electric motors running at 45 r.p.m., the drive being by Renold chains. The electric power is supplied by two Diesel-engine-driven dynamos, each comprising a Metro-Vick generator and a Paxman 200-b.h.p. eight-cylinder four-stroke single-acting engine running at a speed of 750 r.p.m., and having cylinders of 6½ in. diameter with a 10-in. piston stroke. A notable feature about the first-mentioned vessel is that electric welding has been used throughout its construction.

A Remarkable Insulating Foil

A NEW insulating material, known as aluminium metallic foil, was recently demonstrated by Dr. C. P. Crowden, of the department of Industrial Physiology of the London School of Hygiene and Tropical Medicine. It is claimed that the heat-insulating properties of a layer of the new material are equal to several inches of brick. In London, while experimenting with police helmets, Dr. Crowden found that when the temperature inside a helmet with the new foil lining was 109°, with the ordinary lining it was 120°. In another experiment in a liner cabin, situated near a funnel, in which the temperature rose to 120°, this was reduced to 87° by interposing a sheet of the foil.

THE MONTH'S SCIENCE SIFTINGS

"Glyptal" is the name given to the new glass produced by the B.T.H. Company. It is a synthetic resin made by condensing anhydride with glycerine, and can be produced in transparent sheets, which are claimed to possess considerable advantages as an "unbreakable" glass, particularly for aviation work. It is lighter than glass, harder than celluloid, and is insoluble in ordinary organic solvents.

A steam-driven motor car, recently constructed in Germany, has a four-cylinder compound steam engine having an output of about 120 h.p., the car having a maximum speed of 93 m.p.h.

The British Mannesmann Tube Co. has recently rolled a seamless steel tube 8¾ in. diameter and 178 ft. in length. The tube weighs approximately 2 tons and is claimed to be the longest ever made.

Under the auspices of the Swedish Government experiments are being conducted with a new process of producing petrol from sawdust and peat.

A telegraph and telephone line which is being built between Moscow and Khabarovsk will, when completed, be the longest in the world. Its total length will be 5,600 miles.

The glass disc for the reflector of a 200-in. telescope which is to be installed in the Mount Wilson Observatory, California, was recently cast. It weighs about 20 tons, and it is stated that it will require ten months for annealing.

The fastest four-engine air liner in the world has just successfully passed its Air Ministry flying trials. The machine has a maximum speed of over 170 miles an hour and has been built by the De Havilland Company for Imperial Airways. It is a biplane, and is driven by four 200-h.p. engines mounted on the front of the lower wing.

Preliminary experiments with an automatic stratosphere balloon in which another attempt on the existing height record is to be made have recently been carried out at Lutzk, near Leningrad. The balloon was sent up a distance of twelve miles, and it is stated that at that height the wireless equipment worked well. Experts consider that this new balloon, without crew, is capable of reaching a height of at least fifteen and a half miles.

Wonderful Life-saving Machine

A REMARKABLE machine, the invention of two American professors, was recently demonstrated at the Hospital for Sick Children, Great Ormond Street, London. It has already saved life in cases of drowning, gassing and poisoning. Known as the Drinker Respirator, the apparatus consists of electrically-operated bellows connected to an airtight compartment into which the body of the patient is placed. The bellows are used to create a partial vacuum inside the apparatus, thus producing a negative pressure external to the lungs, and causing them to expand. By applying negative pressure and normal air pressure alternately, the lungs are made to inhale as in normal rhythmic breathing. It is claimed that a patient can receive artificial breathing treatment for several weeks, if necessary, in this apparatus, as ports at the side of the casing are provided through which nurses can feed and attend to the patient.

A New "Non-stop" Shell

DETAILS of a new projectile with extraordinary armour-piercing qualities were given by Sir Robert Hadfield at a meeting of the famous armament firm in Sheffield recently. During tests, this huge projectile, which has a calibre of 15 in. and weighs 1 ton, was fired at a modern hard-faced armour plate having a thickness corresponding to the calibre of the gun. The projectile punched a hole through the plate, and in doing so removed about 6 cwt. of hardened steel. After passing through it still had enough velocity to carry it a further nine miles. An ordinary large calibre shell has a range of about 12,000 yards, whereas the new projectile has an efficient range of 15,000 yards.

Music from the Air

FEW people foresaw that the radio receiving set, itself a secondary musical instrument, would give rise to a primary musical instrument. The Theremin principle, which has been successfully demonstrated on the London stage, and also recorded on gramophone discs, has now been developed, and in its present form appears with a keyboard; in general appearance it resembles a piano. Thus it is possible to strike the right note and to play the instrument with a fair amount of precision. The earlier instrument demands a certain amount of skill in locating with the hand the various octaves which it encompasses.

Transmitting Films by Television

Fig. 8.—The new high definition Baird tele-cine transmitter.

By H. J. BARTON CHAPPLE, Wh.Sch., B.Sc. (Hons.), A.C.G.I., D.I.C., A.M.I.E.E.

Recent high-definition television demonstrations have emphasised the importance of the use of talking films for television transmissions. The author here explains the developments which have led up to this side of the work.

A FEW weeks ago the Baird Company staged demonstrations of high definition television of a character which aroused the greatest interest amongst all sections of the community. Both actual living persons and talking films were televised, the standard of scanning being 180 lines and twenty-five pictures per second. Hitherto in this country the attitude adopted was that there was more immediate entertainment value in the televising of a living image than in the presentation of a television film, but there are definite signs that this situation will need amendment. It is felt that there is room for both, and it will therefore be of particular interest to "Practical Mechanics" readers at this stage to trace the steps in the evolution of the transmission of visual transparencies.

A Simpler Proposition

In point of fact, tele-cinematography, which involves only the transmission of moving transparencies, is a somewhat simpler proposition than "real" television where the human figure and associated objects form the subject This arises from the larger amount of light available for influencing the photo-electric cell.

The films used are those known as the sound on film type, and Fig. 1 shows a small section of the first film to be demonstrated publicly in this country nearly five years ago. Down the right-hand edge is a ladder-like strip of light and shade representing the accompanying sound while, of course, as is well known, the individual pictures are "stills" showing a degree of movement slightly different from its immediate predecessor.

The original transmissions were of the thirty-line vertically scanned type, and the cinema projector employed for the purpose was known as the "Arcadia" machine, popular some twenty-five years ago. It had no chopper gate for cutting off the light during the quick movement from one picture to the other. In place of this the film moved continuously and an elaborate and ingenious device of cam-operated mirrors gave an uninterrupted picture when projected on to any screen.

Televising the Film

One of the actual machines is seen in Fig. 2, the large metal cylinder housing the cam-operated mirrors, while the film was accommodated in vertical lengths hung on rollers. The moving pictures were projected through a focussing and condensing lens on to a rotating apertured disc, the thirty holes being square and positioned at equal angular intervals round a single turn spiral (see Fig. 3).

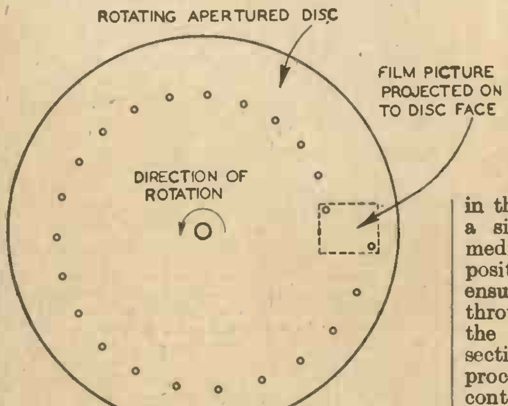


Fig. 3.—Indicating how the film is projected on to the disc face for exploration.

As each hole moved upwards across the small picture focussed on the scanning disc face, the light variations in the film passed through and influenced a single photo-electric cell mounted immediately behind. A second lens was positioned between the disc and the cell to ensure that the small amount of light passing through was spread over the active areas of the cell, and in Fig. 4 is shown a simple section drawing to illustrate the complete process. The aperture gate is included to control the spotlight depth and give the masked synchronising signal, and as the television image ratio was seven vertical to three horizontal, some of the image area available had to be masked off to make it suitable for the talking film having a ratio of four horizontal to three vertical.

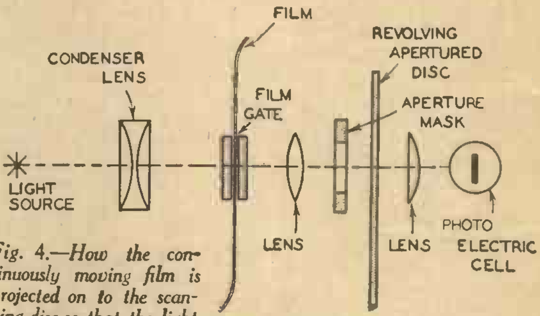


Fig. 4.—How the continuously moving film is projected on to the scanning disc so that the light passes through the holes and influences the single photo-electric cell.

Producing the Accompanying Sound

The light variations activating the photo-electric cell were converted to current variations in the normal manner, and, after amplification, were transmitted to the receiving end

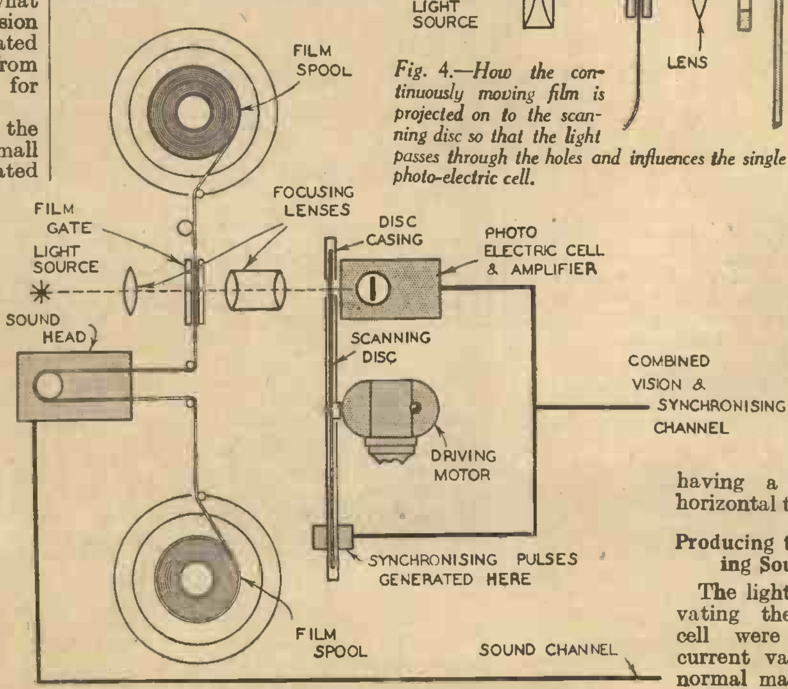


Fig. 9.—Pictorially showing how talking films are televised by the high definition process.

by wire or wireless to be shown on standard thirty-line receivers. Since these early machines had no sound head incorporated, as only silent films were used with them, special arrangements had to be made to reconvert the sound record running down the side of the film into intelligible speech and music.

The equipment was mounted on the side of the machine, and can be seen in Fig. 2, while Fig. 5 shows how the scheme worked. A projector lamp had its light beam condensed on to a mask with a narrow slot cut in it. Another lens focussed and projected the resultant strip of light on to the film sound track, and according to the overall density so a proportionate and continuously varying amount of light passed through the film to be dispersed over the photo-electric cell by another lens. In this way the light pulses were converted into current pulses, amplified and transferred to the loud speaker at the receiving end by wire or wireless.

Fig. 1.—*A section of the first talking film to be publicly televised nearly five years ago.*

Work in Germany

The complete scheme worked extremely well, but, naturally, with only a thirty-line vertical scan being used, the film subjects had to be specially chosen ones, such as head and shoulders or scenes with little detail. Similar arrangements were adopted by the Germans using the Arcadia projector, and radio transmissions from the Döberitz station were sent out according to a regular programme schedule for many months in 1931. In this case, however, horizontal scanning was employed, using forty-eight lines, twenty-five pictures per second and an image ratio of four horizontal to three vertical. The machine and associated amplifiers employed for this purpose are shown in Fig. 6, and the wavelength employed was 142·9 metres. With the increased number of scanning lines greater detail could be shown, but even so, the results fell short of the standard demanded by an interested "looking-in" public.

Other developments in Germany for televising talking films were associated with Baron von Ardenne, the cathode ray tube expert. He conceived the idea of using a cathode ray tube in his transmitting apparatus, and one of the machines built for this purpose is illustrated in Fig. 7. The light source consisted of a cathode ray oscillograph tube, the image of the electron beam spot being optically focussed on to a diapositive film of the standard 35 mm. size, the light passing through the diapositive being allowed to impinge on a single photo-electric cell. The intensity of the light incident on the cell controlled the horizontal scanning velocity of the electron spot in accordance with the principles of variable velocity scanning as distinct from variable intensity exploration, and the screen of the scanning oscillograph consequently carried an image of the diapositive scanned. It will thus be seen that, in practice, scanning necessarily occurs not with a scanning point

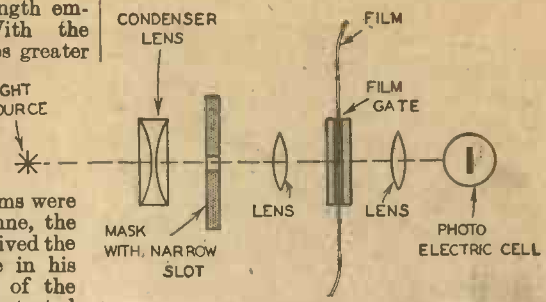


Fig. 5.—The scheme used to produce the round portion of the film.

of constant intensity, but with a point whose intensity before passing through the diapositive is already controlled by the density of the corresponding point of the diapositive scanned on the previous traverse. The varying output from the photo-electric cell and the transmitting arrangements were of normal character. The results shown by this device were particularly good, and inspired other research workers to turn once more to the talking film as a television subject.

To accommodate the increased detail demanded by the suggested high definition processes, attention was devoted to the design of amplifiers free from amplitude and phase distortion up to frequencies not hitherto considered possible. At least half a million cycles had to be accommodated, otherwise justice would not be given to the mechanical, electrical and optical improvements affected in the transmitters themselves. That this double line of attack proved fruitful was evidenced by the results shown by the Baird Company in the series of demonstrations which they rather dramatically staged towards the end of March of this year.

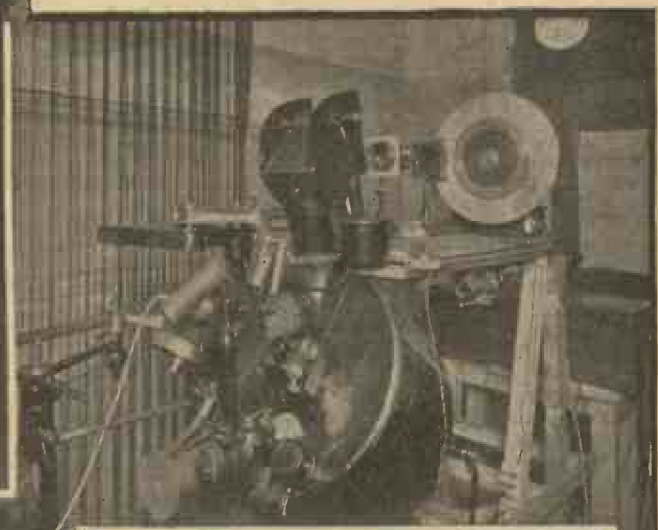
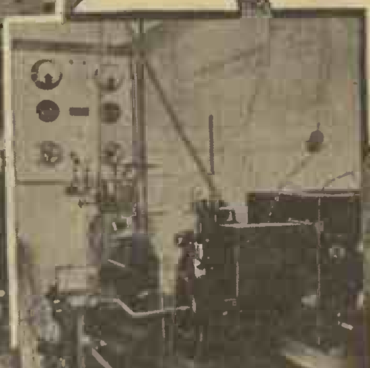


Fig. 2 (Left).—One of the original Arcadia projectors used for televising talking films in the early days.

(Continued on page 389.)



Figs. 6 and 7 (Above).—The tele-cine transmitter used at the German Döberitz station, 1931. (Right) The cathode ray tube television apparatus developed by Von Ardenne for televising cinema films.

HOW TO MAKE

The theory of stereoscopic vision interesting practical data, and instruc- stereoscopic

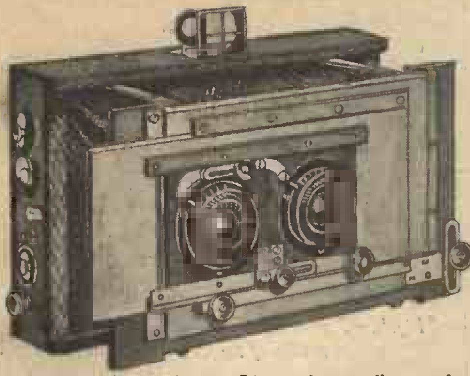


Fig. 3.—A typical camera designed especially to take stereoscopic pictures.

IT is unfortunate that the practice of stereoscopic photography is dying out, presumably because of the advent of the cinema camera. But it is a fact that stereoscopy offers one of the most interesting branches of photography, and one which, in my opinion, is definitely superior to cinematography. Stereoscopy means "seeing solid," from two Greek words: *stereos*, solid, and *scopeo*, I view. Everyone with two sound eyes sees everything in three dimensions—length, breadth and depth. This latter dimension is, unfortunately, absent to those who have only one eye, although if you close one eye you might imagine that you can still appreciate depth. This is, however, only imagination, as I will shortly demonstrate.

How Distance is appreciated

The reason why when we look down a street or across a piece of country we can state that such and such an object is "about 400 yd. away," is to be found in the fact that each of our eyes sees an entirely different view. This might at first appear to be rather a ridiculous statement, but in Fig. 1 is illustrated a simple experiment which everyone can carry out at home to prove the truth of the statement. On a table place a box or other rather bulky object, and a short distance behind it and to one side stand a smaller object, such as a candle or small bottle. Now take up a position as shown in the sketch, and close the right eye. The smaller object will be visible with the remaining eye. Without moving the position of your head, open the right eye and close the other eye. The smaller object will now be invisible. The small dotted cone projected from each eye in the sketch shows the angle of view of each eye, although to illustrate the point more forcibly these have been drawn much narrower than actually occurs in life. These angles of view show that the large object obscures the smaller one from the view of the right eye, but as the left eye is situated further to the left, it is able to see the smaller object. Thus, the fact that we can "see solid," is actually due to the fact that our two eyes are situated some distance apart. Proof that this is so, and that people with one eye can only see "in the flat," may be obtained by carrying out the simple trick which is often introduced at parties and which is illustrated in Fig. 2. A thimble or matchbox is stood up on a mantelshelf or other similar place, and you take up a position some feet in front of it. The left eye is closed and the right arm is extended with the hand closed and the forefinger projecting. You now walk forward and stop when you think you are within range, and with one sweep of the extended arm attempt to knock the box over. This is generally only accomplished about once in every ten attempts, owing to the fact that you have no appreciation of depth with only one eye, and you therefore stop short of the object.

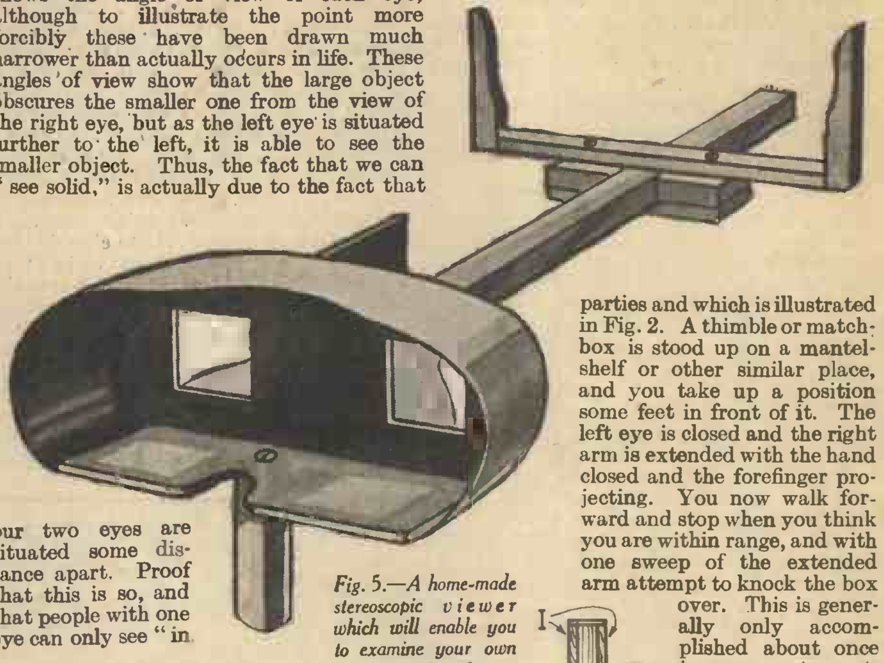


Fig. 5.—A home-made stereoscopic viewer which will enable you to examine your own stereoscopic prints.

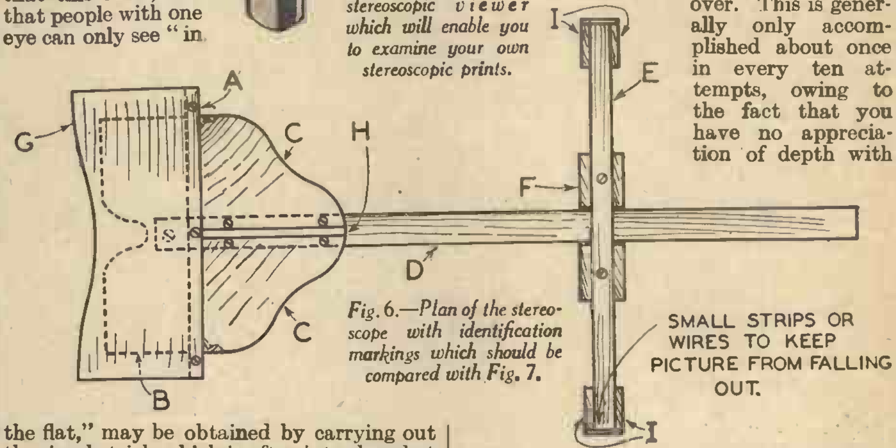


Fig. 6.—Plan of the stereoscope with identification markings which should be compared with Fig. 7.

Stereoscopic Photography

This branch of photography enables pictures to be taken which when viewed through a suitable medium have the full three dimensions, and I have already shown that the third dimension is appreciated owing to the fact that our two eyes are situated some distance apart. Therefore, to produce a photograph with depth, it is only necessary to take two pictures of a scene from two different view-points, and then to look at these two pictures with the respective eyes. The distance which separates the centres of the eyes of normal persons varies between 2½ and 2¾ in. (64 to 65 mm.), and, therefore, for normal pictures, the two views should be taken with this separation as it is called. When prints of the two pictures are made they are usually mounted with that distance separating the centres of the prints and then viewed with the correct eye, when the full depth will be visible, and the picture will be said to "stand out." An alternative method of mounting and examining the stereoscopic

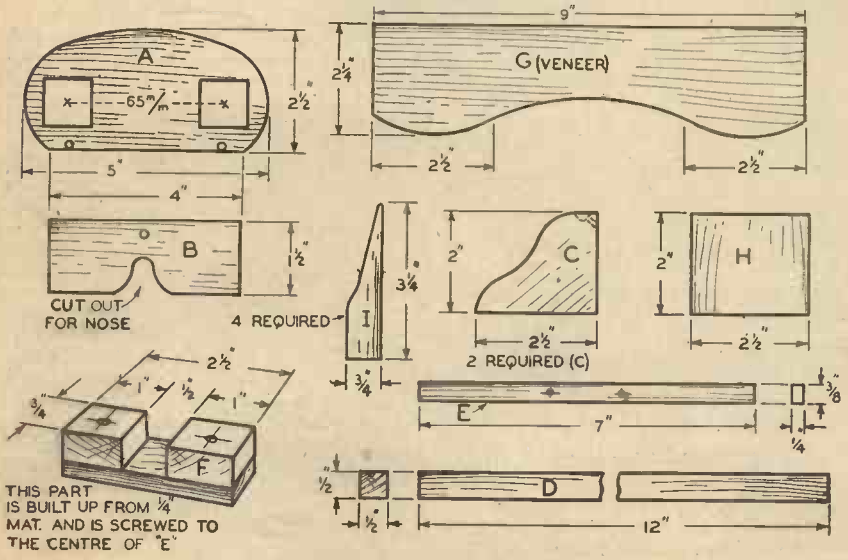


Fig. 7.—Details of the various parts of the stereoscope.

A STEREOSCOPE

and stereoscopic photography, with tions for making a viewer for photographs. By "OIDAR"

Fig. 2.—A simple experiment which proves that depth is absent when only one eye is in use.

pictures is to be found in the combined colour scheme. With this arrangement the two separate views are each printed in a different colour, generally red and blue. Thus the left eye's view is printed in red, and the right eye's view is printed in blue, and by ordinary printing methods the two pictures are printed one on top of the other, without the customary 65 mm. separation. The double picture is, of course, in this condition indistinguishable, and to see it in relief it is inspected through a pair of spectacles or similar arrangement in which two coloured glasses or other transparent material are incorporated. If the pictures have been printed as given above, then red glass would be fitted to the right side and blue to the left, or, in other words, the opposite to the colour of the print. The right eye, looking through red glass, would therefore only see the blue print, owing to the fact that the red would be filtered out through the red glass, and *vice versâ*. The objection to this method is that the two eyes are focussed together at a point rather near to the face, and this produces eye-strain and tends to develop cross-eye if used too often. To enable stereoscopic pictures to be taken as easily as ordinary snapshots, special cameras are obtainable, and these consist in effect of two small cameras joined together, with two lenses, and a division running through the centre of the apparatus to confine each view to its respective plate or film. One such camera is illustrated in Fig. 3. The processing or development of the negatives is carried out in the usual manner.

Using an Ordinary Camera

It is not essential, however, to use a special camera, as the simple device shown in Fig. 4 may be easily constructed to enable pictures to be taken with a standard camera, and this method is to be preferred when it is desired to take a stereoscopic view of a distant object. In Fig. 1 the objects are placed near to the viewer, and if you stand in the ordinary room and close each eye alternately you will notice how certain nearby objects appear to jump from one position to another. Objects which are situated some distance away, however, will not appear to move, owing to the fact that the angle of view is not so dissimilar to each eye. To overcome this when taking a photograph, all that is necessary is to increase the distance which separates the two view-points; in other words, one view is taken from one position, and the camera is then moved a certain distance to the left or right and a second picture is taken. The device in Fig. 4 is designed to be mounted on an ordinary tripod, and for normal pictures the camera is slid from one side to the other for the separate views. When no nearby object exists to give depth to the picture, the tripod should itself be moved a few feet in the required direction, and the finished prints should be mounted with the standard separation of 64 to 65 mm. The best size for prints for stereoscopic viewing is either $3\frac{1}{2}$ by $2\frac{1}{2}$ or quarter-plate, and prints should be trimmed to this size for viewing. At one time special cameras were on sale which took pictures on a $3\frac{1}{2} \times 7$ in. plate. These cameras may still be obtained from dealers in secondhand photographic apparatus, but the results are expensive. Continental cameras are obtainable at practically all photographic stores, however, and these take very small pictures on a plate 45×107 mm. Instead of ordinary paper prints, special lantern-slide transparencies are made for this particular size, and these are viewed in small viewing machines which give a great improvement over the ordinary paper print, owing to the fact that you look through the glass and thus get a sort of focussing effect on the eye as compared with the effect of focussing the eye on the paper upon which the other type of view is printed. However, if an ordinary camera is used with the apparatus shown at Fig. 4, very good results are obtainable, and the prints may be stuck on cardboard and viewed in the home-made viewer shown in Fig. 5.

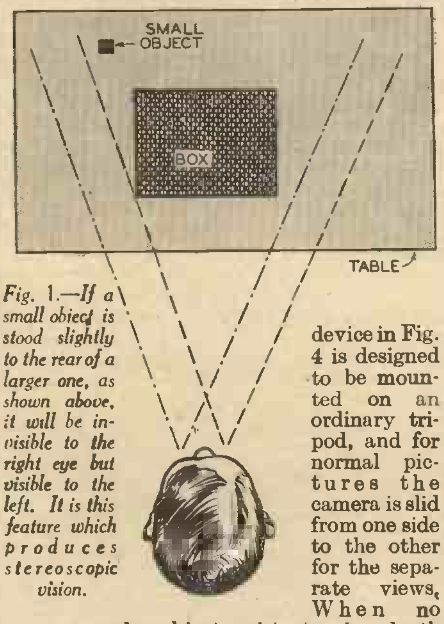


Fig. 1.—If a small object is stood slightly to the rear of a larger one, as shown above, it will be invisible to the right eye but visible to the left. It is this feature which produces stereoscopic vision.

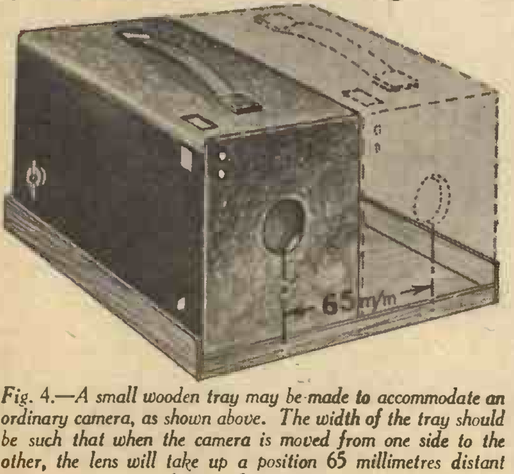


Fig. 4.—A small wooden tray may be made to accommodate an ordinary camera, as shown above. The width of the tray should be such that when the camera is moved from one side to the other, the lens will take up a position 65 millimetres distant from its first position.

The Stereoscopic Viewer

This is made to accommodate the standard stereo print which is approximately $3\frac{1}{2} \times 6\frac{3}{4}$ in. It is made up from ply or other wood to the shapes and dimensions given in Figs. 6 and 7, and the two holes which are cut in the front must be slightly smaller than the lenses which are used. A pair of lenses may be obtained from any good optician for about 2*s.* 6*d.*, and these must be mounted on the front by cutting a second thin piece of wood similar to A, but with the holes a little larger. The lenses are thus clamped between the two portions and a small rebate cut in the thicker piece will make all secure. Thin veneer, or stiff card, is next cut to the shape shown in Fig. 6 and is bent round and screwed to the front to form a hood to cut off extraneous light, whilst the bottom of the apparatus is cut from $\frac{1}{4}$-in. material. A piece of $\frac{1}{2}$-in. square section wood is then cut off to about 12 in., and this is screwed down the centre of the instrument in order to carry the picture-holder for focussing purposes. This is built up from a strip of wood and small side pieces, measurements being given in Fig. 7. An ordinary tool handle, obtainable from the popular stores or a hardware merchant for a few pence, should be attached by means of a wood screw near the front of the instrument in order that it may be held comfortably for viewing. The finished prints are stuck upon pieces of stiff card, $3\frac{1}{2} \times 6\frac{3}{4}$ in., with the centres of each picture 64 mm. apart, and care must be taken to get the left-hand view on the left and the right-hand view on the right. The pictures should also be accurately aligned to avoid eye-strain. The hood is placed against the forehead and the picture carrier is slid along the main member of the instrument until the picture is in focus, when all objects will stand out in full relief.

MAKING A 40,000-VOLT WIMSHURST MACHINE

By

W. SHEPHERD, F.G.S.

Made from simple materials this hand-driven machine will generate high voltages with which interesting experiments in electricity can be conducted.

Figs. 1 and 2.—Front and back views of the Wimshurst Machine described.

A WIMSHURST machine, as shown in Figs. 1 and 2, is simply a mechanical device for rotating in opposite directions two sets of conductors—in this case slips of tin-foil seccotined to 8-in. gramophone records—with appropriate apparatus for collecting the electric charges induced on them.

The essential parts of the machine must be perfectly insulated, for which reason they are usually mounted on glass pillars. In this model, vulcanite or some such composition is used, but it must be remembered that dry wood is no insulator to high potential static electricity.

The vulcanite "posts" are the tubes of 6-in. wireless lead-in tubes. The brass rods and terminals, which are first removed, come in for use in other parts of the machine. The base is a block of 1-in. oak, and the posts are mounted on it in the following way: Holes slightly larger in diameter than the posts are bored half-way through the wood. Some flowers of sulphur are then melted in a tin over a gas jet, and the liquid poured into one of the holes. The post is stuck in, squared up, and held until the sulphur cools. Posts mounted in this way are surprisingly firm (Fig. 3).

To strengthen the middle posts, which carry the bearings of the plate-spindles, a hole is drilled through each about half-way up, and a brass rod from a lead-in tube pushed through and bent into a semi-circle. The two ends, which are threaded, are then bolted down to the base in the manner shown.

The Bearings and Collecting Combs

These can be attached to the tops of the posts by tight-fitting screws, which will cut their own threads in the vulcanite. The collecting combs themselves are made from lengths of brass rod bent into a U. A convenient number of small holes are drilled through each arm of the U, and gramophone needles, broken off to a suitable length, are soldered or cemented in. In the model shown, ordinary metal cement was found to be very effective. The ends of the rods should be carefully rounded, as it is essential in electrostatic machines to have all metal parts smooth and polished, and to avoid all sharp corners. (As, however, electric charges are carried on the surface, it does not matter whether the parts are hollow or solid.)

The combs are then mounted so that the plates can revolve between them without quite touching them. The clearance may be as much as a fifth of an inch without any serious loss of electrical charge.

Eight strips of tin-foil—"silver paper" does very well—are seccotined at equal distances on one side only of each gramophone record, and a wheel with a set-screw is bolted to the centre to facilitate attachment to the spindles. The records are then mounted to rotate back to back, the foils facing the points of the combs. To keep the records apart, a ball-bearing is slipped in between the two spindles, a device which also makes for smooth running, since the spindles rotate in opposite directions.

On the tops of the brass knobs to which the combs are attached, the terminals from a lead-in tube are soldered. Two of the brass rods can then be bent into semicircles and screwed in to form the "conductor arms." These terminate in two brass balls (between which the sparks are produced), at the top of the machine. It is as well to use smooth rods, to avoid the sharp edges occurring inevitably if they are threaded throughout their length. The brass knobs are those known as "bell-knobs," bought at a penny or so each, and are attached by filling them with metal cement, and then pushing the rods in. Alternatively, large, bright ball-bearings could be soldered on.

(*Continued on page 362.*)

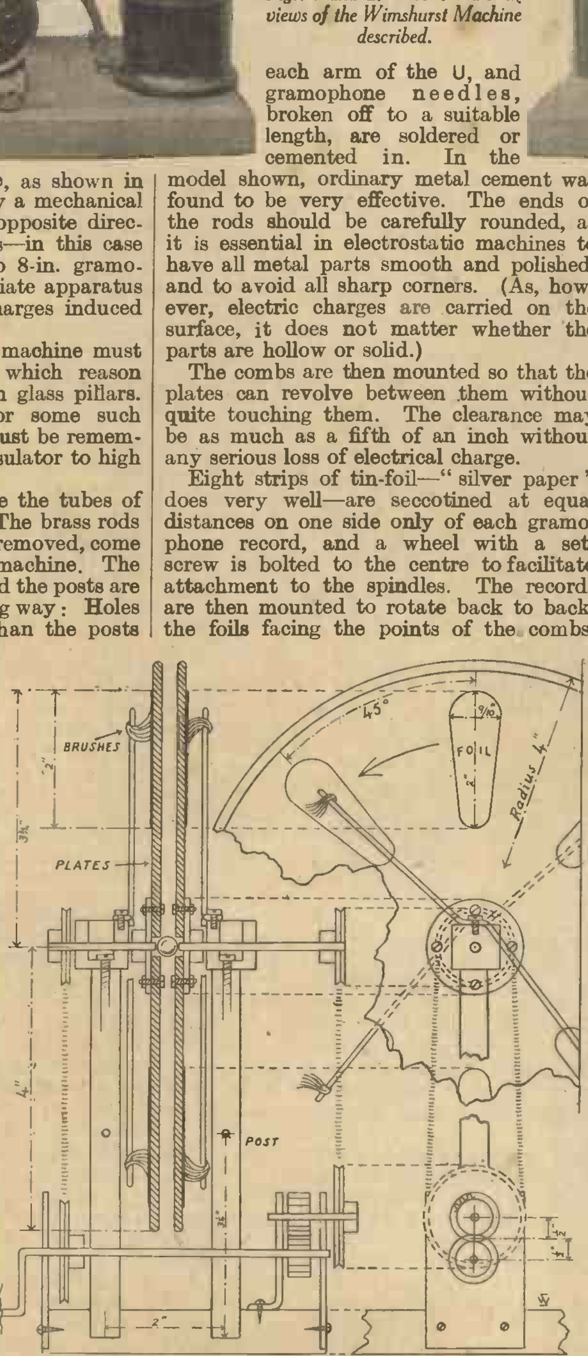


Fig. 4.—General details of the disc and its mountings; also method of connecting the brushes.

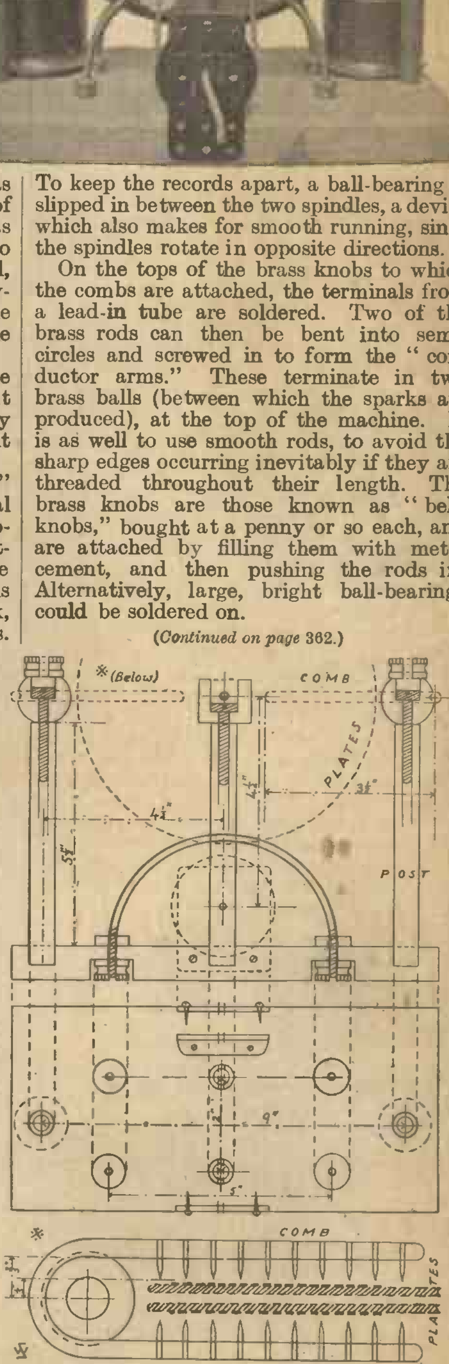


Fig. 3.—Showing method of mounting the posts and also details of the comb.

OVERHAULING A LAWN MOWER

By "HOME MECHANIC"

From now onwards the lawn mower will have to be in fairly constant use to keep down the growth of the grass. Unless the machine is kept in good mechanical condition as explained here, what should be an easy task is rendered tedious.

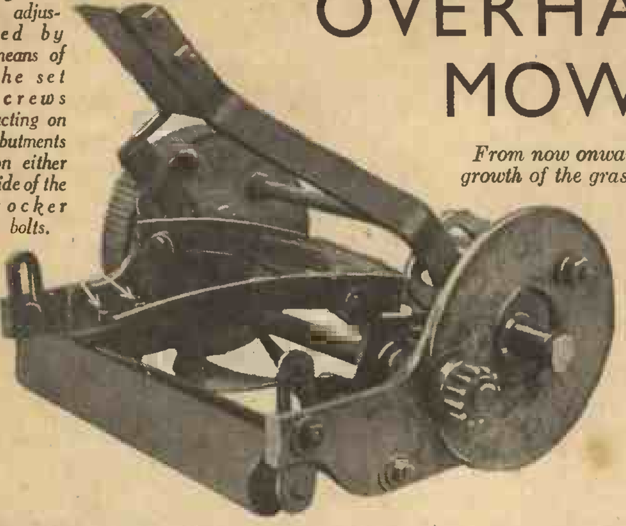


Fig. 1.—The bottom blade is adjusted by means of the set screws acting on abutments on either side of the rocker bolts.

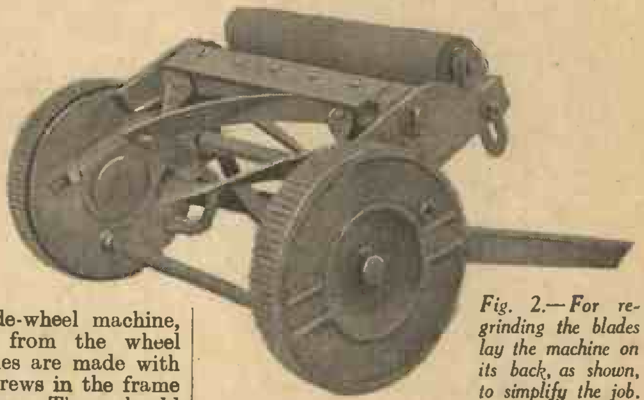


Fig. 2.—For regrinding the blades lay the machine on its back, as shown, to simplify the job.

THE essential parts of a lawn mower are a set of rotary blades mounted on spiders attached to an axle. These form a skeleton cylinder, each blade being twisted to form a segment of a coarse pitched spiral. The blades are made of shear steel, and the edges forming the outside diameter are truly ground with the axis of the spindle. The leading or cutting edges of these blades are also ground on the faces. Mounted in bearings the cylinder is driven by the action of pushing the machine. On the bottom of the machine is a stationary blade arranged in such a manner that the revolving blades are almost rubbing it throughout their entire length. Each blade bearing in turn along the edge of the stationary one works like a pair of scissors. As with scissors or shears that are blunt and rocky in the joint, the cutting action is impaired and made difficult, so is that of a mower, the condition that is analogous to a loose joint being excessive clearance between the blades. Then instead of cutting, the tendency is for the grass to fold between the blades and tear. The effort required to propel a machine with blades that are blunt and out of adjustment is many times greater than that when in proper order.

Lawn mowers in general use are one of two types, these are "side-wheel" and roller, or drum. The fundamental difference between these types lies in the method of driving the cylindrical cutters. There are driven by a pinion attached to each end of the cutter spindle, actuated by internal gear teeth made on the insides of the rims of the wheels of the side-wheel type. In the other type the drive is taken from the live spindle of the drum either through a train of gears or by a chain. A slight variation between different makes occurs in the manner of adjustment, arrangement of bearings and so forth apart from difference in type, but the following remarks will be found to apply more or less generally.

Examination

Presumably the machine was put away in a clean condition as far as the exterior parts were concerned. Therefore the first thing to look at is the condition of cylinder spindle and bearings. To do this properly means that a certain amount of dismantling will have to be done. While the bearings may not be worn, there is every likelihood that they will be clogged with grass particles and dried oil, which, if allowed to remain, would prevent any lubricant from reaching the bearing surfaces.

To do this with a side-wheel machine, remove the split pins from the wheel spindles, or if the spindles are made with a head, loosen the set screws in the frame and drive out the spindles. These should come out fairly easily, driving from between the frame of course, and using an old bolt as a punch. The removal of the wheels exposes to view the driving pinions on the ends of the cutter spindle. Lift these off, but when so doing watch that nothing falls out. The backs of the pinions are recessed to form internal ratchet wheels having three teeth. Corresponding with these are short slots cut through the spindles, into which pieces of flat material are loosely fitted. This arrangement acts like a free-wheel when the mower is pulled backwards. Remove these pawls, noting which way the straight edges are facing. By the way, on some machines channels are cut in the frame castings to facilitate their removal.

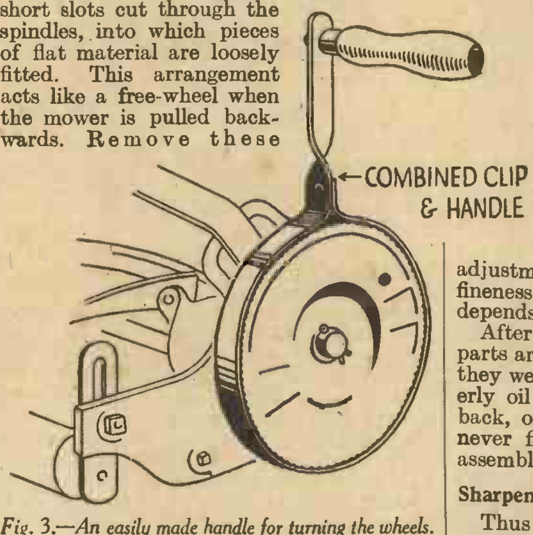


Fig. 3.—An easily made handle for turning the wheels.

The ends of the spindle can now be tried by shaking to see if there is any play in the bearings. If no shake is apparent, spin the cylinder to see if it revolves freely. Then if satisfied on this point wash out the bearings with paraffin, but if very sticky it is best to remove the cylinder for cleaning purposes. This is done by removing one of the nuts on the ends of the tie rod, exposed by removal of the wheels, and one rocker bolt holding the bottom blade, marked by an arrow in the front of the photograph, Fig. 1. One side plate can then be lifted clear and the bearings thoroughly cleaned. The bearings may be ball or roller, in which case there is less likelihood of them being badly worn than if made of bronze. In the latter case some wear can be taken up by adjustment of set screws, afterwards securely tightening the locking nuts. Do not let the bearings go without adjustment if at all slack, as the degree of fineness to which the blades may be set depends upon them.

After well cleaning the gear teeth the parts are reassembled in the order in which they were removed. Don't forget to properly oil all working surfaces before putting back, or the chances are that the oil will never find its way where it is wanted if assembled dry.

Sharpening the Blades

Thus we come to the restoration of the cutting edges of the blades. We will presume that the blades are merely dull and not badly gapped. Should such be the case, regrinding may be successfully carried out by hand. Lay the machine on its back, as in Fig. 2, resting it on a plank or block, and supporting it by the tie bar and handle bar, so as to leave the wheels free to rotate.

The bottom blade is adjusted by means of the set screws acting on abutments on either side of the rocker bolts (see arrows on back of Fig. 1), until the cylinder blades rub when rotated.

It will be necessary to provide some form of handle with which to turn one of the wheels.

A suitable one for this purpose is shown in Fig. 3. As will be seen, it is of iron

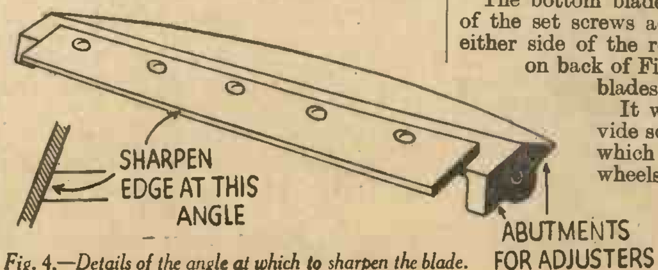


Fig. 4.—Details of the angle at which to sharpen the blade.

(Continued on page 396.)

STORING ON A

A description of the Blattnerphone

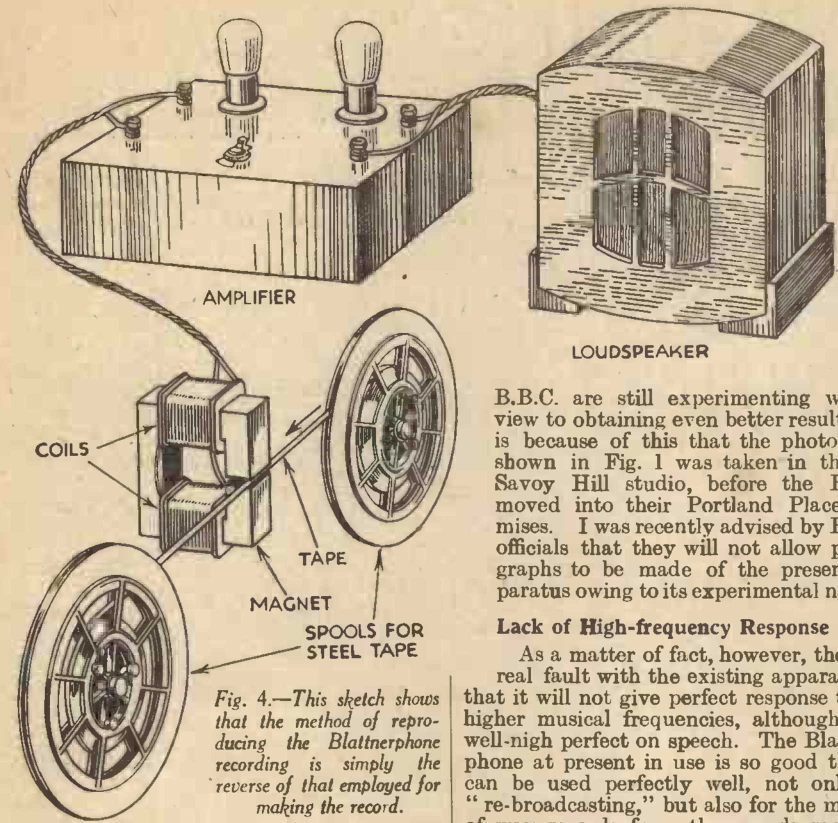


Fig. 4.—This sketch shows that the method of reproducing the Blattnerphone recording is simply the reverse of that employed for making the record.

MANY readers have no doubt often wondered how the B.B.C. manage to reproduce a talk or other item during the evening programme which was actually given earlier in the day; or how it is possible to give a selection of important items in the past year's broadcasts on New Year's eve. Similarly, it has probably often puzzled listeners to know how "trailers" of forthcoming plays are given without having the caste in the studio. All these questions can be answered very simply and by means of one word—Blattnerphone. This is a marvellously efficient recording apparatus which is in many ways far superior to ordinary wax recording such as is employed for gramophone reproduction, and it is so good that the British Broadcasting Corporation have found it worth while to instal at least three expensive Blattnerphone outfits at Broadcasting House.

Advantages of the Blattnerphone System

The Blattnerphones are used extensively for making records of programme rehearsals so that the artistes can hear their own performances within a few minutes of completion. This would be impossible if ordinary wax recording were used, since a considerably greater time is required in order to "bake" the original matrix, prepare the record from it, and so on. From this it might be imagined that, since the Blattnerphone is so good, it should replace the gramophone. But when it is explained that the simplest type of apparatus costs hundreds of pounds, whilst the "record" itself is valued at several pounds for a "playing time" of a few minutes, it will be realised that the Blattnerphone is by no means a rival to the gramophone. Those readers who have compared the reproduction given by the Blattner-Stille system (the name is after the inventors) with the original must have been struck by the amazing fidelity, and yet it can be stated definitely that the B.B.C. are still experimenting with a view to obtaining even better results. It is because of this that the photograph shown in Fig. 1 was taken in the old Savoy Hill studio, before the B.B.C. moved into their Portland Place premises. I was recently advised by B.B.C. officials that they will not allow photographs to be made of the present apparatus owing to its experimental nature.

Lack of High-frequency Response

As a matter of fact, however, the only real fault with the existing apparatus is that it will not give perfect response to the higher musical frequencies, although it is well-nigh perfect on speech. The Blattnerphone at present in use is so good that it can be used perfectly well, not only for "re-broadcasting," but also for the making of wax records from the sounds recorded by it.

Variable Magnetisation

The principles underlying the functioning of the Blattnerphone are quite simple and easily understood, even though the practical details present no little difficulty. The operation of the apparatus depends upon the variable magnetisation of a specially prepared steel strip or tape as it passes between two magnets which carry windings into which sound frequencies are fed. This will be more easily understood by referring to Fig. 2, which is a diagrammatic representation of the "input" or "recording" section of the Blattnerphone. It can be seen that the ordinary broadcasting microphone is connected to an amplifier which feeds into the coils surrounding the recording magnets. It will be understood that the fluctuating signal currents constituting the output from the amplifier will vary the strength of magnetisation of the magnets. Thus, as the steel tape passes between the poles of the magnets its degree of magnetisation is varied along the complete length of the tape. The effect can be compared with that described in the November, 1933, issue of PRACTICAL MECHANICS, under the title of "Music from Pencil Lines!" In the latter cases, however, it was shown that sounds were produced by varying the area of blackness on the "sound track" of a film or strip of paper, whilst in the present case the sound is recorded by varying the intensity of magnetisation. The effect is shown graphically in Fig. 3, where the magnetic strength of the tape is represented by a graph which corresponds to sound waves such as are produced when a person speaks.

The steel tape is run between the magnets at a definite speed in one direction, and then, after the required "record" has been made, the tape is wound back (much more quickly this time) in readiness for reproduction. At this juncture it might be mentioned that in order to compensate for the deficiencies of the Blattnerphone at high audio frequencies the amplifier which feeds it is specially designed to give high-note emphasis. This largely compensates for the failings of the recording system, but it is impossible for it to do so completely at the present stage of developments, since, if too much emphasis is given, a form of "hiss," which is similar in effect to the needle scratch experienced with wax records, becomes evident, due to the "grain" in the steel. It should also be explained that the normal microphone, besides supplying the Blattnerphone, may also be connected to the standard amplifiers and broadcast transmitter in the usual way, so that any or every broadcast transmission can be "Blattnerphoned" for further use.

Reproducing the Steel "Record"

The method of "reproducing" the Blattnerphone record is just the opposite of the recording system, and consists of passing the tape, at the same speed as was used in recording, between the poles of a second magnet, which might be likened to the "works" of an ordinary gramophone pick-up. The magnet has a double coil, which is connected, just like a pick-up, to the input terminals of a standard amplifier feeding into a loud speaker (see Fig. 4). Variations in magnetisation of the tape thus cause corresponding varying or fluctuating currents to flow through the windings. These currents are (almost) exactly the same as those passing through the first or recording magnet coils, and therefore the speaker reproduces the sounds as they were picked up by the microphone in the first place, so completing the cycle of operations.

Wiping-out the Recording

It was mentioned above that the special

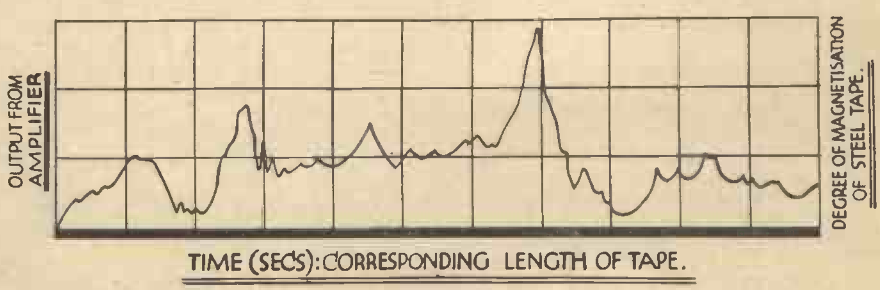


Fig. 3.—A graphical representation of the degree of magnetisation of a length of the Blattnerphone tape by comparison with the output from the recording amplifier. The wavy line represents a sound wave.

SPEECH AND MUSIC STEEL TAPE

method of sound recording on steel tape

By P. STONE

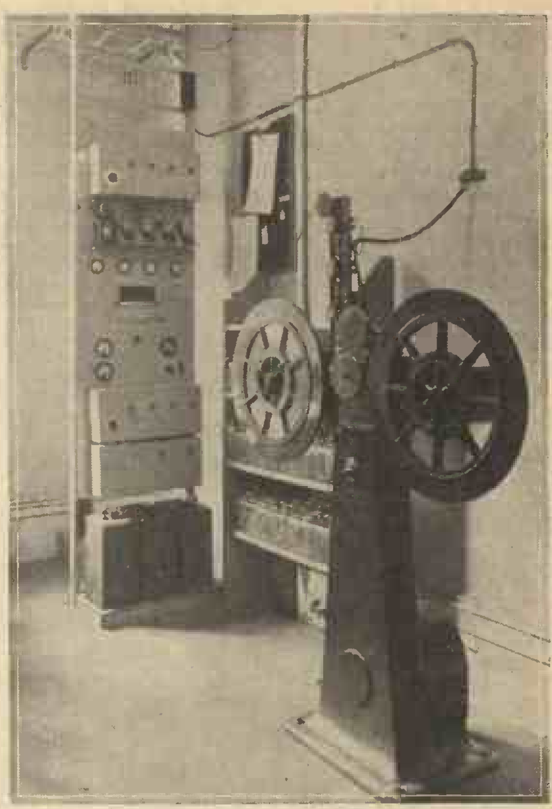


Fig. 1.—This photograph shows the Blattnerphone installed in the B.B.C.'s premises at Savoy Hill in 1931. The amplifier and control panel can be seen in the background.

Blattnerphone steel tape is very expensive. This is actually true in regard to its first cost only, since a single tape can be used time after time by "erasing" or wiping out one set of "magnetic impressions" and applying another recording. The method of "erasure" is simple enough in theory and consists of passing the tape between the poles of yet another magnet system. This time the magnets are very powerful and are energised by means of a uniform direct current, with a result that the tape becomes magnetically saturated so that all traces of the variable magnetism are entirely removed. Because of this it will be appreciated that the recording process consists of a partial demagnetisation of the tape, in addition to the variable magnetisation produced by the audio-frequency currents fed to the magnets from the amplifier.

The complete Blattnerphone instrument consists of three distinct parts whose functions have been briefly described above; these are referred to as the "recording head," the "reproducing head" and the "wipe-out head," for reasons which will now be apparent.

Ensuring Good "Quality"

In using the Blattnerphone there are several important points to watch. One of these is that the output from the amplifier is not sufficiently great to "overload" the tape by allowing it to become magnetically saturated at certain points, and another is that high-note tone compensation should be provided in the amplifier. The first item is looked after by controlling the amplification produced by the amplifier, for which reason an H.F. voltmeter is included in the output circuit so that the control engineer can ascertain that the audio frequencies supplied to the recording head do not exceed a certain predetermined figure.

In practice it is generally found better to design the reproducing amplifier so that it tends to emphasise the higher frequencies. Thus, double tone compensation is provided, first in the recorder and then in the reproducer. By this means there is less risk of distortion and of obtaining the undesirable "hiss" which was mentioned above.

The Blattnerphone is already one of the most important pieces of apparatus employed by the B.B.C., and it is safe to predict that, in view of the improvements which are still being made in this method of reproducing, it will eventually attain to perfection.

That the efficiency of the Blattnerphone as at present in use is extremely high can be judged by listening during the day to any important speeches which are made, and again listening when they are re-broadcast in the evening programme or at the end of the News Bulletin. In numerous instances it will be found that the steel tape recording bears so close a resemblance to the original that absolutely no difference can be detected, and only in very rare instances will the least trace of distortion be noticed, especially when reception is by means of an average type of wireless receiver.

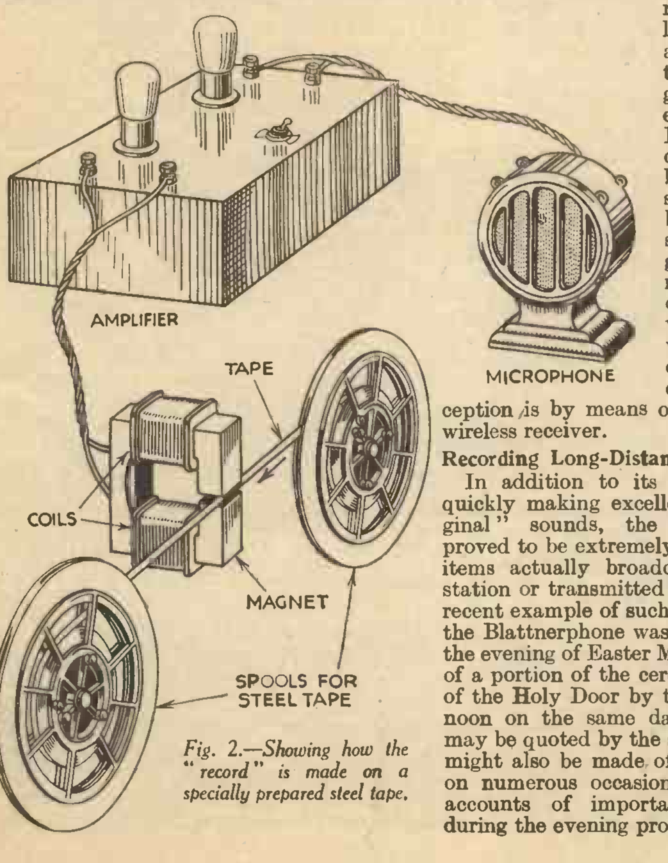


Fig. 2.—Showing how the "record" is made on a specially prepared steel tape.

Recording Long-Distance Broadcast

In addition to its use as a means of quickly making excellent records of "original" sounds, the Blattnerphone has proved to be extremely useful for recording items actually broadcast from a distant station or transmitted over a land line. A recent example of such a use being made of the Blattnerphone was the broadcasting on the evening of Easter Monday by the B.B.C. of a portion of the ceremony of the closing of the Holy Door by the Pope in Rome at noon on the same day. Other examples may be quoted by the score, whilst mention might also be made of the re-broadcasting on numerous occasions of "eye-witness" accounts of important sporting events during the evening programmes.

The methods of making the steel-tape records in such cases as those just referred to are practically the same as those employed when records are being made of actual studio broadcasts. When the item being recorded is received by wireless the recording head simply takes the place of, or is connected in parallel with, the usual loud-speaker attached to the receiver. If the particular item is transmitted by land-line the recording head (in conjunction with its own amplifier) is connected, along with the usual transmitting amplifier, to the telephone wires.

Tone Correction

It will be appreciated that in many instances it is necessary to employ special tone-correcting devices in conjunction with the Blattnerphone amplifier equipment to compensate for deficiencies of the microphone, land-line, wireless transmission, etc., as the case may be. This presents very little difficulty at the present time, however, when it is common practice to include correction or tone-control devices in the circuits of most types of "quality" amplifiers.

The steel-tape recording instrument is probably of greater value to the B.B.C. than any other device installed at Broadcasting House, and it is being used more and more extensively as its efficiency is being increased. One of its great features is that records can be kept of any or every programme at modest cost, after which those items which are not required again can be erased. Those which are wanted again can be retained as long as necessary, or they can be "transferred" from the tape to an ordinary wax record in a minimum of time. All that is necessary is to connect the reproducing head directly, or through a suitable amplifier, to the recording stylus which makes the grooves on the original record or matrix.

THE TWO-STROKE ENGINE

An interesting article dealing with various types of two-stroke engines

MOST readers of PRACTICAL MECHANICS will be familiar with the working of the small valveless three-port type of two-stroke engine as used on motor cycles, but for the benefit of those who are not, the principle of operation is illustrated by the two diagrams in Fig. 1. The engine must, of course, be started by turning the crankshaft for a few revolutions, and assuming that the piston is at its lowest point it will begin to rise, thus causing a partial vacuum in the crank chamber. As the piston nears the top of its stroke it uncovers a port on its underside, allowing the combustible charge to enter the partially-evacuated crank chamber from the carburetter (see the first sketch in Fig. 1). When the piston moves downward again the charge is trapped in the crank chamber and compressed until the piston uncovers the transfer port on its top side. This allows the charge to enter the cylinder and the next upward stroke of the piston compresses the charge which is then ignited. The consequent rise of pressure forces the piston downwards, thus providing the working stroke. At the end of this stroke the burnt gases escape out of the exhaust port (which opens before the transfer port) and immediately afterwards the new charge enters *viâ* the transfer passage and pushes out the residual exhaust gas. The cycle of operations goes on above and below the piston simultaneously, so that a power impulse is obtained every revolution, or in other words, there is a power impulse for every two strokes (one up and one down) of the piston, hence the description "two-stroke cycle."

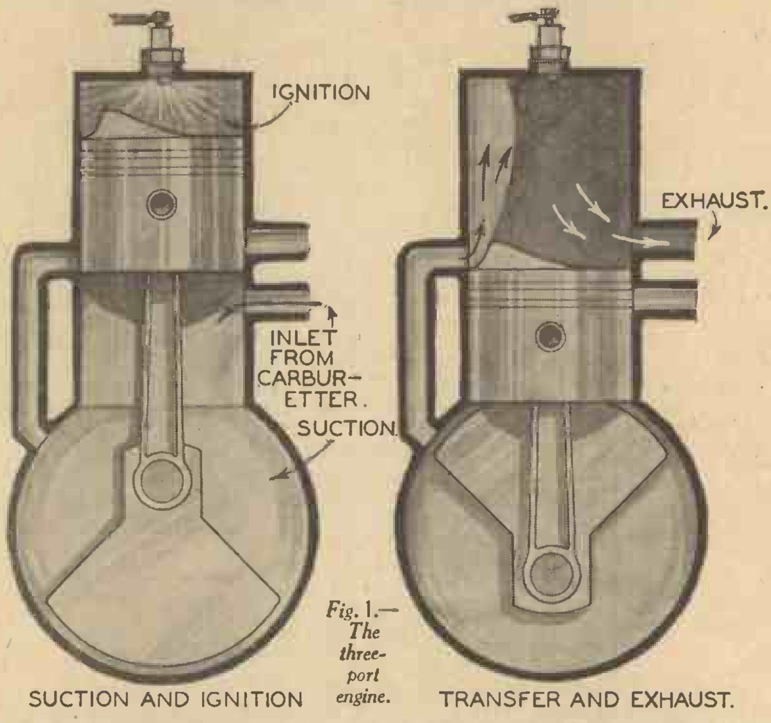


Fig. 1.—The three-port engine.

It will be observed that the space below the piston, *i.e.*, the lower end of the cylinder and the crank chamber, is continually acting as a pump which feeds the combustible mixture of petrol vapour and air to the working cylinder. This pumping action is a feature common to all two-stroke engines, though in some cases it is carried out by means of a separate pump instead of using the crank chamber.

The Two-Stroke Principle

This is by no means a recent invention. It was originated in 1880 by Dugald Clerk, a pioneer in the development of the gas engine. Gas engines were, of course, the forerunners of the modern petrol and oil engines. The cylinder arrangement of the Clerk engine is illustrated in Fig. 2. In this engine the combustible charge of gas and air was supplied by a separate pump, and instead of being introduced into the working cylinder by means of a port at the outer end of the stroke it was admitted at the apex of a conical combustion chamber through a non-return valve. At the end of the outward stroke the piston uncovered a series of exhaust ports in the cylinder wall and as the exhaust gas escaped, the pressure inside the cylinder fell until it dropped below that of the incoming charge. The inlet valve then opened to admit the new charge, which forced the residual exhaust gas before it out of the exhaust port. The object of the conical combustion chamber was to provide a smooth flow to the entering charge, so as to avoid as far as possible mixing it with the residue of the exhaust gas. The engine was water-jacketed to keep it cool, but the cooling jacket has been omitted from Fig. 2 for the sake of simplicity and clearness.

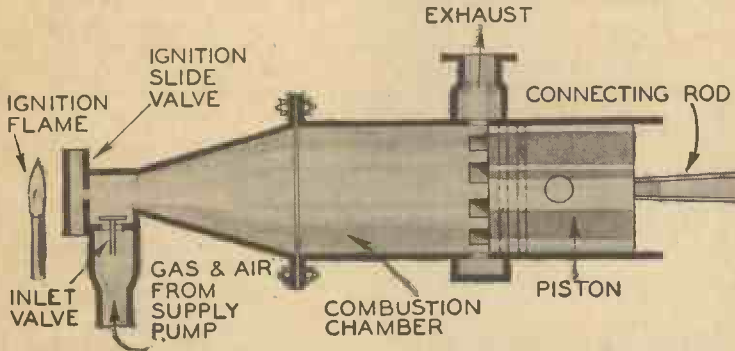


Fig. 2.—The cylinder arrangement of a Clerk gas engine.

Ignition on the Clerk engine was accomplished by means of a slide valve which carried a pocket of burning gas from a flame outside to the mixture inside the cylinder. Electrical ignition was known and used at that time, but was not in universal use, being considered unreliable.

It seems to be assumed by many that the two-stroke cycle of operations is only suitable for very small engines. As far as the valveless three-port crankcase compression engine is concerned, this is no doubt true, but it is certainly not correct to say this of all two-stroke engines.

The Korting Gas Engine

The Korting gas engine, for instance, worked on the two-stroke principle and was made in sizes up to 2,000 h.p. A single cylinder horizontal engine had a bore and stroke of about 30 × 50 in. and ran at about 90 r.p.m. This speed sounds very low nowadays, but when the size and consequent weight of the water-cooled piston is considered it will be realised that it is not practicable to run such an engine at high speed; also the stroke being very long a reasonably high piston speed is obtained at low r.p.m.

The cylinder arrangement of this engine is shown in Fig. 3, the water jackets being omitted. The cylinder was double acting and provided with a series of exhaust ports in the middle of its length. The same

(*Continued on page* 360.)

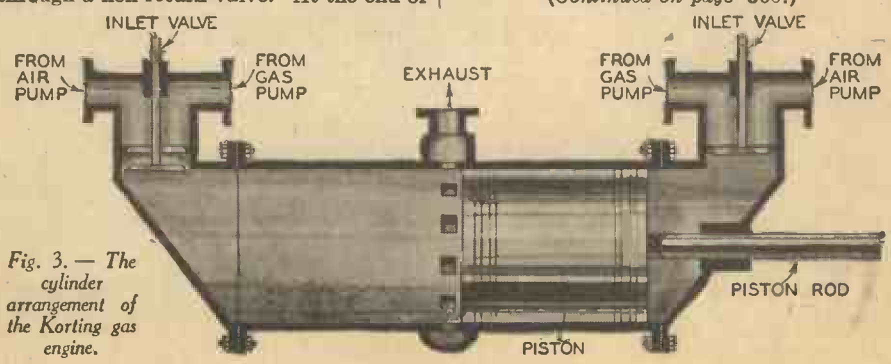


Fig. 3.—The cylinder arrangement of the Korting gas engine.

How a Ship is Launched

Below is a description of the method of launching a ship, which is possibly the most picturesque and thrilling undertaking in modern engineering

THE practical shipbuilder, when building a ship, makes careful preparations for launching before a single plate of the keel is laid; three main precautions being necessary.

(*a*) The ship must be built as near the water as possible. The highest spring tide must just lap around the rudder. If it comes too far up the slip, the work of construction is hampered.

(*b*) The slip must have enough slope to allow the ship to slide off, but not enough to send it off too violently.

(*c*) There must be ample depth of water at the edge of the slip and a clear stretch in front.

All these precautions are carried out in the light of previous experience and are subject to well-known rules and measurements. Fig. 1 shows the method of supporting a partly built ship. The keel blocks are made of English oak. The wedges shown are cast iron. The bottom block is rather longer than the upper blocks and may be iron-shod on top and trimmed off on the bottom, so that the whole stands plumb. Smaller wedge-shaped pieces of oak are now cut out so that the blocks present a perfectly straight slope parallel to the "ground ways" also seen in the sketch. Any blocks showing low or high are raised or lowered by manipulation of the iron wedges.

Commencing Construction

The keel may now be laid and the work of construction proceeded with. The shores seen in Fig. 1 for sustaining the ship are placed by the builders as they fix their plates. These shores are judiciously shifted and replaced to permit riveting, etc. Nothing more is done towards the launching until the hull is almost complete, when the launching ways are drawn up on the ground ways. The sliding ways are two baulks of timber about 3 ft. by 4 ft., built up of deal and about two-thirds the length of the ship. The sliding ways are faced with 3 or 4 in. of teak or other hard wood where they slide on the fixed or ground ways. The next process is to insert the "poppets"; these are built-up timber blocks. They rest on the sliding ways and fit snugly against the ship's bottom. To ensure a snug fit moulds are made where the poppets are to go. These moulds, made of battens of wood, give the curve and height of the bottom and other data for trimming the poppets to the exact shape. Now the poppets under the flatter bottom of the ship will support the ship without being fastened to the hull. If the ship has a bilge or rolling keel or fin-like projection, the poppets, of course, will fit up under it. The poppets up around the bow obviously will not support the hull, and a launching plate is prepared.

Fig. 3.—The photographs show clearly the launching plate, fire poppets and hydraulic rams.

The Launching Plate

This is a narrow ledge riveted to the hull just over the poppets, its function being to give the poppets a "grip." At the bow end the launching plate is stiffened with angle-bars and bends down around the fore poppet. This (Fig. 2) consolidates the hull poppets and sliding ways, forming a sliding carriage or cradle. The sliding ways must be shifted to grease the ground ways. This is done by shoring the poppets up and drawing the sliding ways in towards the keel blocks on brackets fastened to the ground ways (see Fig. 1). The greasing consists of about 3 or 4 in. of tallow, with spots of oil at intervals.

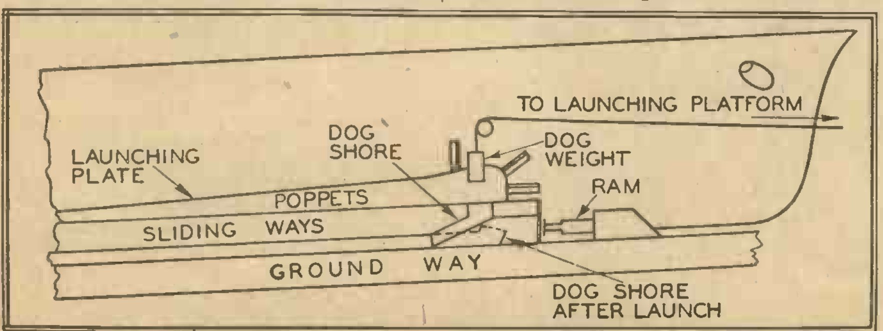


Fig. 2.—A sketch (not to scale) of the fore end, showing dog shore, poppets, ram, etc.

The Ceremony of Launching

When this is finished, the sliding ways are replaced. Meanwhile, the launching arrangements for the ceremonial part are being made. The usual procedure is for some selected personage to cut a rope running over an ornamented block on the launching platform. This rope suspends two large weights over the "dog shores." Fig. 2 shows the whole contrivance. The weights usually slide down inside a cage. The "dog shores" are made of exceptionally tough wood such as green-heart or sabigue. They are inserted between the sliding way and the ground way, one at each side and are the last portions to be removed on the day of the launching.

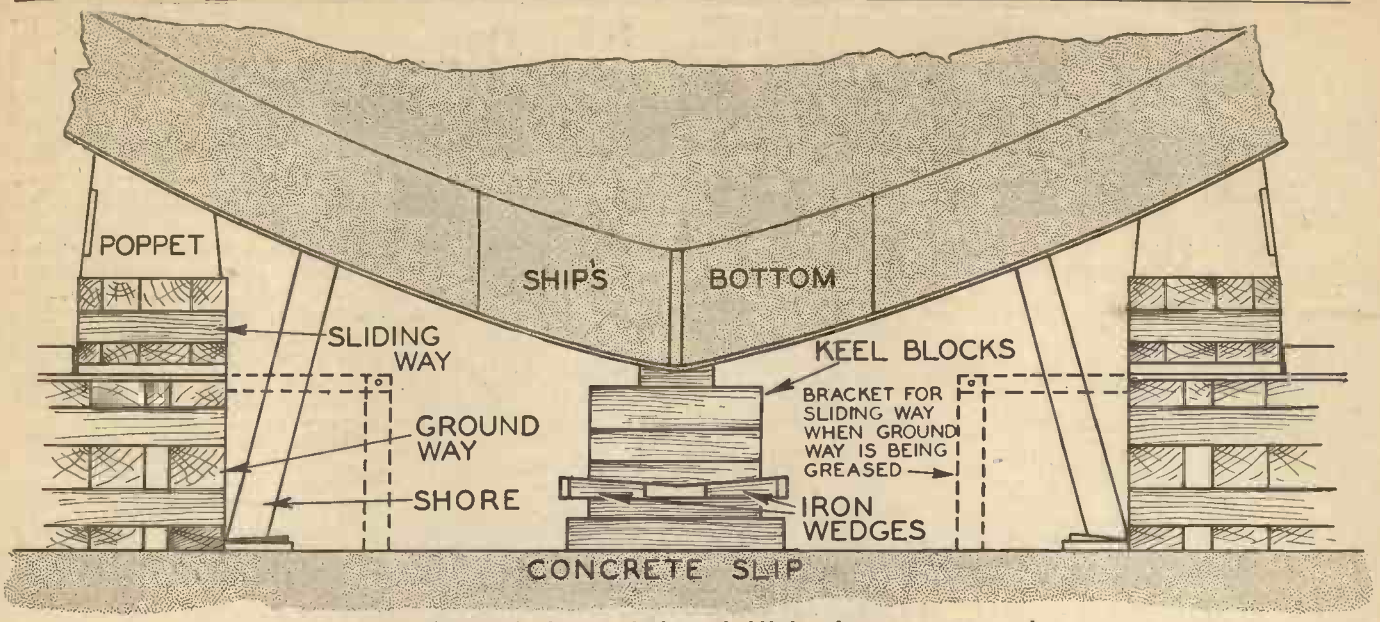


Fig. 1.—A cross-section of a ship on stocks showing keel blocks and poppets, etc., on one side.

"Setting-up"

Before this, however, "setting-up" is done; that is generally the day before the launch. The idea of "setting up" is to transfer the weight of the ship from the keel blocks and shores to the sliding ways. This is effected by driving "slivers" between the sliding ways and the poppets. Slivers are large beech wedges 3 ft. long and 8 × 4 in. at the large end. They must be driven in simultaneously, the method being to work to a gong which signals the blows on the slivers by the launching gang. Two hands take a poppet with four slivers, say, and they strike the slivers in pairs, alternately. Alternate keel blocks are now knocked away. On the day of the launch the launching-master orders as many of the remaining blocks t be removed as he may think fit. The launch "trips" the remainder. It requires considerable judgment and experience to estimate the number of blocks to remain. All is now ready, and the ship is only held by the dog shores mentioned above. These the fair lady launching the vessel removes, after appropriate ceremony, by cutting the rope suspending the dog weights. The dog weights slip down and strike the "dog shores" down clear as previously described (see Fig. 2). It should now need only a few strokes on the hydraulic rams to start the ship sliding down the ground ways into her natural element. The ship may be brought to a standstill by simply dropping anchor or a line led ashore to lengths of cable. The cables dragging along the side of the slip serve the same purpose as an anchor. The ship having no capstan machinery working, the anchor cable must be slipped and buoyed off for recovery later. The ship is now towed to a dry dock and docked, where the launching plates are removed. The sliding ways and poppets break up and float away. Lines are sometimes used to keep them fast to the ship, or boats and tugs may pick them up.

The amount of grease for a launch is calculated by experiment with weighted trays. These trays are slid down an unused portion of the ground ways. The results are tabulated and used in conjunction with the probable temperature on the launching day. Previous experience is a large factor in deciding about the grease.

Broad-side Launching

This is resorted to where the requisite stretch of water for the stern-first method is not available. The method employed resembles the stern-first method in most respects. Occasionally a ship may be built in a dry dock. This method is impracticable for big ships, dry docks being at a premium in most ports, also difficulty in fitting shafting may be encountered.

The photographs show clearly the launching plate, fore poppets and hydraulic rams. In the view from aft the poppets are seen fitted up under the inner shaft bracket. The dog shore method has not been used, however, the ways being retained by a steel tripper further down the slip. Another point of interest in launching is the shoring up of the ship *inside*. The system of shoring and the placing of the shores is known as "fortifications," their purpose being, of course, to help the hull to sustain the unusual strains inseparable from launching.

THE TWO-STROKE ENGINE

(*Continued from page* 358.)

exhaust ports were used for both the front and the back end of the cylinder, the piston uncovering the ports at both ends of its stroke. The cylinder was supplied by two double-acting pumps, one of which supplied pure air only and the other a mixture of gas and air. After the exhaust ports were opened, the air pump (or "scavenge" pump) forced pure air into the cylinder, which cleared out all the residual exhaust gas, leaving the cylinder full of clean air. Immediately after this the gas pump came into operation and introduced the combustible charge which was compressed by the return of the piston and ignited electrically. It will be seen that there were two power impulses per revolution owing to the engine being double acting, so that the torque of this engine is comparable to that of a steam engine. Both scavenging air and gas charge entered through inlet valves at each end of the cylinder, no exhaust valve being required. By suitably timing the pumps all chance of losing unburnt gas through the exhaust ports was avoided. This source of loss is always present to a certain extent in the three-port engine.

The two-stroke principle has been applied with success to Diesel engines of all sizes, both single and double acting. The cylinder is provided with the usual row of exhaust ports uncovered by the piston, and is scavenged and supplied with a charge of clean air by means of a separate pump. The air is then compressed very highly, thus raising its temperature enough to ignite a charge of fuel oil which is sprayed into the cylinder at the end of the compression stroke. The oil then burns immediately upon entering and no other ignition arrangements are required.

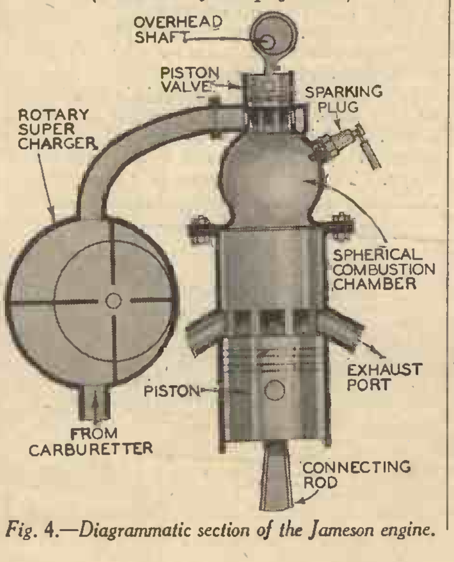
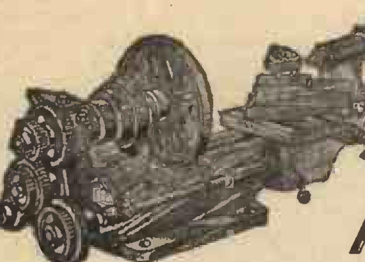


Fig. 4.—Diagrammatic section of the Jameson engine.

A Supercharged Two-stroke Engine

A very interesting engine on which experiments have recently been carried out for motor cars is the Jameson supercharged two-stroke, a diagrammatic section of which is shown in Fig. 4. As before, the water jackets are omitted. At first sight this would appear to be a kind of twin piston engine, but the upper piston is a small affair which works as an inlet valve. The cylinder has the usual exhaust ports at the outer end of the piston stroke, and the detachable head provides a combustion chamber as nearly spherical as possible in shape.

The principle on which this engine works is similar to that of the Clerk gas engine.



Lathe Work FOR AMATEURS

THE CHOICE OF A SMALL LATHE

By FRED HORNER

A useful article for the model engineer, giving useful information on the various types of lathe, with practical advice on choosing a lathe.

THIS is a perplexing problem when the user requires only one or two lathes, and must therefore obtain the utmost value in regard to varied capabilities. A small workshop has to undertake such an extensive range of operations with very limited equipment that the lathes must be in a sense universal machine tools. Special care in design is necessary in order to ensure rigidity and accuracy, notwithstanding the handling of extra large pieces, and the use of attachments for carrying out processes which would be effected on appropriate machines in a larger shop. It will be apparent that the best-made lathe is really the cheapest, forming a solid basis for quick and accurate production, and not becoming worn prematurely.

Amateurs and small workers in various spheres have such diverse requirements that any particular recommendation would be inadequate for one, and superfluous for another. The heaviest class of work, engine, motor, and small machine building makes demands in the way of turning, boring, screw-cutting, drilling, milling, grinding, etc., which may not be necessary in certain light manufacture. Consequently a small simple lathe suits the latter, but it is sometimes well to consider future possibilities, and purchase one with proper facilities for employing attachments later.

The Height of a Lathe

A lathe is specified by the height of centres, or " swing " in American practice ; that is, the diameter turned. To deal with flywheels, pulleys, rods, and so on, which will not swing over the bed, a gap is cast in front of the headstock. There are two types of gap, one of moderate width, always open, the other of greater width, but filled by a gap-piece over which the saddle slides to give it support when working close to the chuck. In wood-turning lathes large objects can be swung by having a faceplate to go on the tail end of the spindle ; a floor stand carries the hand-rest or slide-rest at the correct height.

The cross-sectional form of a bed is important, because it must guide and maintain the truth of movement of the slide-rest or saddle, and keep the loose head or poppet in line, against the effects of wear. English practice has usually been to have a flat-topped bed with vee or square guiding edges, but many are now constructed with the American vee tops, which should wear down equally without dependence on the edges for control. The problem of keeping the loose head true is often solved by employing separate vees for it, thereby avoiding ill effects of wear of the saddle, destroying the alignment of the vees, or an inside edge not rubbed by the saddle acts as control. Flat-topped beds in many instances possess " narrow-guide " fit to the saddle, that is, it makes sliding contact against the front and rear edges only, providing a guide very long in proportion to width. Such a fit gives and maintains accurate movement better than when the saddle is controlled by the whole width of the bed.

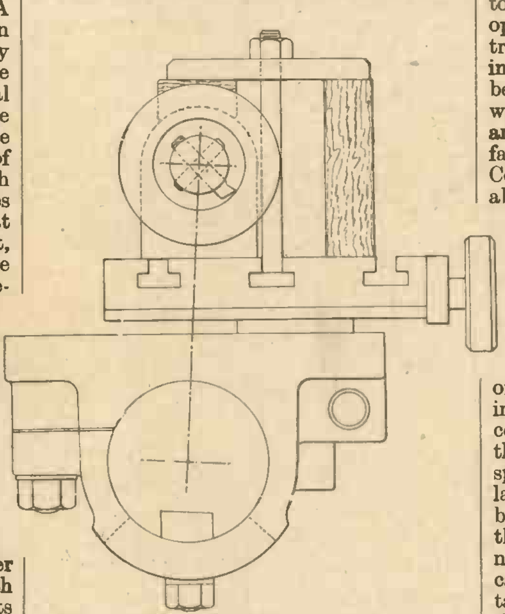


Fig. 2.—Showing a cylinder adjusted for height on the Drummond 4-in. lathe, by swivelling the saddle around the bed, and setting over the cross-slide.

Alternative Methods of Driving a Lathe

These comprise treadle, belt drive from an overhead shaft, belt drive from an electric motor, or spur gear or chain from the same source of power. Treadle motion has been improved by using anti-friction bearings, including those for the main spindle, but as electricity is so readily obtainable conditions have altered during recent years. Sometimes treadle gear is retained for occasional running, but a motor is fitted as well for main service.

An obvious point in the selection of a lathe concerns whether the headstock has plain pulley for direct drive, or is fitted with back-gears to afford alternative of slower speeds with considerable gain of power, for turning, boring, and screw-cutting. Only the lightest classes of metal work can be executed by plain drive.

The Headstock

The constructional features of a headstock must be strong, so that the casting will not deflect under end pressure applied to the spindle (during boring or facing operations), nor vibrate, and affect the truth and finish of work-pieces. The all-important matter of the spindle has always been a subject for controversy ; it must run well under load, without heating or scoring, and retain accuracy, otherwise the centre, face-plate, and chucks will not remain true. Consequently a cheap lathe is never advisable, because the bearings cannot be well made, and the turner will often experience trouble. Hardened steel bushes were formerly the customary style, being coned to fit the tapered necks, and so tend to keep it wearing concentrically. Phosphor-bronze bushes largely have preference nowadays and in many cases the necks are parallel, but the exterior of each bush is coned to draw into a taper in the head casting ; the bush being split, it contracts concentrically, and thus maintains the spindle in alignment. End thrust needs special care in small lathes, because of the large amount of drilling performed, and it is best to have a ball-bearing washer rather than plain, which gives more friction and is not easy to lubricate. Very light running can be ensured by spending more and having tapered roller bearings which take the end thrust as well, and automatically keep the spindle central after wear has occurred, though this is very slight. A hollow spindle should always be chosen ; a solid one is a handicap, in view of the frequent handling of wire, rods and bars, held in the chuck for turning or filing.

The Simplest Lathe

This carries a compound slide-rest bolted to the bed, but this imposes severe limitations, as there are no automatic feeds nor screw-cutting motion, and only small

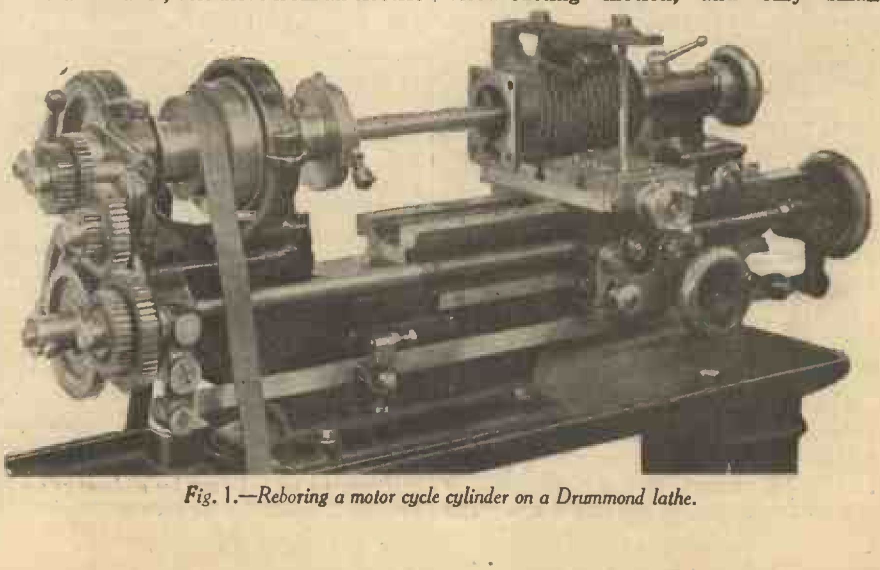


Fig. 1.—Reboring a motor cycle cylinder on a Drummond lathe.

articles can be held for boring. With a saddle sliding along the bed there is scope for bolting cylinders (Fig. 1), beds, frames, bases, and rods on the T-slotted top, to be cored and faced by a bar driven between centres or to be milled. And attachments can be secured to hold work or operate cutters or grinding wheels. In ordinary saddles height regulation for anything bolted on is made by insertion of packings as necessary, but the Drummond 4-in. centre cylindrical bed lathe has a height adjustment by swivelling the saddle around the bed (Fig. 2).

The self-acting feed of a saddle is produced from the lead-screw, though an objection lies in the wear of the screw thereby, tending to affect its accuracy for screw-cutting. In the smaller lathes this is not a matter of much concern, because simplicity and reasonable cost must be studied, but in larger sizes the screw is reserved for screw-cutting, and the feeds come from a splined shaft operating gears which rack the saddle along, and often also move the cross-slide. As an alternative the lead-screw may be splined to drive a first-motion gear for the same results, without any serious effect on the threads, although strictly it is better practice to keep them intact. Automatic cross-feed, though omitted in many small lathes, is advantageous not only from the point of view of time saving, but because it gives better work. The regularity of feed, difficult to imitate by hand movement, supplies even progression and pressure on the tool, hence the surface left is more accurate. In a good make of lathe provision is arranged for addition of power cross-feed at any time.

Lead-Screw Operation

A matter of convenience, the mode of actuating the lead-screw or feed-shaft, has received greater attention lately. The ordinary way of transmitting the ratio of speed from the spindle to screw or shaft is by loose change wheels, placed on as required. This takes time in selection and fixing, though some firms offer an improvement on the usual nut and washer retention: in Britannia practice a knurled sleeve is pressed by a spring against the face of the stud end on which the gear goes. A pin in the sleeve enters alternative holes, either to lock it with the projection in line with the key, or at a quarter-turn position, holding the wheel hub from movement. In order to avoid frequent changes, several models are built with gear-box selection; by moving a handle to different positions the feed may be instantly altered for any given set-up of change-wheels. The box lies in front of the head-stock, affording two or three changes, while at a higher cost a Norton type box can be had, with handle and selective pinion engaging any of a set of gears supplying twenty-four threads and feeds, or thirty-three in a more elaborate style.

Tool-holding arrangements need careful consideration when choosing a lathe. Years ago national practice was definitely clear. American makers fitted the round slotted tool-post to all machines of small and even considerable size, and British firms the four-stud plate with flat clamps. Now many British lathes have the American post, while the single-bolt triangular plate with adjusting screw for height (Fig. 3) is also much liked, and the triangular block which pinches the tool with a pair of screws into a slot. The triangular plate is perhaps most to be recommended for convenience of holding all sorts of shanks of tools, holders and attachments.

Height Adjustment

This is effected in various ways. The swivel shoe of the regular American post has the disadvantage of altering the cutting and clearance angles of a tool, consequently some have a screwed gland device for direct vertical motion, or a ring with steps at various heights. The British holders require packing under the tool to elevate it, but the separate tool-holders clamped on them embody height regulation without such necessity. The Norman design, fitted to Drummond 3½-in. lathes, consists of a rectangular block, taking the tool in a square hole by two set-screws. The block fits by a round hole on a stout vertical stem, and is held by a split and contracting bolt. Therefore the height up the stem can be altered, and the block be slewed to any position around it.

In a lathe not intended to include boring examples held on the saddle there is no special provision in the way of T-slots, but most of the small lathes sought by amateurs and small workers possess ample bolting facilities on the saddle, or else the cross-slide is extra large in area, taking several T-slots, so that quite bulky pieces may be accommodated when the tool-holder is taken away. Sometimes a large boring table is substituted for the ordinary cross-slide for the same purpose. In exceptional circumstances a specially long table is employed, the outer end supporting the extremity of a lengthy object, such as a connecting-rod.

Fig. 3.—4-in. screw cutting lathe with boring table.

Three main features about the loose head or tailstock are: (1) The system of preserving the alignment, (2) supporting the barrel, (3) providing for taper turning. The first requirement is met by giving a particular guiding edge, as mentioned in connection with bed sections, otherwise the tailstock may lie askew, and prevent parallel turning being accomplished. The foot should always pull down or against a surface which is not subject to wear from the saddle. Condition (2) is specially important in small lathes for varied service because so much drilling is done, and if the barrel is inadequately supported it soon wears untrue. Many makers have reverted to what was common in the earlier days of lathe construction, namely, a solid barrel extending right through the head, and operated by a handwheel controlling the square thread along the tail end (Fig. 3). This affords full support at all parts of the travel, whereas the type with shorter barrel moved by a separate screw does not have the same effect.

Short tapers may be turned by swivelling the compound rest, but for long ones the tailstock must embody a set-over action. This is obtained by making the top portion distinct, to be fed over by slideways and a screw. The central or zero setting is indicated by matching lines on the end faces of the base and top part. By means of a movable centre attachment an ordinary rigid head can be adapted for taper work, the fitting being clamped on the barrel, and holding a centre which may be set over by a screw and slide, guaranteed to show the amount of displacement.

Attachments constitute very important adjuncts to any small lathe of the kind we are considering. Some are used without any extra sort of details, but an overhead drive must be included in certain cases, so it is well to have this when purchasing the lathe, or at least buy one which can have the drive added subsequently. From the pulleys on it grinding, milling and gear-cutting attachments are driven. By inclusion of a division-plate at the headstock drilling and gear-cutting are carried out, running a spindle in an attachment on the slide-rest. External and internal grinding spindles can be revolved from the overhead, or self-contained motor-driven designs are sold to go on the rest.

Rest or saddle attachments that are utilised in conjunction with a tool driven from the spindle comprise a saw-table with one or two guide fences, and a universal milling-slide, bolted to the saddle, and having a T-slotted table fed vertically or angularly by screw and handle. All kinds of surfacing, slotting, keyway cutting, grooving and drilling are thus possible by the compound movements obtained.

Making a 40,000 Volt Wimshurst Machine

(Continued from page 354.)

All parts of the machine so far described are thoroughly insulated from the base by the vulcanite posts, except the spindles bearing the plates. The rest of the apparatus—the simple system of pulleys and gears, and the "earthing brushes"—need no insulation. In fact, it is better if they are earthed.

The Gears and Pulleys

With regard to the gears and pulleys, these must be chosen so that the two plates rotate at the same rate. The brushes are made from short tufts of wire taken from a piece of "flex" electric lighting wire. One brush is soldered to each end of a piece of brass wire about 7 in. long, and the wire mounted on the spindle-bearing, as shown in Fig. 4. This assures its being well earthed. The two arms of the wire are bent so as to make an angle of 45° with the vertical, and the brushes adjusted so that they earth a foil on the opposite edges of the plate simultaneously. The brushes on the other plate are set at right-angles to these, and earth their foils at the same time.

Blue Glow

If the whole instrument is brightly polished and perfectly dry, on turning the handle slowly, a "sizzling" sound will be heard. This is due to internal discharges in the machine, visible as a blue glow, with sparks, if performed in the dark. On turning a little faster, sparks up to ½ in. in length will jump between the brass knobs at the top of the machine.

Testing the Machine

If you get no results at the first attempt, see that the brass knobs are not touching, and then rub a vulcanite rod briskly on your sleeve to electrify it. Hold it to *one* of the combs while turning the handle, and the machine will soon charge up and function normally. Sparks produced in this way, without the use of Leyden jars, can be taken on the finger or knuckle without harm or appreciable shock, though the voltage for a centimetre spark in dry air is 30,000!

WONDERS OF THE NEON TUBE

By BERNARD DUNN

The principles and method of operation of Glow-discharge Lighting Systems are simply explained in this article.

RECENT developments in regard to the use of so-called glow-discharge tubes are of epoch-making importance. Not only have they entirely modified the art of street advertising, but they have had no little effect upon the progress of safe street lighting, and they are also proving of value to the medical profession. Considering first of all the fascinating flashing advertising signs which to-day abound in every town and city in the country, a moment's reflection and a comparison with the electric signs of but a few years ago convinces one of the crudity of the latter, and of the marvels of the new neon effects. Instead of producing thousands of points of annoying and dazzling light, the neon tubes which are used to-day show far softer, though more intense, lines of light, which are both attractive and pleasing. Besides, the attempts which were made to obtain moving "pictures" with the old-fashioned system of using ordinary filament lamps appear poor by comparison with the results which are made possible by the use of neon signs. Movement could not properly be depicted by means of ordinary incandescent electric lamps because of the comparatively great length of time which was required for the filaments to heat up and to cool down—in other words, due to the inevitable "inertia." Such difficulties do not exist with neon lights, however, and any time-lag which there might be is imperceptible.

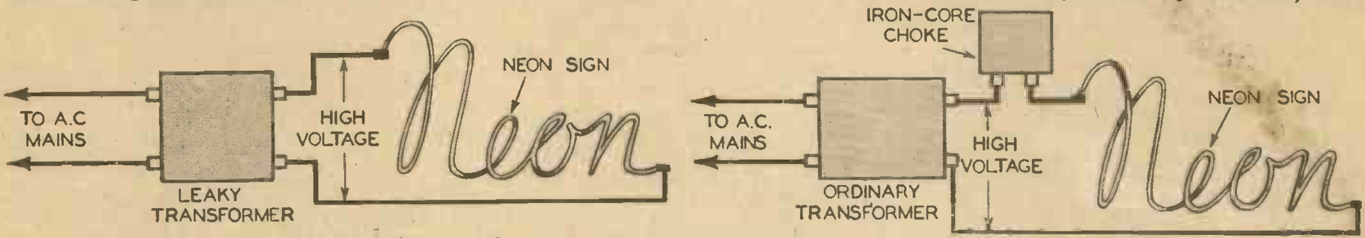


Fig. 2.—Alternative methods of obtaining the correct voltage regulation for neon signs. In one case a leaky (or air-gap) transformer is used, and in the other a reactance (iron-cored choke) is wired in series with the transformer secondary and the sign.

"Moving" Signs

Thus, it is possible to produce simple moving pictures by using two or three "overlapping" signs and arranging a rotary switch to bring different pictures into circuit at appropriate times. The success of this idea depends upon the same principle which is made use of in cinema practice, namely, the persistence of vision of the human eye. In other words, the eye retains any image which is impressed upon it for a fraction (about one-twelfth) of a second, so that any change of position which takes place in a smaller space of time does not appear as a definite change, but as a *movement*. Thus, if, say, two arrows made of neon tubing are placed in the same line with one a short distance in front of the other, and the current is switched from one tube to the other every sixteenth of a second, the arrow appears to be moving backward and forward very quickly. This simple idea is made use of in a number of modern signs, and complicated modifications of it—depending upon the very same principles, however—are by no means uncommon.

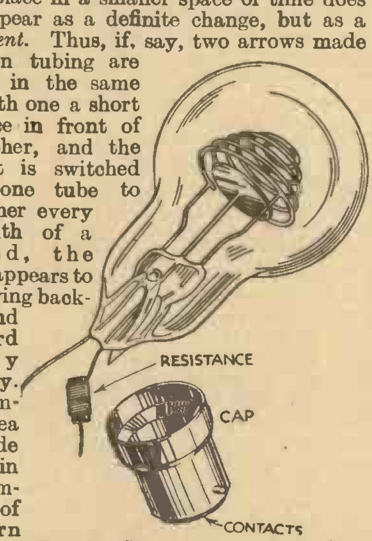


Fig. 1.—Showing construction of a simple beehive neon lamp.

Another very interesting type of glow-discharge (generally referred to as neon) sign is that which takes the form of a circular glass tube in which a ribbon of coloured light appears to be constantly and rapidly going round. This also depends for its success upon the optical illusion already mentioned, and the principle upon which the tube works will be described later, after general behaviour of neon tubes has been dealt with.

How Neon Lights function

The simplest, and probably the oldest, form of neon tube is that known as the glim lamp. This is similar in outward appearance to an incandescent electric lamp, but in place of a filament it has two electrodes which are not in metallic contact. One of these lamps, of the beehive pattern, is shown in Fig. 1, but there are others in which the cathode (larger electrode) takes the form of a letter of the alphabet, whilst in another specialised type used by Catholics, the cathode is in the shape of a cross. Instead of simply being evacuated, as in the case of the simplest type of electric lamp, the glass bulb contains neon gas at low pressure. This gas, as well as others including nitrogen, argon, helium, carbon dioxide and xenon, has the property of easily splitting up into its positive and negative constituents when a pressure of electricity is applied between the two electrodes. This splitting up, incidentally, is known as ionisation, due to the fact that the positive constituent is the ion, the negative being the electron. When ionisation takes place, the gas emits the glow which is made use of in the tubes under discussion.

Glow-discharge Colour Effects

Different gases, and mixtures of gases, emit different colours when they are ionised, and this explains how the beautiful colour effects are produced in the modern neon signs. Pure neon gives a pleasing and penetrating orange-red glow, helium glows with an ivory-white coloration, and argon emits a pale violet light. By mixing different gases in various proportions, and by adding vapours such as that of mercury, an almost unlimited range of colour effects can be obtained, although for practical purposes we are limited to red, blue, green, white and yellow at the present time, due to the fact that tubes containing suitable mixtures for other colours are comparatively short lived, and therefore too expensive to be of value at the present time.

It would seem to be a long step from the glim lamp to the multi-coloured glow-

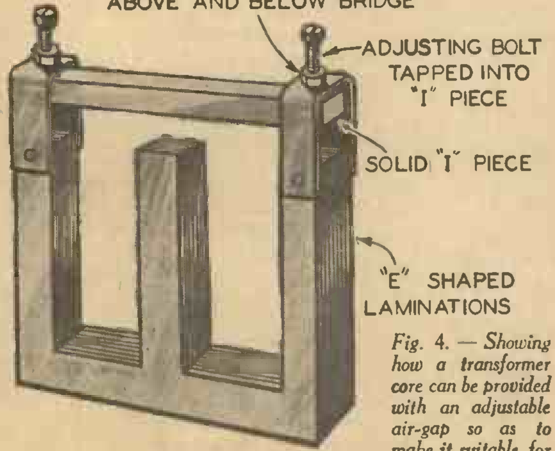


Fig. 4. — Showing how a transformer core can be provided with an adjustable air-gap so as to make it suitable for use in conjunction with various types of neon tubes.

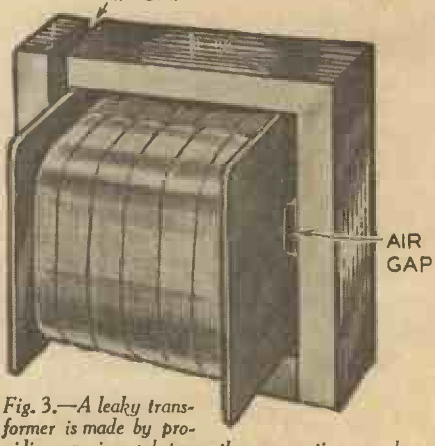


Fig. 3.—A leaky transformer is made by providing an air-gap between the core sections as shown above.

discharge tubes which form the advertising signs referred to in the opening paragraph, but actually the difference is not really so great. The arge signs simply consist of glass tubes containing the appropriate amounts of gases to produce the required colours and fitted with electrodes at each end. When the tubes are very long, it becomes necessary to operate them from voltages up to 10,000 or so, or alternatively to split up the sign into a number of shorter sections which can be connected in parallel and operated from a lower-voltage supply. When A.C. is used for operation, there is no difficulty in stepping up the supply voltage by means of a transformer in order to produce the high voltage required by the signs, but when the supply is D.C., it is generally necessary to employ a rotary converter in order to increase the voltage to a suitable figure.

Wriggle Tubes

Reverting for a moment to the circular tubes in which the glow appears to be travelling round following a wavy path (these are commonly called "wriggle" tubes, for obvious reasons). Instead of being filled with a pure gas, they contain a small proportion of another gas which has a higher electrical resistance. Thus the discharge takes place through the pure gas only, "avoiding" the other as much as possible. In so doing the line discharge meets certain "opposition," and thereby takes on the wriggling motion.

Striking and Running Voltage

Experiment with any neon tube or lamp will soon prove that, in order to make the glow commence or "strike," it is necessary to apply a much higher voltage between the electrodes than that which is required to maintain the glow after it has been started. It will also be found that, after the glow has been created, the current consumption of the neon increases rapidly, or, in other words, its resistance becomes much less. This introduces a little difficulty into the matter of operating neon lights, because, if the initial voltage were maintained, the current might attain such an intensity that the lamp would quickly be damaged.

In the simplest form of neon lamp, such as that shown in Fig. 1, the latter difficulty is overcome by fitting a small wire-wound resistance in the bayonet cap. When the voltage is first applied to the lamp, there is a negligible current consumption, and therefore the resistance has little or no effect. But as the current rises, so the effect of the resistance increases and reduces the voltage applied to the electrodes. This perfectly simple arrangement is all very well for use in a lamp which consumes only about 25 milliamperes, but it would be most uneconomical and even impracticable for use in conjunction with lighting systems consuming up to several amperes.

Methods of Voltage regulation

It therefore becomes essential to employ an entirely different idea. There are actually two methods which are made use of, one being to include a reactance—an iron-cored choke coil—in series with the neon tube and the supply, and the other to feed the neon through a leaky transformer; both methods are illustrated in Fig. 2. The reactance has the effect, on alternating current, of offering an impedance (equivalent to resistance in D.C. circuits) which is proportional to the current flowing through its windings, and it therefore provides the necessary limiting effect on the voltage applied to the neon electrodes. A leaky transformer is simply a transformer (such as those described in the January issue of PRACTICAL MECHANICS) whose iron core does not provide a complete magnetic circuit. In other words, the core stampings are assembled with an air gap between them, as shown in Fig. 3. Very often it is found desirable to provide a variable air gap, in which case the core is generally formed of "I" and "E" sections arranged as shown in Fig. 4. For convenience, the "I" piece may be solid, so that its distance from the "E" stampings can be varied by adjusting the screws which are tapped into it.

Some of the larger signs are operated from a single transformer, whose maximum output voltage is dependent upon the length of the tube employed, but for smaller signs it is common practice to employ separate letters individually supplied and mounted side by side on a suitable background. In the latter case, each letter is provided with its own leaky transformer, the primary windings of all transformers being joined to spring plungers which make contact with metal "rails" upon which the various boxes are mounted.

There are a number of regulations which must be observed in installing neon signs, and although these vary slightly in accordance with local bye-laws, they are generally as follows: No point in the wiring should have a voltage in excess of 5,000 in respect to earth. All transformers must be out of doors, as near to the sign as possible, and must be adequately protected by means of an earthed metal screen. All high-tension wiring must be encased in earthed metal conduit with screwed joints. Transformers must be of the double-wound type; that is, auto-transformers are not allowed.

It might at first appear that the first regulation would prevent the use of signs taking up to 10,000 volts, as is frequently required, but it should be remembered that it is quite practicable to employ a centre-tapped 10,000-volt secondary of which the centre point is earth connected.

The Future of Neon Lighting

Glow-discharge tubes are not only used for such spectacular things as advertising signs, and reference might be made to the neon beacons which are being employed with great success at various airports. These beacons usually consist of a number of inverted "U"-shaped tubes assembled on a truncated conical tower. Due to the penetrating neon glow, they can be seen over tremendous distances, and are especially useful in fog.

It has also been found possible to obtain powerful infra-red rays from neon tubes, and these are extremely useful medically in that they have excellent curative powers and penetrate the skin without producing harmful effects.

Specialised forms of neon lights are also being tried experimentally on several stretches of road in place of the more usual electric lamps. They produce a far safer light and are almost entirely free from dazzle, but have the disadvantage of giving a dirty green light which makes faces take on a grey pallor.

Contrary to general opinion, neon lights are very efficient as compared with incandescent filament lamps, and in many cases have an efficiency of 1 candle-power per half watt of current. Were it not for the difficulty of supplying them with the necessarily high voltage, it is probable that neon lighting systems would become serious rivals to those at present in use. Another difficulty which must be overcome before neon lighting can come into common use is that of obtaining really white—or, more correctly, colourless—light from glow-discharge tubes.

NEW MIDGET VALVES
FOR DEAF AID EQUIPMENTS, ETC:

TWO extremely interesting "Tom Thumb" valves are announced by Marconi-Osram. These new valves, which are supplied by the General Electric Company Ltd., under the titles H.11 and L.11, are miniature amplifying valves of truly "Lilliputian" dimensions. A photograph of one of these valves is shown alongside two ordinary valves to indicate comparison in size. The actual overall length is only about 2 in.

The main feature of these valves is, of course, their very small size. In order to avoid any waste space the use of an ordinary pin base valve holder has been done away with, and a new form of side contact base, specially developed for these valves, is fitted. This consists of a bakelite base with metal strips running along the side of it to make contact with the special type of valve socket required. It is not intended at the moment that this form of base shall be applied to any valves other than the "Tom Thumb" type.

The characteristics of these two valves, although naturally not of a very high order, considering the very low filament rating of 1 volt 0·1 amp., are nevertheless adequate for the purpose in view. The H.11 gives an amplification factor of 15 for an impedance of 30,000 ohms, and the L.11 an amplification factor of 5 for an impedance of 12,500 ohms. Both the valves are designed to operate up to a maximum H.T. voltage of 45 volts.

The midget valve is shown on the right, and its size may be gathered by comparing with the two ordinary valves shown with it.

Economy in size and current consumption being the main feature of these valves, they are obviously ideal for use in a compact amplifier designed in conjunction with a microphone and an earpiece, for deaf-aid equipment, or for other equipment where it is of paramount importance that the valves utilised are of the smallest possible dimensions.

The distortion associated with mechanical deaf-aid amplifiers is well known, and the use of valves for amplification purposes has hitherto been impossible owing to the bulk of the valves and batteries necessary. These new Osram "midgets" render the construction of a really compact and portable amplifier (with distortionless characteristics) for the deaf a practical possibility, and an enormous field is thus opened up by their introduction.

The valves, which are listed at 15*s*. each, are not intended for ordinary broadcast reception. In fact their characteristics are not quite comparable with those of 2-volt valves designed for battery operation with modern radio receivers. For the purpose for which they have been designed, however, they represent a big step forward in scientific achievement.

SILVER SOLDERING AND BRAZING

By W. H. DELLER

In our recent articles on making a model road tractor various parts of the model had to be silver soldered. Below a special article has been prepared to enable readers to carry out this part of the work efficiently.

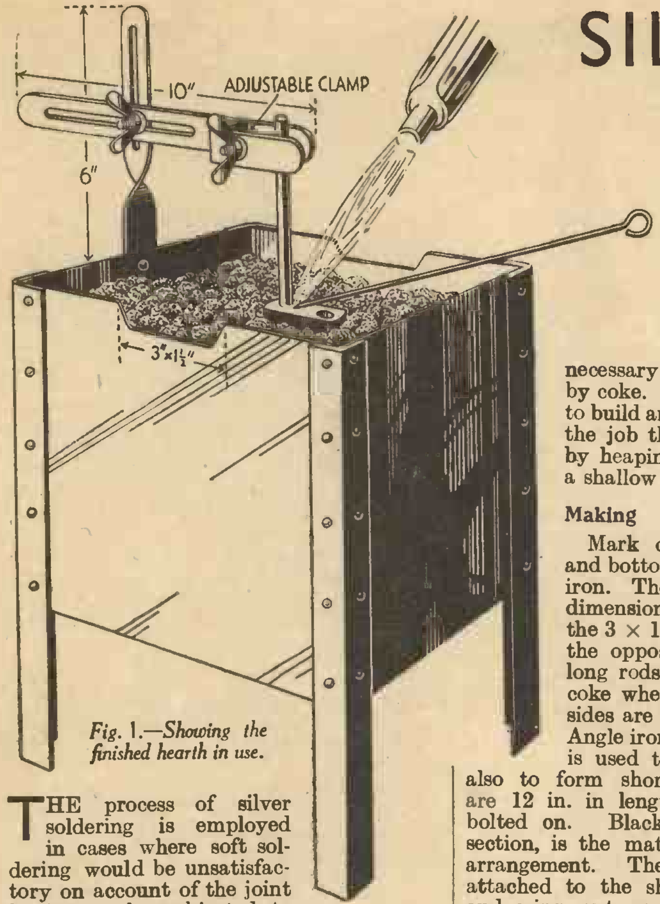


Fig. 1.—Showing the finished hearth in use.

THE process of silver soldering is employed in cases where soft soldering would be unsatisfactory on account of the joint having to be subjected to great heat in use, or being insufficiently strong for the purpose.

As with a sweated joint, the parts are joined by a film of soft solder, so in silver, or hard, soldering they are joined with an alloy containing silver. The chief difference in the operations, however, is that while one is carried out at a temperature of about 400° F., which varies, of course, according to the tin content in the solder, the other requires a red heat.

Heating the Work

For this reason, some means of heating the work to a corresponding temperature is necessary. A gas blow-pipe and bellows is the most convenient heating agency, although for small work a self-blowing or Bunsen type gas blow-pipe is suitable. Failing gas, a good paraffin blow-lamp will do the job. With certain classes of work these may be dispensed with, but such conditions will be dealt with later on. With most jobs it is necessary in order to obtain sufficient heat to lay the work on a bed of coke, more particularly so for brazing. The following details are given for making a small hearth for this purpose.

Brazing Hearth with Work Holder

The hearth about to be described is shown in use in Fig. 1. From this it will be seen that the construction is simple and could be carried out in a few hours. Provision in the form of an adjustable clamp attached to one side has been made for holding small or awkward work.

The sheet metal box is 9 in. square × 8 in. deep. These proportions may seem unusual, but the extra depth is to allow for longish jobs that have to be worked upon at the ends. As an example, to silver solder an end cap into a boiler the job must be stood on end, and to attain and conserve the necessary heat it is surrounded by coke. Thus it is more certain to build and retain the coke round the job than doing the same job by heaping the coke round it on a shallow hearth.

Making

Mark out and cut the sides and bottom from 18 S.W.G. sheet iron. These are cut in one piece, dimensions being given in Fig. 2; the 3 × 1½ in. sections cut out on the opposite sides are to allow long rods or tubing to lie in the coke when necessary. The four sides are bent up at right angles. Angle iron, 1 × 1 × ⅛ in. section, is used to join the corners and also to form short legs. These pieces are 12 in. in length and are riveted or bolted on. Black mild steel, 1 × ¼ in. section, is the material for the clamping arrangement. The vertical slotted bar is attached to the sheet metal with a bolt and wing nut on the outside, so that it may be quickly removed at any time. A ¼-in. cup head coach bolt and wing nut through the slotted portions form the means of adjusting the work holding bar. On the end of this a simple clamp is formed by bending the end of a short piece of the flat material to form a heel. This has a square hole in the centre to suit a ¼-in. coach bolt, and a round hole is drilled to correspond in the end of the bar. The bolt is then fitted with a wing nut and washer. After filling the box with small clean "nut coke" the hearth is ready for use. Should the coke be dirty—clogged with dust—riddle in a sieve and cleanse in a bucket of water and allow to drain well before using. For small jobs asbestos blocks sold by weight are sometimes used. Where such are employed it is not a bad plan to make a small shallow tray from sheet iron, provided with clips to hook over the sides of the hearth. This can then be lifted off when the full depth of the hearth has to be utilised.

Preparation of Work

All parts to be silver soldered or brazed must be thoroughly cleaned by scratch-brushing, to remove any scale, such as is likely to be present on the surface of black finished steel or forged parts by filing. The surfaces to be joined should be neatly fitted, and cylindrical parts are made a good sliding fit into respective holes. Driving fits may prevent the molten metal from penetrating as desired, whereas a sloppy one allows it to run through without filling. Before assembling, paint the surfaces with flux made up to a creamy paste with water. This may be either borax or boracic powder or one of the special brazing fluxes such as "Boron." After assembling, the parts, where practicable, are drilled and pinned, treating the pins with flux before inserting. Where the nature of the work prohibits pinning, iron wire is used for binding. Tinned or galvanised wire must not be employed for the purpose.

With certain jobs, such as the boiler end shown in Fig. 3, a gutter formed by slightly chamfering the end cap ensures that the silver solder when melted will flow where it is wanted.

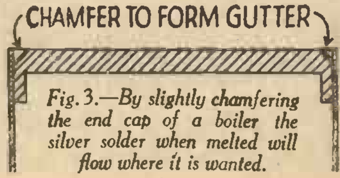


Fig. 3.—By slightly chamfering the end cap of a boiler the silver solder when melted will flow where it is wanted.

The Choice of Brazing Wire

For general use on small work silver solder is obtainable in sheet and wire form. This is suitable for all articles likely to be handled by the reader, of steel, brass, bronze or gun-metal. Silver solder is an alloy and contains copper, zinc and silver in proportions governed by the required melting point. The correct grade for most model engineering requirements is supplied by dealers in model-making requisites.

On larger work, brazing wire composed of copper and zinc is more economical. The most common grade, containing roughly two-thirds copper, is used for steel work. For brass articles it is natural that the wire must have a lower melting point than the job, and thus a special brazing material is called for. In this the copper content is about one-third; owing to its brittle nature the material is supplied in short strips cut from sheet.

Brazing

Having prepared the work, lay it on the hearth, holding in the clamp if necessary, and build the coke round it, but leaving the portion that it is intended to work upon exposed. Play the flame on to the exposed

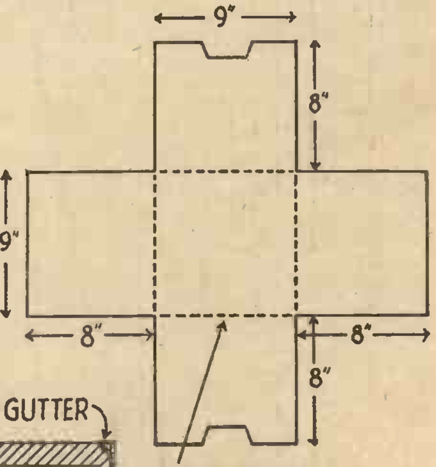


Fig. 2.—Details of the sides and bottom of the hearth.

portion until the part attains the desired heat—a very dull red for brass or bright red for steel—and apply the brazing medium. For the sake of economy silver solder is cut into small pieces and applied with fine tongs, but whatever the medium employed, avoid applying a surplus, so as to reduce the work entailed in cleaning up. Should the metal be disinclined to flow, that is, remain in a small lump or ball, heat the end of a piece of ⅛-in. iron wire, flattened as shown in Fig. 4, and dip into dry flux. Place this on the work and lightly scrape the surface with it, and as the flux dissolves so will the metal flow where required. If the work has been properly prepared and heated, inspection after allowing to cool should reveal perfect penetration of the brazing.

Cleaning Up

Owing to the nature of the process a certain amount of cleaning up is necessary. When cool the flux sets hard like glass and can be cleanly removed by chipping with the edge of a file, when any surplus silver solder or brass is neatly filed off. This scale is readily removable from small or delicate articles by immersion in an acid pickling bath.

(Left.) Fig. 4.—Details of the spatula to aid the flow of silver solder.

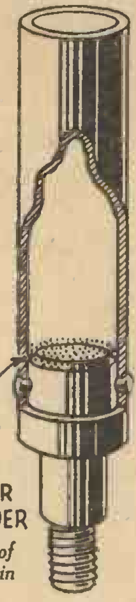


Fig. 5.—Another method of hard soldering is shown in the above sketch.

Other Methods of Brazing

As stated previously, there are other methods of brazing which may be employed for work such as is shown in Fig. 5. This is prepared as previously stated, and granulated brass (spelter) and a little dry flux is placed inside the tube. The end is then placed upright in a fire or forge until the brass melts.

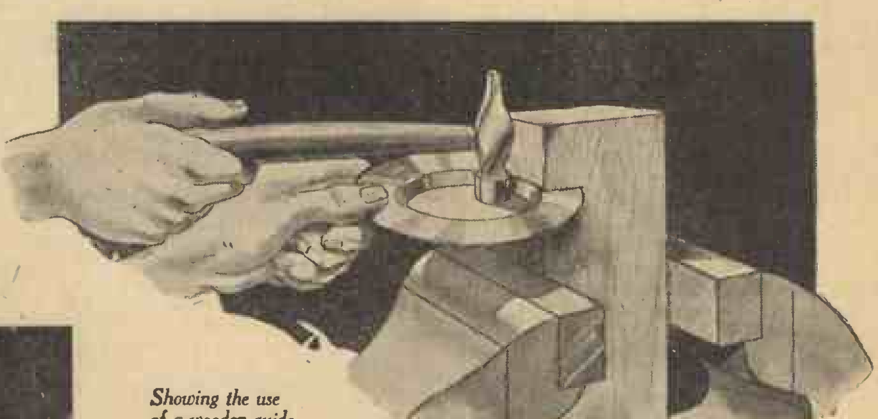
Small articles can be brazed by covering round the joints with clay or fire cement, leaving an exposed portion at the top surrounded by the clay to form a cup. Granulated brass is put into the cup or cups and heated by placing in a forge in a short length of steam barrel laid horizontally in the fire. The whole job is then heated uniformly, the brass running into the joints. Several joints may by this method be made at once. Owing to the difficulty of controlling the heat with an open fire, these methods, without exception, should be adopted for steel work only.

TWO USEFUL HINTS FOR THE SHEET METAL WORKER

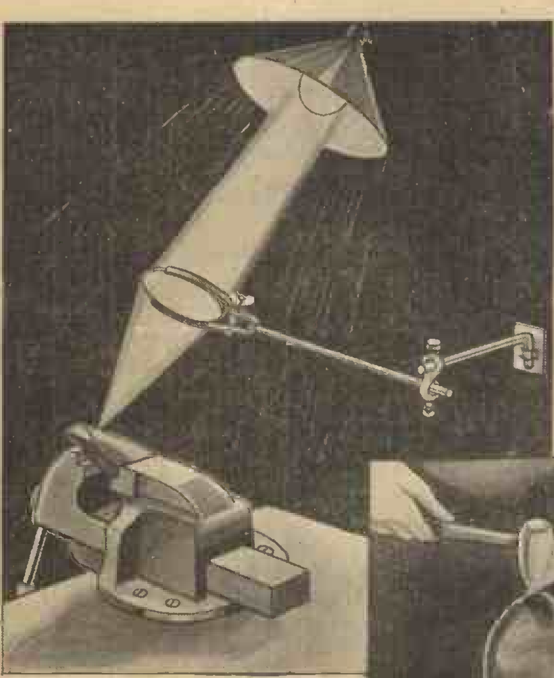
ONE of the greatest difficulties encountered with in the "raising" process in art metal work, especially by the inexperienced, is to deliver an efficient and perfectly "placed" blow—*i.e.*, one that will result in a definite "crease."

In order to accomplish this, the hammer-head must come in contact with the work about ¼ in. ahead of the actual point of contact of the stake.

It is difficult even for the experienced craftsman to be able to judge this "position" accurately—in fact his only guide, if the work is large, is the "ring" of the blow, and his keenly developed senses of touch and position. This error can be minimised by resorting to the simple device shown in accompanying sketch. A ray of light from any convenient source, such as an electric or gas lamp, is concentrated at a point and directed, by means of an ordinary lens (convex) of fairly large focal length, to the required location of hammer-head in relation to the stake. This, of course, is adjusted when stake is firmly fixed in vice, and before work is applied. One need only strike on the spot of light—and the accuracy of the blow is guaranteed.



Showing the use of a wooden guide in "raising" a tray.



By focussing a light on to the work, as shown, it is much easier to direct hammer blows when doing accurate work.

Working a Rim

To work up a rim as, *e.g.*, in the case of a simple plate, or small ash tray, the usual method is to place the disc on a block of hardwood, and, with a suitable hammer, hollow out the "raised" part. This procedure is not at all satisfactory, especially to the unskilled, for the work becomes considerably buckled during the process.

The simple device shown in sketch simplifies the work to such an extent that the most inexperienced can confidently expect good results. A piece of ordinary hardwood, 3 × 1½ × 7 or 8 in. or thereabouts, has a saw-cut let into it to the depth of required rim, or slightly over, to allow for a slight "drawing out" during hammering. The annealed, flat disc is now rotated, at the same time firmly held to the end of slot; while a few solid blows from suitable hammer are directed as near to the wood as possible.

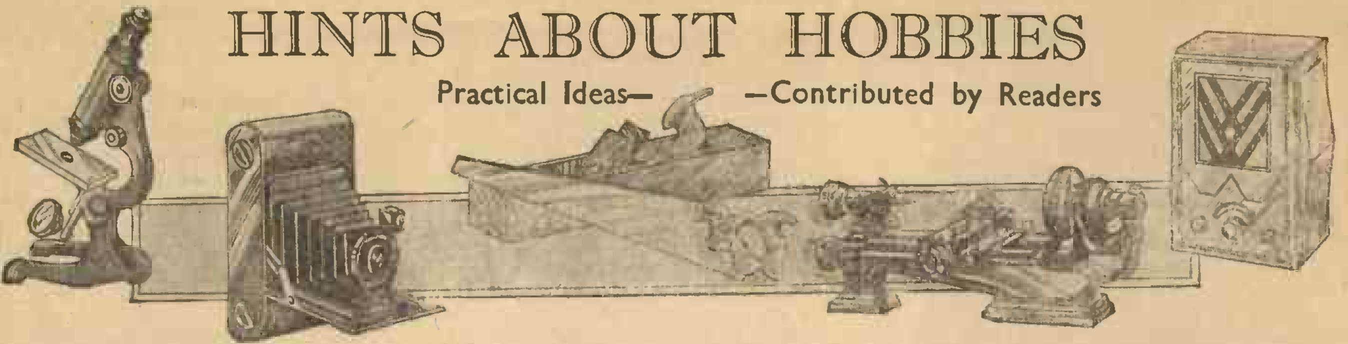
If, as in the case of rather thick metal (of over 20 S.W.G. in small work), the hammering has a tendency of drawing the work away from the slot in spite of the pressure of the left hand to the contrary, it will be found that slightly inclining the saw-cut slot will remedy this.

Protecting Drawings

A PENCIL drawing may be protected from smudging or becoming blurred by a thin coating of methylated spirits in which a small quantity of resin has been dissolved. The varnish may be applied with a brush, but a better way is to blow it on with a spray which may be obtained at any chemists. A wash of milk over a drawing will also serve to fix it.

HINTS ABOUT HOBBIES

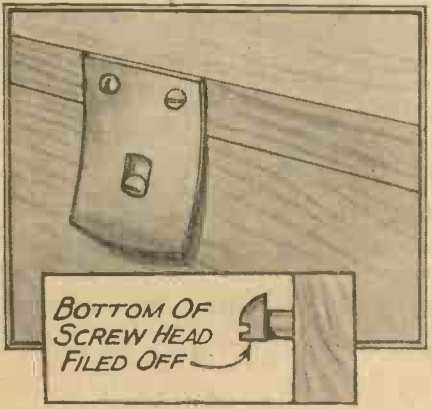
Practical Ideas— —Contributed by Readers



A Useful "Snap" Fastener

A SIMPLE and very effective "snap" fastener for box lids can be easily made from the central end of a clock or gramophone spring. This end provides the rectangular slot required.

The No. 3 round head screw holes are simply made by punching $\frac{3}{32}$ in. diameter holes through the hardened spring, placing, say, a $\frac{1}{16}$-in. nut underneath when punching through; this to act as a die.—C. F. (Leigh-on-Sea).



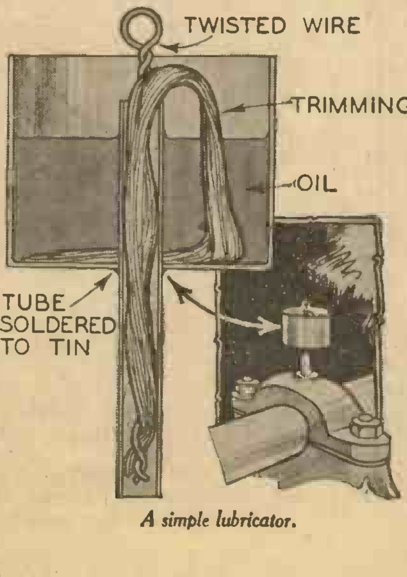
Details of an ingenious snap switch.

A Simple Lubricator

WHERE a machine is in frequent use it is necessary that it should be kept well oiled. The sketch shows a simple lubricator which may be used on a small lathe or emery wheel.

The reservoir consists of a small pill or mustard tin with a hole drilled through the bottom and a piece of tubing soldered in as shown.

The trimming is made either of pieces of wool or worsted, and should preferably be attached to a piece of twisted wire as shown. With this arrangement it may be withdrawn when not required.—A. P. (Ashford).



A simple lubricator.

A Folding and Collapsible Table

THE table-top consists of two halves of $\frac{3}{8}$-in. plywood, each measuring 16 × 6 in. These two halves are hinged together to form a flat board. Screw on a hook and eye to keep the board rigidly flat. To each of the four corners on the underside, that is to say, the side to which is screwed the hinges and the hook and eye, glue a 1-in. length of $\frac{3}{8}$-in. dowelling. Next cut four lengths of $\frac{3}{4}$-in. stripwood to the required size, which might conveniently be 2 ft., and drill corresponding sockets for the dowels. The table is then fitted together. For extra rigidity the legs should be flush with the edge of the top, so that they can be additionally fastened by a hook and eye. It is also a good plan to fasten down the bottoms of the legs so that they can be pressed slightly into the ground. If a greater length of leg is required, build it up in two halves and join by a dowel joint, as in the fitting of the top. The surprisingly small bundle which this table comprises when taken to pieces should make it especially suitable to hikers, picnickers, cyclists and campers.

THAT HINT OF YOURS

Every reader of PRACTICAL MECHANICS must have originated some little dodge which would be of interest to other readers. Why not pass it on to us? For every item published on this page we will pay 5s. Address your envelope to "Hint," PRACTICAL MECHANICS, George Newnes Ltd., 8-11 Southampton Street, W.C. Put your name and address on every item. Please note that every hint sent in must be original.

A collapsible table for hikers, etc.

Non-splash Whitewash Brush

WHEN whitewashing or distempering a ceiling it is found that after a short period the mixture gradually soaks to the bottom of the hairs of the brush. Once the whole of the hairs become damp the liquid constantly drips from the hairs, down the woodwork of the brush on to the floor or up the worker's sleeve. To prevent this it will be found that if two pieces of tin are cut as shown in the sketch, and soldered to the tin on the brush in the position shown so as to form a cup, whitewashing etc., can be performed in a very clean manner with hardly a splash being made anywhere. On each occasion the brush is dipped for a fresh supply, the cup is, of course, emptied at the same time and with the same movement.

A non-splash whitewash brush.

Home-made "Pick-up"

MOST amateurs have in their "junk-box" an old telephone ear-piece, and possibly possess a portable gramophone whose sound-box is no longer a thing of value.

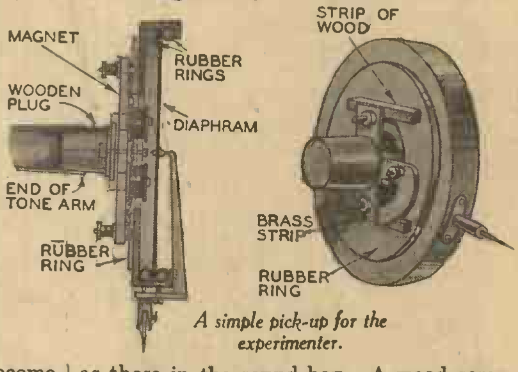
The sound-box is taken and the diaphragm and needle-arm removed. The cylindrical piece which fits into the tone-arm is sawn off and the hole enlarged by drilling, chipping and filing, till the pole-pieces and coils of the earphone magnet (previously removed) can pass freely through it.

A ring of rubber is then cut from an old motor tube nearly the same outside diameter as the sound-box, the inside diameter being slightly larger than that of the hole made in the sound-box.

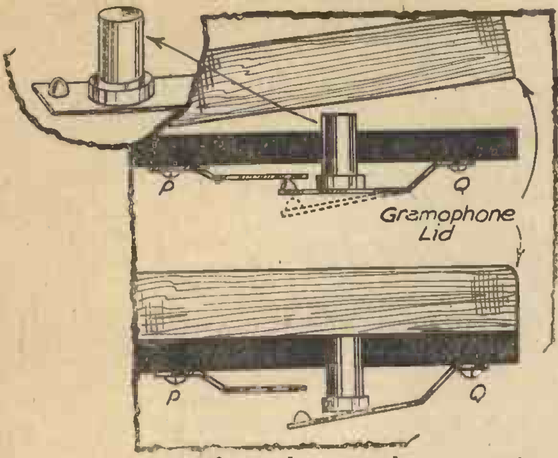
Near the edge of the hole in the sound-box two $\frac{1}{8}$-in. holes are drilled diametrically opposite each other.

A piece of stout brass plate is then cut, $1\frac{3}{4}$ in. long and $\frac{3}{8}$ in. wide. This is then drilled with three holes, the two outside ones being exactly the same distance apart as those in the sound-box. A wood screw is passed through the central hole into a slightly tapered cylindrical piece of wood about an inch long to fit tightly into the tone-arm.

Two 1-in. screws are then passed through the holes in the sound-box and the rubber ring placed in position on the back of the sound-box. The magnet is then placed in position resting on the rubber, and made stable with small strips of wood. The brass plate is then placed over the screw



A simple pick-up for the experimenter.



An efficient radiogram switch.

ends, and nuts screwed on to clamp the magnets tightly in position. These nuts provide a means of adjusting the distance between the magnet poles and the diaphragm. The mica diaphragm of the sound-box is then replaced by the iron one of the earphone, which is drilled with a central hole for the purpose.

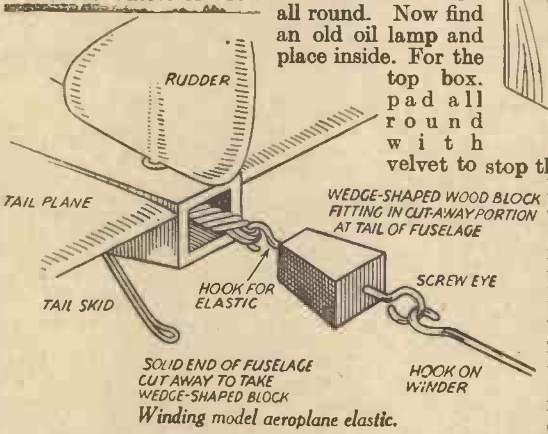
Leads from the magnet coils go to the usual points on the set. The heaviness of the unit can be overcome by arranging a counterpoise on the tone-arm.—M. O. (Wembley).

An Efficient Radiogram Switch

A RATHER neat and very efficient switch for radiogram sets is shown in the sketch. It cuts off the L.T. current when the lid is closed (see sketch). The switch is mounted on the panel facing of the set in such a position that the lid when closed depresses the bell-push knob, so breaking the circuit. One of the leads from the accumulator is broken, and the ends connected to the screws P Q.

Winding Model Aeroplane Elastic

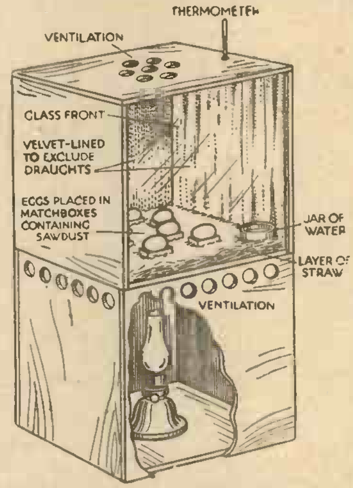
IN order to wind the rubber motor of a flying model aeroplane, the best results are obtained when the elastic is stretched, wound with a machine winder, and slowly allowed to contract as it is being wound. It is easy enough to stretch the elastic in a tractor model plane with just a stick of wood for a fuselage. But with a filled-in fuselage model it cannot be done. Here is a simple method of facilitating this. At the back of a full fuselage model is a thick piece of wood, which holds one end of the elastic. A square block of wood could be made to fit in this back piece, so that it tapers towards the front of the plane to stop it from being pulled in by the tautness of the rubber, which is affixed by means of a wire hook to one end of the square block. At the end of the block facing away from the front an eyelet should be screwed in. All that has to be done then to wind the elastic is to hook the eyelet on the end of a machine winder. pull the loose block of wood outwards, thus stretching the elastic, and turn the winder.



Winding model aeroplane elastic.

A Simple Incubator

FIRST obtain two boxes of the same size, and on the bottom box make a row of ventilation holes all round. Now find an old oil lamp and place inside. For the top box. pad all round with velvet to stop the draught. Fix a lid over the box with a ring of ventilation holes in, and in another hole fix a thermometer. To complete the top box add a glass front. The top box is stood on the bottom over the lamp. A layer of straw is put on the floor of the top box, and the eggs are mounted on matchboxes filled with sawdust. A small pot of water is placed in with them which is cleaned every day. The light underneath is kept burning until chicks appear, then the heat is decreased gradually.

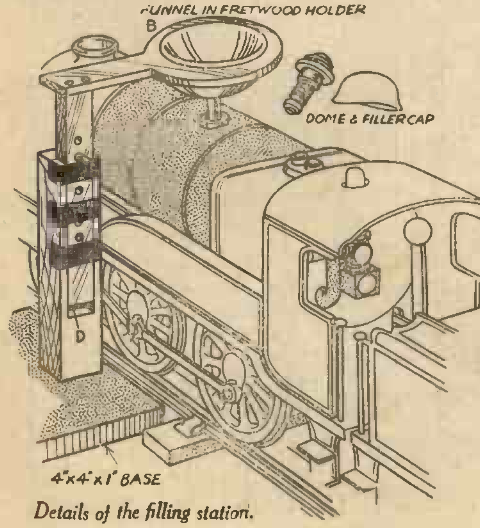


A simply made incubator.

A Novel Filling Station

THOSE readers who are steam model railway enthusiasts have no doubt found it difficult to fill up their engine after the water has been used. When lifting off the lines one is apt to burn oneself. Here is a simple device which will remedy this. All you need is a piece of wood 4 × 4 × 1 in. thick, and a piece of three-ply wood. Supposing the upright post is 6 in. high and 1 in. thick, a slot 2 in. long, ½ in. wide and ½ in. deep must be made at the top; we will call this slot D. Cut a piece of fretwood about 3 in. long by 1 in. wide, and then another one as shown in diagram B. Fix the funnel holder on top of the slotting arm so that it stretches out over the line.

When the arm is slotted into the post, nail strips of tin over so that it can be moved up and down and held into position by pegs (see diagram).

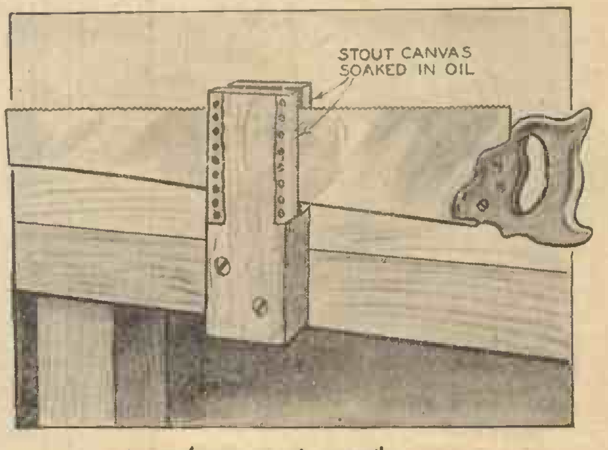


Details of the filling station.

A Rust-preventing Saw Oiler

SAWS kept in damp places soon develop rust, which does not tend to improve the metal or the keenness of the saw. This can be obviated by passing them through this oiler after use, which can easily be mounted in a convenient place in the workshop.

It consists of a piece of 2 × 1 in. wood cut with a slot and lined with canvas which is kept soaked in fairly thick oil. Just pass the saw through this once or twice before putting it away, and it will keep the metal well greased.—A. B. (St. Margarets-on-Thames).



A rust-preventing saw oiler.

PHOTOGRAPHIC FLASH POWDER

THE actinic value of the light given by burning magnesium was recognised in the early days of photography, but its use was restricted owing to the difficulty in obtaining large surface illumination. Magnesium ribbon or wire was used in a special type of spirit lamp which automatically fed the metal into the flame. The length of time taken to burn a foot of ribbon rendered instantaneous photography impossible.

To a great extent this objection was overcome when a lamp was introduced incorporating a bulb, or blower, and a reservoir in which magnesium powder (" dust ") was contained. The lamp was lit, the shutter uncapped, and the bulb squeezed. A fine spray of dust was blown through the flame, when a light of far greater volume than that given by the ribbon was obtained. Moreover, the combustion was instantaneous.

It has been shown in a recent issue of this paper how quickly, vigorously, and brilliantly, magnesium burns in the presence of pure oxygen. It was this property of the metal which prompted experimenters to try the effect of mixing magnesium dust with powerful oxidising agents, such as potassium chlorate, and applying a light. The desired result was achieved.

PRINCIPLES OF THE WATER PUMP

From very early times man has found it necessary to raise water for various purposes, from a well, for instance. The most obvious method was, no doubt, to let down a pot of some sort on the end of a rope and haul up the water by hand, but various other more or less ingenious methods were used until the invention of the water pump.

THE bucket pump shown in Fig. 1 is the simplest type. It is usually worked by a hand lever, though large pumps of this type were sometimes used in mine workings and were operated by old

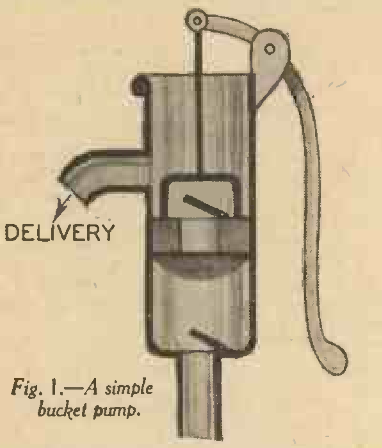


Fig. 1.—A simple bucket pump.

beam engines in the early days of steam power. Hand pumps may still be found in use in county districts for raising water from wells. The apparatus consists essentially of a " barrel " or cylinder, a " plunger " or piston, and two valves. The plunger—which contains one of the valves—is, of course, worked up and down the barrel by means of a long handle. On its upward stroke water is sucked up into the barrel of the pump through the foot valve. When the plunger moves downward the foot valve closes automatically and the water passes up through the valve in the plunger and collects on top. During the next up-stroke the plunger valve closes and the water is lifted bodily until it flows from the outlet pipe.

The Lifting Power of the Pump

The theoretical height to which a pump can lift water on the suction side is rather over 30 ft., but no pump will do this in practice. The bucket pump will lift water satisfactorily to about 20 ft. in practice. If greater lift than this is required it must be obtained on the delivery side. For example, by continuing the barrel upwards for, say, 12 ft. above the plunger before the outlet

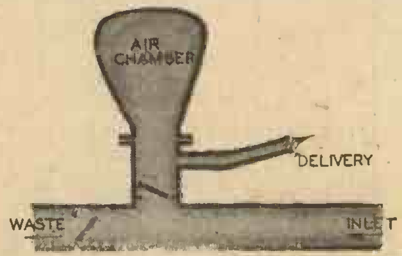


Fig. 6.—Diagram illustrating the principle of the hydraulic ram.

is reached and using a link rod, between plunger and lever, about 12 ft. long, an extra 12 ft. of lift is obtained. The lift on the delivery side may be increased as much as required within reason, but is always limited on the suction side.

Hand pumps of the bucket type are frequently used by contractors for small pumping jobs where only a moderate lift is required. They are usually of large diameter and short stroke, so as to make them compact enough to fit on a small trolley for convenience in moving them about. Some such pumps are made with a flexible diaphragm in place of a plunger working in a cylinder.

A slightly different kind of pump is

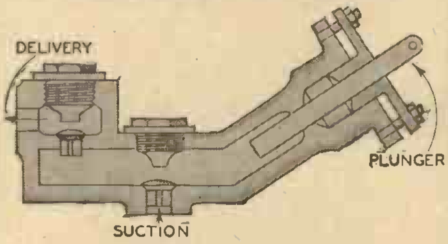


Fig. 3.—A boiler feed pump.

illustrated by the diagram, Fig. 2. The plunger in this case has no valve in it, but is just an ordinary piston, both valves

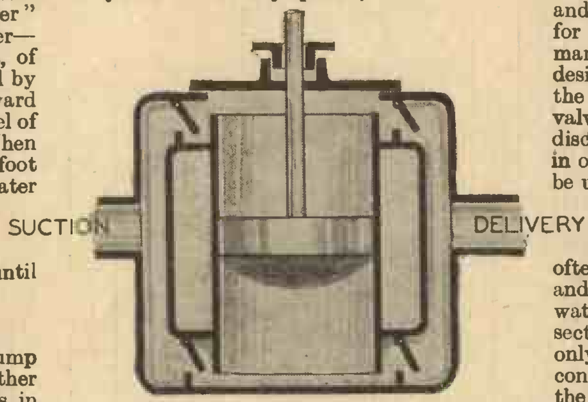


Fig. 4.—A double acting force pump.

being arranged in the cylinder. The water is therefore forced out of the pump by the downward stroke of the piston, and this type of pump comes under the heading of a force pump. A boiler feed pump works on this principle, but as this is required to deliver against a high pressure, the comparatively large piston is replaced by a solid ram of small diameter (Fig. 3).

A Double Acting Pump

It is fairly obvious that we can readily convert Fig. 2 into a double acting pump, by fitting a cover to the top end of the

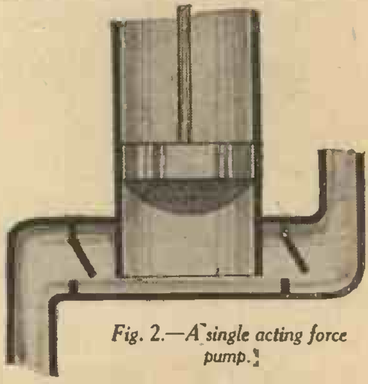


Fig. 2.—A single acting force pump.

cylinder—a gland being provided for the piston rod—and providing a second pair of valves. Such a pump is shown in Fig. 4, and this is the usual type of water pump for driving by machinery. It is used in many forms and varies a great deal in design and construction, depending upon the duty for which it is required. The valves, for instance, may be just plain discs of rubber for low pressure work and in other cases a phosphor bronze ball may be used as a valve.

Where the quantity of water to be dealt with is large and the delivery pressure low, centrifugal pumps are often used. These are extremely simple, and having no valves can pump dirty water without trouble. Fig. 5 shows a section of a pump of this type. The only moving part of a centrifugal pump consists of a series of vanes fixed to the main driving shaft. These vanes revolve in an outer casing, the inlet pipe being in the side of the casing concentric with the driving shaft, and the outlet runs tangentially from the periphery. The whole casing must be full of water before the pump will operate, and when the vanes are rapidly rotated, the water between them

(Continued on page 396.)

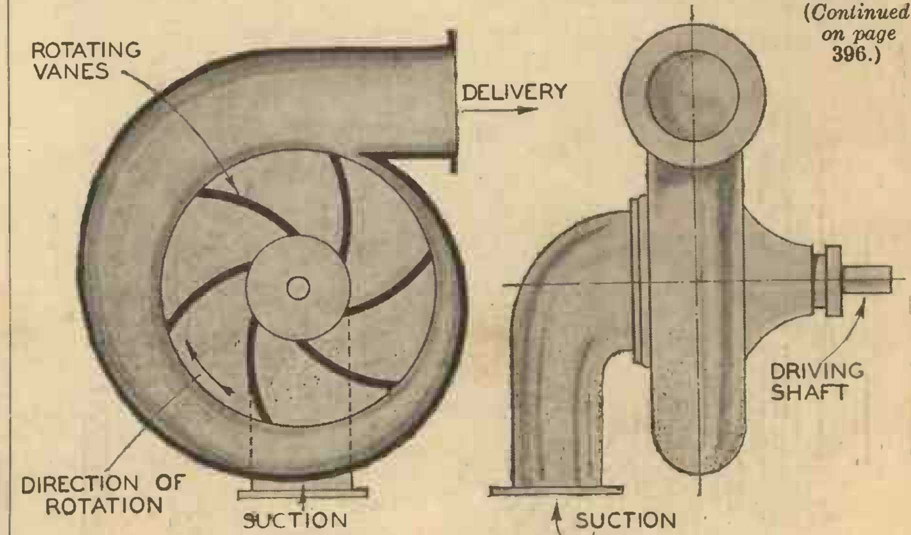


Fig. 5.—A centrifugal pump.

MECHANICAL POWER

An analysis of some of the better-known devices for transmitting the drive from the source of power to work.

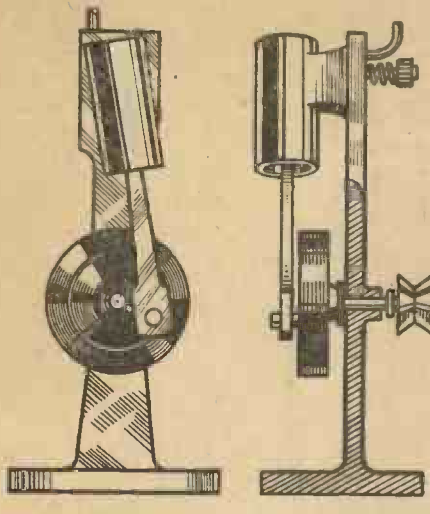
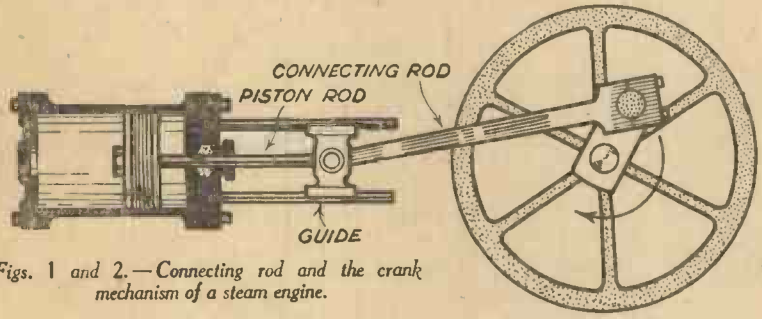


Fig. 6.—Simple oscillating steam engine showing overhung crank.

WHATEVER the source of energy utilised for the performance of mechanical work, whether it be steam, electricity, internal combustion or anything else, some mechanism is usually needed to convert that power into the form necessary for the particular type of work in hand. For instance, in the case of the ordinary steam engine the power is supplied in a *reciprocating* form, that is, by a piston which moves backwards and forwards, whereas it is usually required in a *rotary* form. The necessary conversion is therefore carried out by means of a connecting rod and crank.



Figs. 1 and 2.—Connecting rod and the crank mechanism of a steam engine.

Connecting Rod and Crank Systems

An illustration of the steam engine system of connecting rod and crank is given in Fig. 1. The fact that steam is fed to both the top and bottom of the piston alternately necessitates the use of a rod known as the piston rod, which operates through a steam-tight gland in the end of the cylinder and transmits the power from the piston to the connecting rod. The piston rod is really a necessary evil, for it does nothing in itself to convert the direction of the piston's motion. It is employed merely to convey the motion of the piston to the little end of the connecting rod, without allowing the escape of useful steam from the cylinder. Its external end slides between two guides. Of course, without these guides it would tend to warp or bend with each thrust of the piston, the greatest strain being when the crank is roughly at right angles to the axis of the cylinder. Fig. 3 shows how the force of the piston and the resistance of the connecting rod resolve themselves into this side thrust on the end of the piston rod, thus necessitating the use of guides.

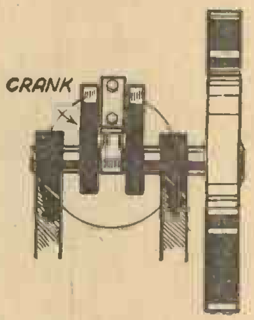
In the internal combustion engine, as employed in motor cars, motor cycles and model planes and speed boats, the driving force is confined to the top of the piston, therefore the use of piston rod and guide rods, etc., is entirely dispensed with. Fig. 4 shows how the little end of the connecting rod is pivoted directly inside the hollow piston.

This form of transmission can be made extremely efficient especially if the main bearings of the crankshaft and the big end of the connecting rod are carried on ball or roller bearings. It suffers, however, from that one disadvantage associated with all reciprocating systems, due to the weight of the reciprocating parts. This weight not only reduces the speed of acceleration and deceleration, but tends to produce vibration. Even with the weight of the piston and connecting rod most carefully balanced by means of counterweights incorporated in the cranks or flywheels, vibration is likely to manifest itself at high speeds. Sometimes vibration "periods" occur. For example, an engine will run quite smoothly up to a certain number of revolutions per minute, say 3,000, and will then vibrate badly up to say 3,500 r.p.m.

Above this speed, however, it will again run smoothly. This phenomenon is often due to the "natural" frequency of the whole unit coinciding with the frequency of the reciprocations of the engine at that certain speed. It is analogous with the classic example of the troop of soldiers marching in step across a suspension bridge and by reason of the rhythmic beat of their feet coinciding with the natural period or frequency of the bridge, causing it to oscillate violently in harmony with each step.

Weight of Reciprocating Parts

The need for making the piston and connecting rod as light as possible becomes very apparent if you consider that quite a usual speed for an internal combustion engine is 5,000 r.p.m. and that this speed means about 167 upward and downward movements of the piston *per second*. In other words, the piston is started and stopped 334 times per second. If you look at Fig. 4 you will see the reason for this. At the instant depicted the piston is moving downward. When half-way down it will be moving at its greatest speed, but this speed will decrease rapidly until it reaches the bottom of its stroke, when for an infinitely short time it will remain stationary. It will then start on its upward journey until it reaches half-way, when it will once more decelerate until it stops at the top of its stroke. It then starts on the next downward stroke, and so on. Thus you see, the piston actually accelerates twice and decelerates twice in the course of one revolution of the crank. Obviously, if the piston and the connecting rod are very heavy, the inertia to be overcome in alternately accelerating and decelerating something like 300 times per second will be enormous. It speaks well for the skill of modern metallurgists that



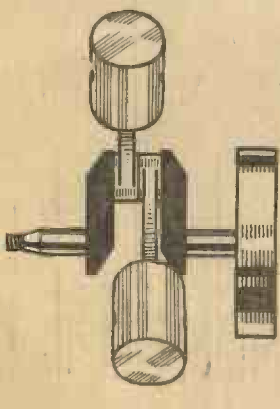
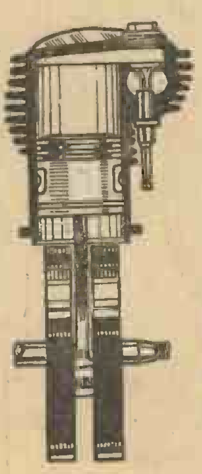


Fig. 11.—To mount the connecting rods side by side the cylinder must be off-set.



(Left.) Fig. 7.—Twin fly-wheels which also form the crank in a motor cycle engine.

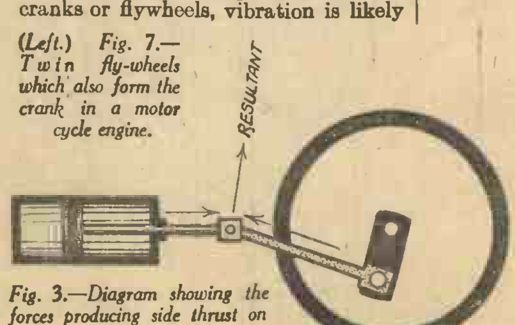


Fig. 3.—Diagram showing the forces producing side thrust on a piston rod.

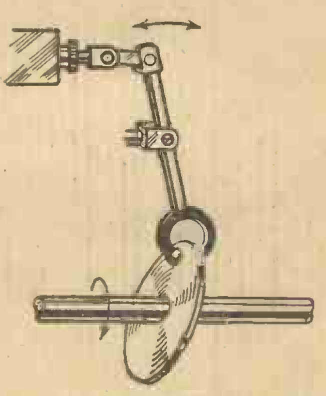


Fig. 18.—Swash plate for operating steam engine valve gear.

—TRANSMISSION

By W. B. RICHARDSON

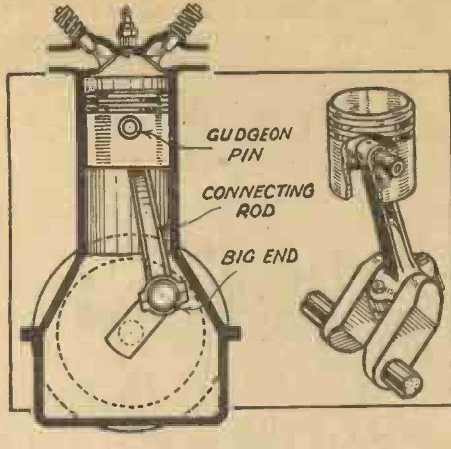


Fig. 4.—Connecting rod and crank assembly of an automobile engine.

alloys are available for piston and con. rod construction which are light enough and strong enough to permit of speeds up to 10,000 r.p.m.

The design of cranks is by no means uniform, and various types are employed in different mechanisms. In some cases the crank is built up as in Fig. 2, in others it may be a solid forging such as the crankshaft of an automobile engine as shown in Fig. 5, or again crank and flywheel may be combined as in Fig. 6. This last arrangement is commonly used for small model steam engines of the oscillating cylinder type, while Fig. 7 shows a motor cycle engine in which the big end of the connecting rod bears on a crank pin joining the two flywheels.

In aero engine design, where multi-cylinder power units are the rule, some very elaborate con. rod and crank assemblies are to be found. Fig. 8 shows the principle of the radial and rotary types of engine. Here several connecting rods operate on the one crank, and some ingenious methods are employed to accommodate the big ends of the various connecting rods. A simple example of how more than one big end can be accommodated on one crank, when the cylinders are in line, is shown in Fig. 9. This is the usual arrangement adopted with a "V" type twin-cylinder engine. A stirrup-shaped big end is used for one of the con. rods. An alternative method is shown in Fig. 10. Of course, where it is not necessary to have the cylinders in line, the big ends may be placed side by side as in Fig. 11. However, in the design of radial and rotary engines with perhaps fourteen or eighteen cylinders, the problem is not quite so simple. Usually an elaboration of the method shown in Fig. 10 is employed.

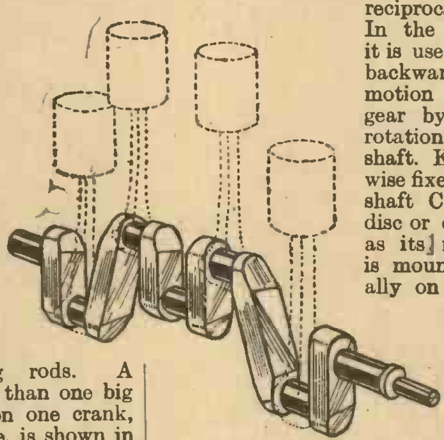


Fig. 5.—The arrangement of the cranks in a 4-cylinder engine (three-bearing crank shaft).

The Eccentric Belt Cam

A piece of apparatus which is closely allied to these crank devices is the eccentric cam. Builders of model steam engines and locomotives will be quite familiar with this. It is illustrated in Fig. 12, and is usually used to carry out a reversal of the action performed by the con. rod and crank, that is, it converts rotary motion into reciprocating motion. In the steam engine it is used to impart a backward and forward motion to the valve gear by utilising the rotation of the crankshaft. Keyed or otherwise fixed to the crankshaft C is a circular disc or cam E. This, as its name implies, is mounted eccentrically on the shaft so that as the shaft revolves the centre of the disc traces out a circular path round the shaft. A metal strap S encircles the eccentric, which is able to rotate freely inside the strap. As this strap is an integral part of the eccentric rod R, the rotation of the eccentric causes the rod to adopt a crank-like action and so push the rod V backwards and forwards. This latter rod operates the valve. The dotted lines in Fig. 12 show various positions of the eccentric and rod in the course of a revolution of the crank.

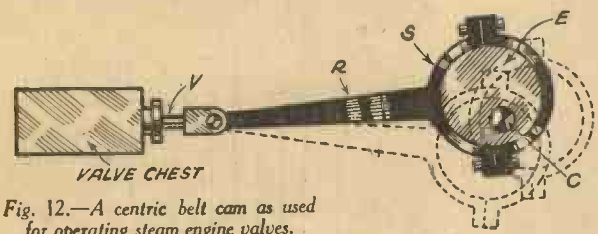


Fig. 12.—A centric belt cam as used for operating steam engine valves.

The circular belt cam of the steam engine is but one of countless cam devices used for converting circular motion into reciprocating motion and *vice versâ*. The cams used to operate valve gear of automobiles are either pear-shaped or else squarish, as in Fig. 13. The object of a cam is to open and close its associated valve at the appropriate times during the explosion cycle. The ideal to be aimed at is the sudden opening of the valve to its full open position at just the right instant; the retention of it in this position for a certain period, during which time the gases are entering or escaping from the cylinder; and then its instant closing. The "square" cam conforms to these requirements. For about 180 degrees of its movement its contour is circular, and while this part passes under the tappet T the valve remains closed by reason of the valve spring S.

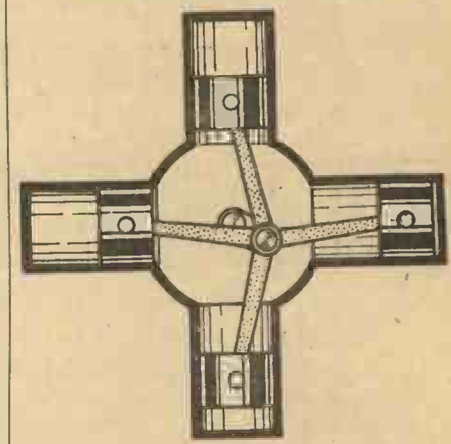


Fig. 8.—Principle of radial and rotary type engines.

However, as soon as the "hump" of the cam arrives in the position shown in the second drawing in Fig. 13, the tappet is suddenly pushed upward and opens the valve. This then remains open during the passage of the "hump" of the cam, after which the valve is instantly closed again

(*Continued on page* 380).

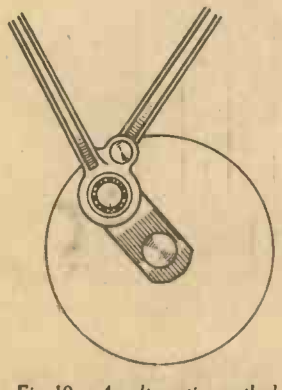


Fig. 10.—An alternative method.

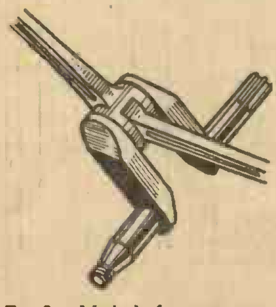


Fig. 9.—Method of mounting two connecting rods on one crank when the cylinders are in line.

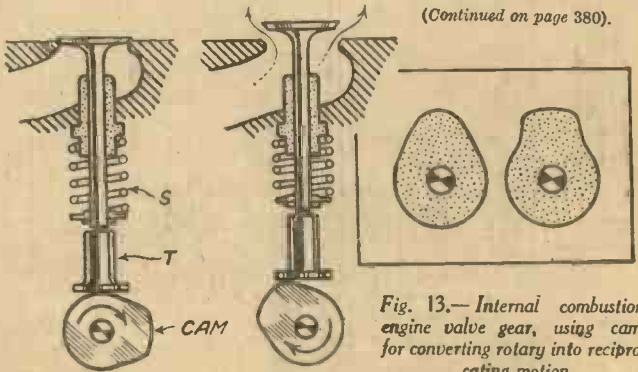


Fig. 13.—Internal combustion engine valve gear, using cams for converting rotary into reciprocating motion.

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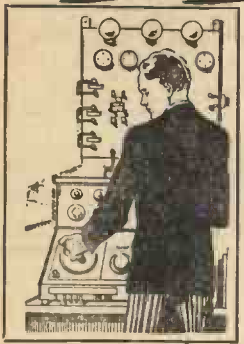

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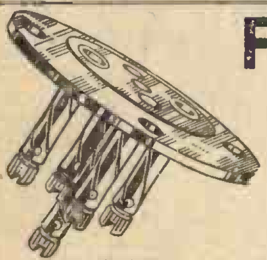

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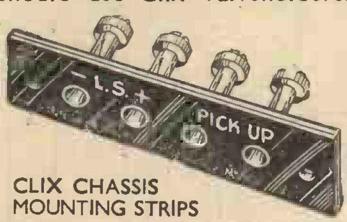

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THE P.M. THREE-FIVE PORTABLE

An easily made set which can be used equally well for indoor or outdoor reception

A PORTABLE wireless receiver is a very desirable possession at this time of the year, but there are few people who are prepared to employ a separate set for outdoor listening in addition to that which is kept for normal indoor use. The set to be described is therefore designed so that it can be used quite as well in the home (in conjunction with an outside or indoor aerial) as outside, or in a position where an aerial cannot be erected. This receiver employs only three valves, but as the name is intended to imply, it is the equivalent of a five-valve instrument of the ordinary kind. The fact is that a special valve of the multiple type is used for low-frequency amplification. This valve is the Hivac combined Class B and driver, which is comparatively new, and was first introduced

to "Practical Mechanics" readers two months ago.

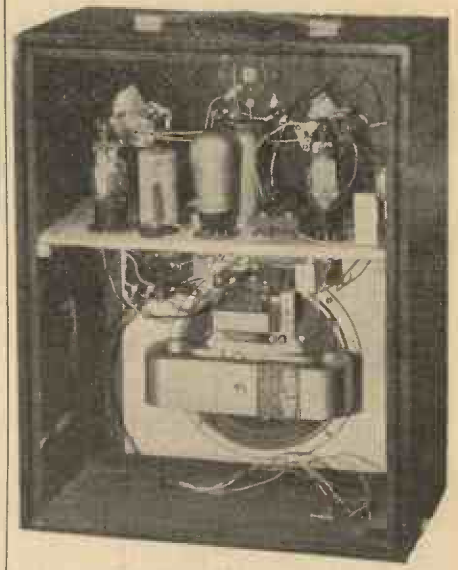
Not only is the special valve useful in reducing the initial cost of the set, but it effects a useful saving in space, with a result that the complete set is very compact indeed. A fairly large containing case has been chosen, however, so that good-sized batteries can be accommodated easily. It might at first be considered that large batteries are not required, since the set is undoubtedly economical in the way of running costs, but it is an undisputed fact that double-capacity batteries have a much

The neat appearance of the finished receiver can be judged from the above photograph, whilst the views on the left and right show the frame aerial and inside of the set.

longer life in proportion to their cost than have smaller ones, such as are generally employed in portable sets. This point is of especial importance where a Class B valve is employed, as in the present case, because, although the average H.T. current consumption of this valve is distinctly low, high "peak" currents are required on loud passages. It is principally for this reason that a large capacity high-tension battery is specified.

Range of Reception

It has been said that the Three-Five can be used either with or without an external aerial, and it might be added that it will give a maximum undistorted signal output of nearly 1 watt at a distance of about fifty miles from a local station with an aerial, or up to fifteen to twenty miles when operated from its own self-contained frame aerial. Needless to say, a large number of foreign stations can be well received when a good outside aerial is employed, but the receiver is intended principally for "local station" reception on the frame aerial. This does not mean that stations other than the local cannot be received on the frame, but that these should not be expected to give sufficient volume for real outdoor entertainment.



The Three-Five is very easy to operate, tuning being carried out by means of two good slow-motion dials acting upon the aerial and intervalve tuning condensers respectively. There is also a reaction control, a push-pull on-off switch and a three-point switch that serves for wave-changing on both the frame aerial and inter-valve tuning coil. Reaction works very smoothly, because of the insertion of a fixed resistance of 350 ohms between the anode of the detector valve and the differential reaction condenser.

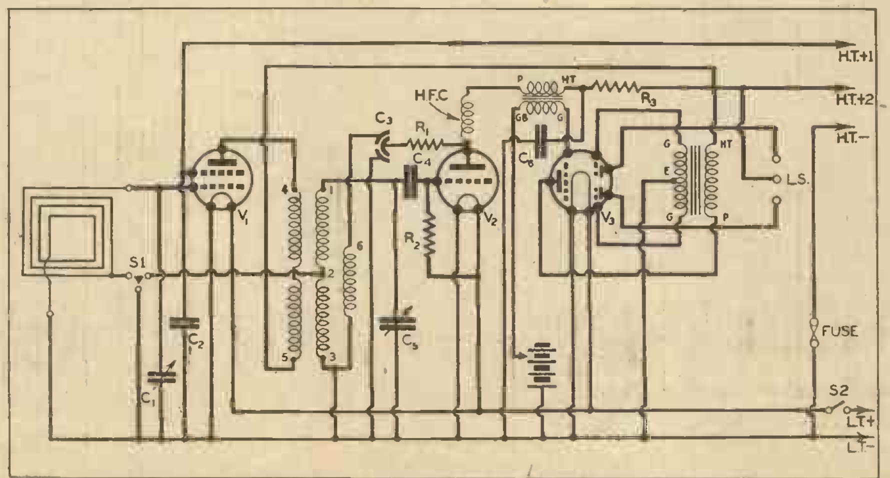
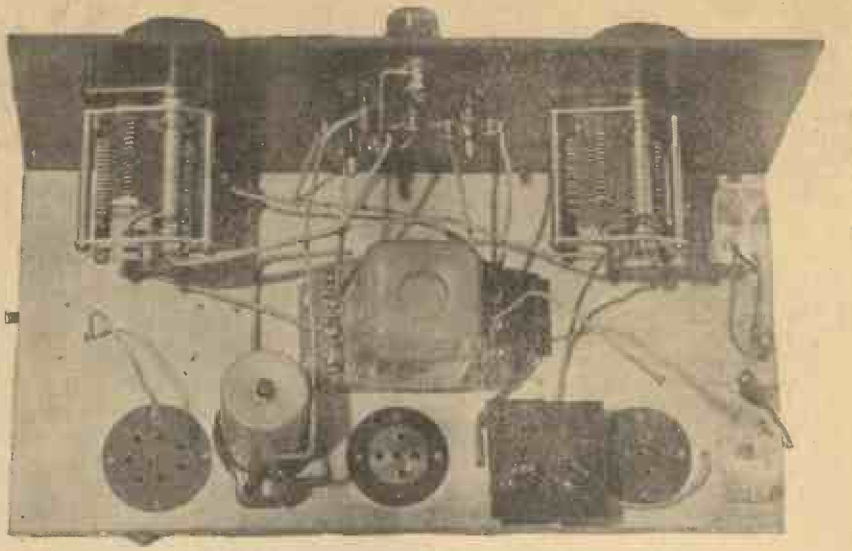


Fig. 1.—The above circuit diagram shows the simplicity of the "Three-Five Portable."

The Circuit

Technical readers will be interested in

the circuit diagram given in Fig. 1. This shows that a frame aerial wound for both long and medium waves precedes the screen-grid H.F. amplifier. A tuned H.F. transformer is used to couple the first valve to the leaky-grid detector, and a three-point switch serves to short-circuit a portion of both the frame aerial and the coil winding on medium waves. Reaction is applied to the tuned H.F. transformer by means of a differential condenser, an "anti-parasitic" fixed resistance being included in the reaction circuit. A plain 5 : 1 L.F. transformer is used to couple the detector to the driver portion of the triple (driver, plus two triodes forming the Class B section) valve used in the output stage. A 1·5 : 1 special driver transformer is then used for coupling the driver and Class B sections of the D.B. 230 valve. The output is fed directly to the speaker, which is fitted with a multi-ratio transformer and which therefore gives accurate matching and excellent quality.



This semi-plan view shows the above-baseboard component lay-out and wiring.

Simple Construction

The receiver is very easy to make, partly because the Peto-Scott special portable cabinet is supplied complete with the aerial frame, ebonite panel and baseboard. It is thus only necessary to drill the panel and baseboard according to the dimensions given in the accompanying drawings, and to mount the loud speaker. Even the latter task occupies only a couple of minutes,

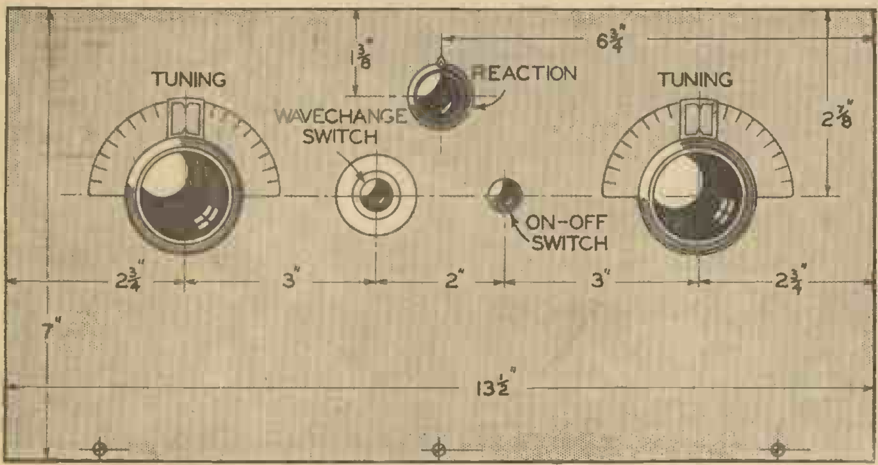


Fig. 2.—This drawing will be useful in drilling the ebonite panel.

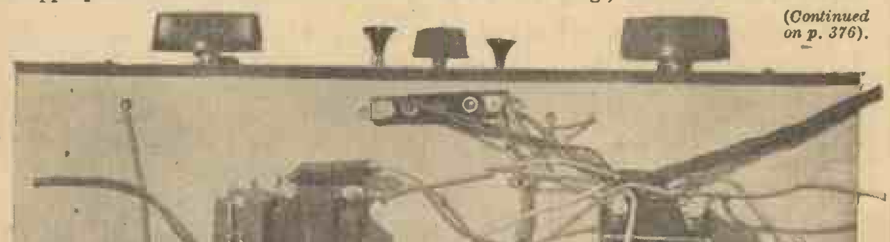
since the necessary baffle board is supplied (with the cabinet) all ready fretted.

First of all remove the baseboard and panel, and then drill the latter and mount the condensers and switches on it in the positions shown. Three holes are required in the baseboard to take the valve holders; two of these are 1 in. in diameter to take the 4-pin holders, the other one being 1⅛ in. for the 7-pin holder used for the Class B driver valve. When the valve holders have been screwed down, the remainder of the components should be mounted on top of the baseboard, after which as much of the wiring as possible may be carried out between the parts already mounted. The under-baseboard components can then be attached and the wiring completed. All the wiring, excepting that in connection with the battery and speaker leads, is carried out in British Radiogram "Push-Back" wire, the ends of which are bared simply by sliding back the insulated sleeving. It will be seen that a little soldering is called for in respect of the leads to the detector grid condenser and the decoupling resistance, but this will present no difficulty, since the wires concerned are already well tinned. There is one little point which might be explained in regard to the wiring; this is that of the five terminals on one side of the Varley driver transformer, only three are used, these being the centre and two lower ones. As a matter of fact, the five terminals are provided so that two alternative ratios can be obtained, and the terminals used provide the appropriate ratio of 1·5 : 1.

The Frame Aerial

After the receiver proper has been completed, the frame aerial can be wound round the inner frame of the cabinet. The arrangement of the two (medium- and long-wave) sections can be seen in the photographs, whilst details are given in the drawing at Fig. 3. The medium-wave winding is put on first, and consists of 13 turns of 24-gauge D.C.C. wire wound near the front of the sinking made to receive the aerial windings. Start by making two small holes with a bradawl or drill, and anchor the end of the wire by passing it through these and leaving a length of 6 in. or so projecting on the outside. Then commence to wind on the correct number of turns, leaving a space of about $\frac{1}{16}$ in. between each. Keep the wire quite taut whilst winding, but do not stretch it. At the end of the winding make two more holes and anchor the wire as before. Now leave a space of ⅜ in., make two more holes and wind on 34 turns of 28-gauge D.C.C. wire for the long-wave section. These turns should be touching each other, and it is important that they should go in the same direction as those of the medium-wave winding. On completion, anchor the end of the wire as before, and take a short length of flex for making connection between the windings and the terminals in the set. Start with the "beginning" end of the medium-wave winding and cut the projecting wire off to about 1 in. long; next bare it and solder a

(*Continued on p. 376*).



The components and wiring on the underside of the baseboard are shown above.

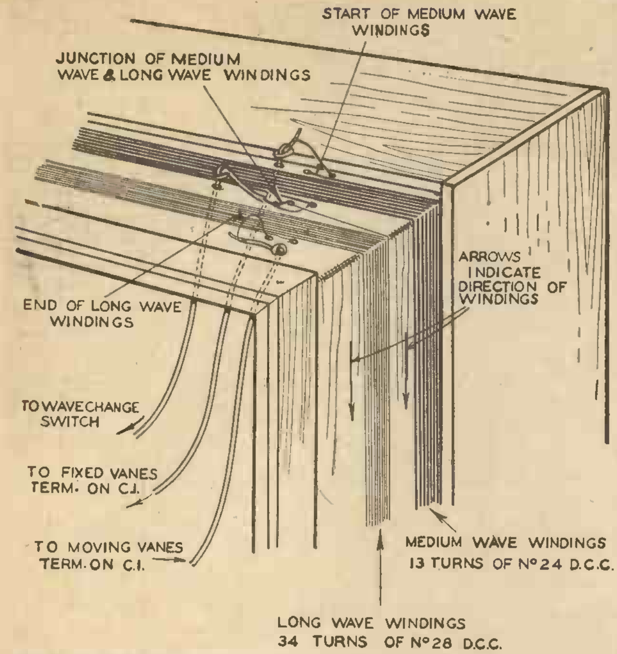


Fig. 3.—All frame aerial details are given in this sketch, which shows one corner of the aerial frame.

7-in. length of flex. Make a knot in the flex near to the joint and pass it through a $\frac{3}{32}$-in. hole, connecting the other end to the side terminal (fixed vanes) of the aerial tuning condenser. The "end" of the medium-wave winding and the "beginning" of the long-wave one must be joined together and a second length of flex soldered to the pair. This is then passed through a hole in the frame and connected to the top terminal on the three-point wavechange switch. The "end" of the long-wave section is connected by means of a length of flex, to the terminal on the end of the aerial tuning condenser.

Speaker Connections

Lastly, the loud speaker can be wired up by means of three pieces of flex. One piece is joined from the main H.T. positive lead to the centre terminal on the speaker transformer, and the other two connect the anode sockets of the 7-pin valve holder to the two outside terminals on the speaker.

Operating the Set

Connect up the batteries, putting wander plug H.T. + 1 into the 60-volt socket of the high-tension battery and plug H.T. + 2 into the 120-volt socket. The two G.B. plugs should be placed in the + and $4\frac{1}{2}$-volt sockets respectively, although the negative one should later be tried in different sockets, between $1\frac{1}{2}$ and 6 volts, to find the optimum setting.

The set is turned on by means of the right-hand switch, whilst the left-hand one gives medium waves (pulled out) and long waves (pushed in). First of all, turn the reaction knob to zero and then rotate the two tuning knobs together until the local station is received; it might be helpful in the first place to do this with an aerial connected. Incidentally, it should be mentioned that the numbers of turns specified for the frame aerial windings have been so chosen that the two tuning condensers work almost exactly "in step"; that is, the readings of both are practically the same on any station. When using the set without an external aerial it will be found that reception is very directional, so that the set must be rotated until the frame is in line with the station which it is desired to receive. The proper direction can soon be found by tuning in the station and then orientating the set until signal strength is at its greatest.

LIST OF COMPONENTS

- One "Universal" Coil, Wright and Weaire.
- Two ·0005 mfd. Slow-motion Tuning Condensers, Jackson Bros. "Tiny" (C1 and C5).
- One ·0002 mfd. Differential Reaction Condenser, Graham Farish (C3).
- One 5 : 1 L.F. Transformer, British Radiogram.
- One Class B Input Transformer, Varley type D.P.41.
- One Screened H.F. Choke, Ward and Goldstone.
- One Three-point Push-Pull Switch, Ward and Goldstone (S1).
- One Two-point Push-Pull Switch, Ward and Goldstone (S2).
- Two Four-pin Chassis-mounting Valve Holders, Clix.
- One Seven-pin Chassis-mounting Valve Holder, Clix.
- Two Terminals, marked "Aerial" and "Earth," Clix.
- Two Wander Plugs, "G.B.+," "G.B.−," Clix.
- One pair Terminal Mounts, Ward and Goldstone.
- One 2 mfd. Fixed Condenser, T.M.C. type 30 (C6).
- One ·1 mfd. Tubular Condenser, T.M.C. (C2).
- One ·0003 mfd. Tubular Condenser, T.M.C. (C4).
- One 30,000 ohm Electronic Resistance, 1 watt, Varley (R3).
- One 350 ohm Electronic Resistance, 1 watt, Varley (R1).
- One 1 megohm Electronic Resistance, Varley (R2).
- One 100 m.a. Safety Fuse, Microfu.
- One Five-way Battery Cord, 30 in., Belling-Lee.
- One pair Grid Bias Battery Clips, Bulgin type No. 1.
- British Radiogram Connecting Wire, Screws, etc.
- One Portable Cabinet, complete with Frame, Baffle Board and Ebonite Panel, Peto-Scott.
- One Moving-coil Speaker Unit, Amplion, type M.C.22.
- 4 oz. 24-gauge D.C.C. Wire, Lewcos.
- 4 oz. 28-gauge D.C.C. Wire, Lewcos.
- Three Valves; types S.G.210, L.210 and D.B.230, Hivac.
- One 120-volt High-tension Battery, Ediswan type 69706.
- One 9-volt Grid Bias Battery, Ediswan.
- One 2-volt Accumulator, Ediswan type ELM4.

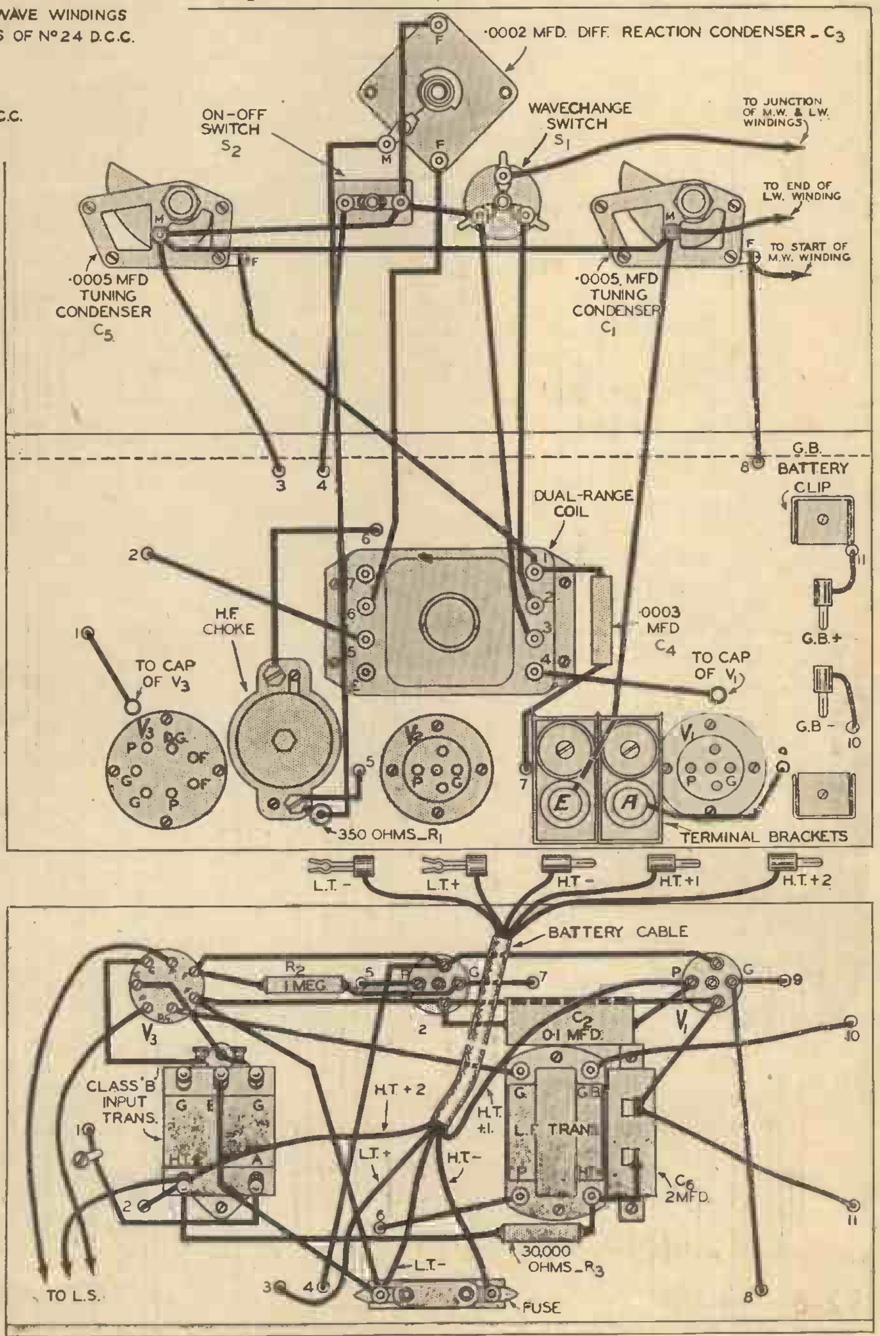


Fig. 4.—All wiring, as well as the exact disposition of the components, is shown in the above wiring plans.

MODELLING HISTORIC LOCOMOTIVES—PART I

The first article of a series dealing with the history of locomotive development from the year 1803 down to the present day.

By E. W. TWINING

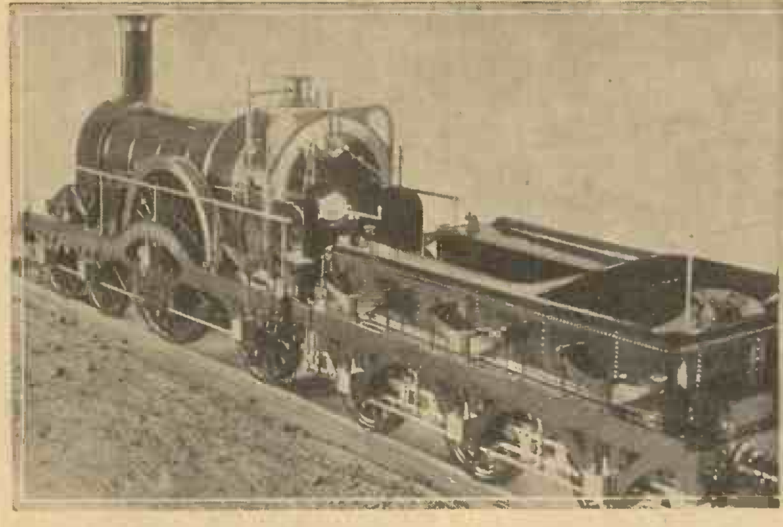


Fig. 2.—Model of Sir Daniel Gooch's 8 ft. single broad gauge locomotive "Herondelle," Great Western Railway of 1848. Scale, one-twelfth.

Fig. 1.—Model of George Stephenson's "Killingworth" locomotive of 1815—scale, one-eighth.

ALTHOUGH it is recognised that a vast amount of interesting work is being done, both by enthusiastic makers of models and by writers of articles and books, upon the subject of locomotives in miniature, the principal object of such making and writing appears to be amusement. This is a commendable enough object in its way, because, of course, such amusement is of a scientific and engineering nature. Some model makers have for their objective an engine which shall be as powerful as possible for a given size and be capable of pulling them along a railway: others wish to realise their ambition to possess in miniature the noble proportions of some particular, right up-to-date, prototype: still others there are who embark upon the building of a scale model for the sheer love of the work, and these frequently put into their models the finest workmanship and the most delicate care and finish.

It is to this class of worker, more particularly, to whom I wish to address my remarks and to whom the suggestion I make is most likely to appeal.

Considering the large volume of work that is being done in the making of locomotive models, I think it is a great pity that the reproduction of historic engines is so much neglected: indeed, it seems somewhat strange that it should be so considering the great number of people who are keenly interested in the history of locomotive development. It is a deplorable fact that of dozens of famous locomotives, or classes of locomotives, many even of comparatively recent times, not a single model exists and in some cases no published drawings. Of course, for the use and benefit of posterity there are photographic records of most engines which were running after the invention of photography, but before that time, that is to say, of many early engines, there are only drawings which to the young mind and the "man in the street" convey little or nothing. What we need and what should be in all museums is a collection of models of every noteworthy link in locomotive development for the benefit of the historian, the student and as an aid to the education of the public generally.

Societies of Model Engineers

I write these articles with the object of urging model makers generally, and societies of model engineers in particular, to devote their attention to this matter of making good the omissions of the past by providing future generations with tangible records, for even though the models may not be purchased by such institutions as those mentioned, they will doubtless, at least, be frequently exhibited publicly.

The making of really good perfect scale models of present-day engines is by no means to be discouraged, for the time will undoubtedly come when these, like all their predecessors, will be superseded and broken up; but it would be of little use for the education of future generations if every craftsman in model locomotive engineering devoted himself, as he is more or less doing, to duplicating the most modern types only or making engines of free-lance design.

I remember that years ago one of the older members of the London Society of Model Engineers made a beautiful and perfect model of the "Agenoria," the old engine of the Shutt End Railway, built in 1829. That is the sort of thing which I urge others to do, only it would, I think, be better to avoid copying a machine the prototype of which is still in existence. The "Agenoria" is, of course, in the Science Museum at South Kensington. The same thing applies to other engines such as Hedley's "Puffing Billy," Stephenson's "Rocket" and others.

Stephenson's "Killingworth" Engine

There is this to be said in favour of such copying, namely, that other museums distant from London would be glad to have duplicates, in miniature, of the full-size engine and even of the Kensington models, such as the one, for instance, which my company built of Stephenson's "Killingworth" engine of 1815 (shown in Fig. 1), or Messrs. Stuart Turner's "Rocket." But there is such a vast field from which to choose that for the present it should be needless to select something which has already been done.

If my suggestion or, if I may call it such, my appeal meets with any response, either on the part of individuals or societies, the scheme should be to some extent organised so as to avoid, so far as is possible, duplication of choice. Such organisation should be arranged between societies, and I venture to commend the matter to the London Society of Model and Experimental Engineers.

Models of old engines are better not made to steam, because such ability to work involves modification to meet steam conditions and the truth to scale, and correct appearance is unavoidably spoiled even if a large scale is adopted. The cylinders should be internally correct, so that the wheels may be revolved by compressed air whilst the model is in its show case, and that is the only extent to which it needs to work. The boiler can be either a perfect replica or consist of the lagging only. Particular attention should be paid to correct scaling down of small parts and fittings. These are frequently made too large and look heavy and clumsy. With regard to size a scale of one-eighth, $1\frac{1}{2}$ in. to 1 ft., is generally considered best, although 1 in. to 1 ft. is quite permissible. Whatever scale is chosen all models should, if possible, be uniform.

The History of Locomotive Development

In these articles, partly to arouse interest in the subject and partly by way of suggestion for suitable models, I propose to run through the history of locomotive development from the year 1803 down to the present day. To deal adequately with the subject one would need far greater space than will be at my disposal. Several large bound volumes would be required, so I shall be able to select only examples from approximately every decade of the last 130 years. For several reasons I have decided to let my selection follow Great Western history and practice, first because I think it would be confusing and of little use in a brief space to dodge about from one railway to another, and second because it was on the broad gauge that, up to a certain time, the greatest and most outstanding advances were made in size, speed and

(*Continued on page* 392.)

MECHANICAL POWER TRANSMISSION

(Continued from page 371)

by the force of the spring. Needless to say, with a " square " cam the whole mechanism is inclined to wear more rapidly than when a pear-shaped one is used, owing to the fact that a very strong valve spring is needed to induce the tappet to follow the violent contour of the cam, especially when

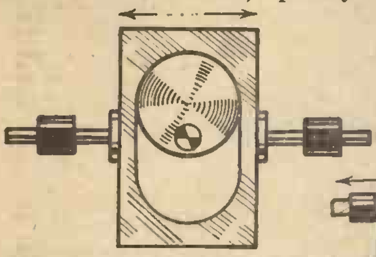


Fig. 17.—Another cam device.

it is rotating at speed. With wear the valve gear becomes noisy as well as losing its efficiency. For this reason cams of the pear-shaped type are usually employed for the engines of touring cars. Of course, with pear cams the valves do not open and close quite as rapidly as efficiency demands, but they are quieter in operation and wear better.

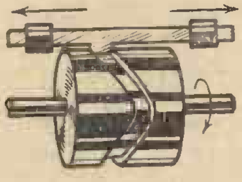


Fig. 16.—Drum cam for converting rotary motion into irregular reciprocating motion.

Other Cam Mechanisms

Some interesting, though less well known, cam devices are shown in Figs. 14—17. The first one is a face cam mounted on the end of a rotating vertical shaft. In the example shown, two separate cam contours are incorporated on the face of the one disc at the head of the shaft. Bearing on these two cams are two rockers, pivoted at A and B respectively, and each fitted with tiny rollers which bear on the cams. The object of the rollers is to reduce friction. As the shaft and cams rotate, so the two rockers move up and down, thus converting rotary into reciprocating motion.

The heart cam and the drum cam shown in Figs. 15 and 16 respectively are both of the positive motion type, no springs being required to make the reciprocating element follow the contour of the cam. They are both designed to convert rotary motion into irregular reciprocating motion.

The device shown in Fig. 17 is somewhat similar to the eccentric belt cam of Fig. 12. It employs a circular eccentric cam, but dispenses altogether with a connecting rod. The circular motion of the cam shaft is converted into an irregular backward and forward motion by the rotation of the cam within the rectangular-shaped yoke.

The Swash Plate Device

A device which is very similar to a face cam is illustrated in Fig. 18. It is known as a *swash plate*, and consists of a circular metal disc mounted concentrically on a shaft, but tilted at an angle to its axis. It is sometimes used for operating the valve gear of certain steam engines where the valve chest is mounted on the top of the cylinders and the valve works parallel with the axis of the crankshaft. This is illustrated in Fig. 18. As the crankshaft rotates, so the swash plate rocks from side to side and oscillates the lever. The upper end of this lever is attached to the valve spindle by a simple link mechanism which conveys a reciprocating motion to the spindle.

A description of the various types of gears, clutches, ratchets and other mechanisms associated with the transmission of mechanical power will be dealt with in a later article.

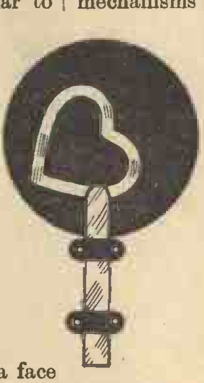


Fig. 15.—Heart cam mechanism.

The swash plate has also been used in place of a crank in both internal combustion engines and various pump devices. In these mechanisms a number of vertical cylinders are arranged in circular formation with their connecting rods bearing on the surface of a swash plate whose axis is parallel with that of the cylinders. Compared with the orthodox crank, this arrangement is somewhat inferior, as considerable fri tion is introduced at the contact of the connecting rods with the swash plate.

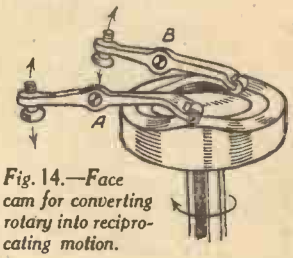


Fig. 14.—Face cam for converting rotary into reciprocating motion.

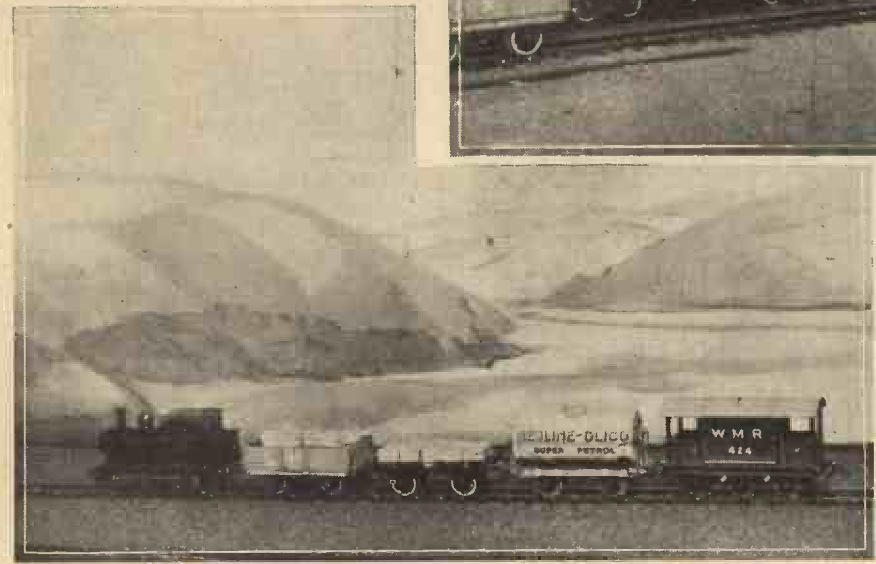
MODELLING RAILWAY FREIGHT FOR 00 GAUGE RAILWAYS

By THE PADRE

A model railway layout is improved if well equipped with articles of freight such as are suitable for carrying in the various wagons.

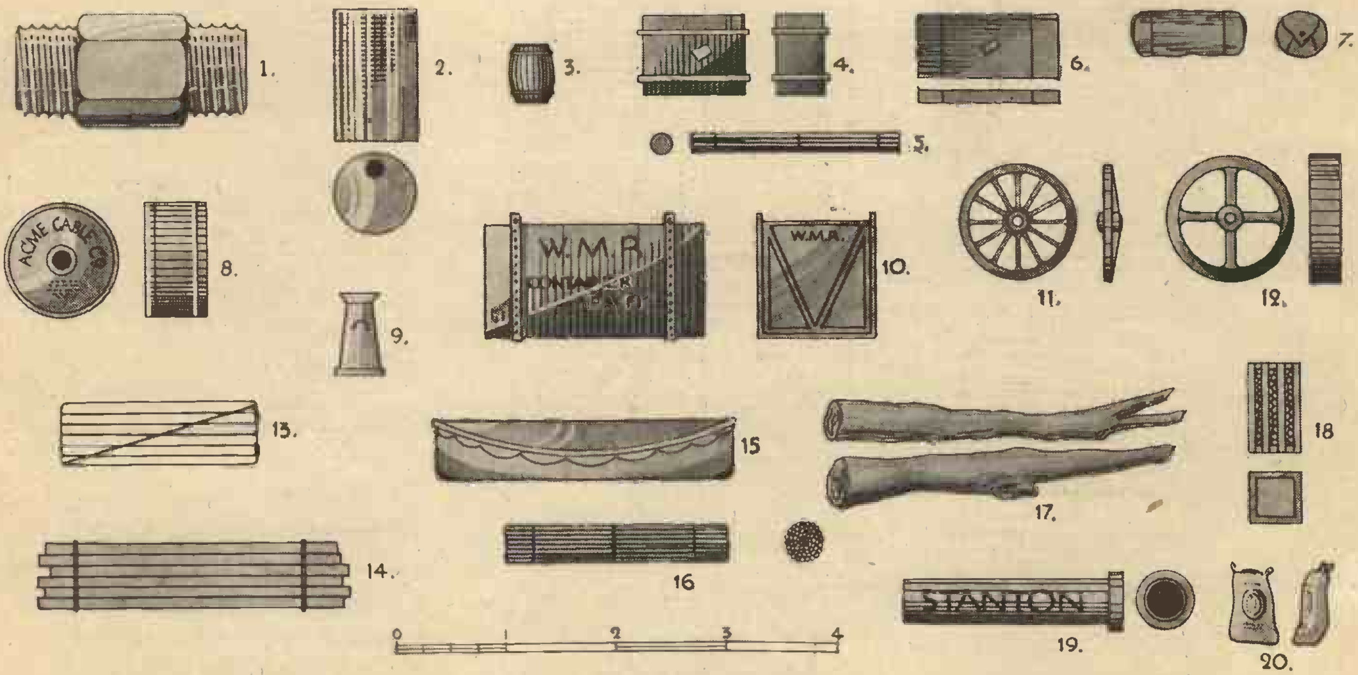
THERE are two characteristics which have to be borne in mind in constructing and designing these: first, they must be light, when that is possible; secondly, they must be realistic and to a suitable scale. For bulky articles the second condition hardly needs to be laid down, for if the cargo is out of scale it will not accommodate itself to the loading gauge of the railway and calamity will at once follow. And for smaller articles it must be remembered that nothing looks worse than a nice goods shed with its banks loaded with commodities altogether disproportionate in size. Half the pleasure of running a model system consists in carrying freight from one point to another, coal from mine to country depots, lime from the works to the stations, timber from a felling-site nearby some wood to a timber yard, and so on. The photographs show a scene at the Laurenceton yards on the West Midland Railway, and should furnish the reader with an interesting task—that of counting the actual commodities on view. Perhaps it would be well to enumerate them, and to say that they include coal in the bulk, rough timber, bales of jute, a case of machinery, crates of glass, hogsheads of wine, a large drum of electric cable, a large and heavy pulley wheel (sufficient in itself for a load), a number of galvanised tanks, some sawn timber and a large wrapped package.

Model freight on the West Midland Railway.



A model 00 gauge W.M.R. train loaded with model fish boxes.

(*Continued on page* 389.)



Various articles of freight for 00 gauge railway.

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A LIGHT-WEIGHT —

This model is of the ultra-light-weight type, built entirely of balsa wood.

As the title suggests, the model described below is of the ultra-light-weight duration type built entirely of balsa wood. The prototype of which it is practically a copy was made by Mr. Howard Boys, of the Northants Model Aero Club, the year before last, and I can vouch for the fact that, if built accurately to the drawings and specification, it is capable of putting up some excellent duration performances: in fact, it may very well prove to be a cup winner. Only in one or two respects have I departed from Mr. Boys' design. The most important of these is the introduction of an independent motor spar in the fuselage.

Motor Spar

It appears to me that there are very great advantages accruing from the arrangement, the chief of which is that the whole of the torque of the motor when winding is taken up by the spar and none of it is transmitted to the fuselage. This means, of course, that the fuselage can be built lighter, that the tail unit is not liable to be distorted out of line with the main wing, and that there is no risk whatever of damaging the machine itself when winding, either from the breaking of the rubber or hard handling. As may be seen from the side elevation in the general arrangement drawing, Fig. 1, and from Figs. 2 and 3, the spar is, at the front end, glued into the detachable nosepiece. No fastening is provided at the nose, but the whole spar, with the motor and the nosepiece, is held in place by a short elastic band at the tail end of the fuselage.

General Design

I do not know if it is common practice for models of this type to have propellers made of balsa wood, but at any rate Mr. Boys' machine has such a one. As a matter of fact, his first propeller had a diameter of 18 in., and it was curious to see the machine flying with this enormous prop. lazily turning over and over like a windmill. He afterwards tried other propellers down to as small as 12 in. in order to secure a high rate of climb, which, theoretically, should have given him great altitude for a long finishing glide. In my own opinion this end was not perfectly achieved, and the model never did so well as when fitted with the largest diameter. I have, however, in the drawings decided to reduce by 1 in., so making the propeller 17 in. in diameter.

Size of Model

As will be seen from Fig. 1, the span is 50 in. and the length of the fuselage 34½ in. Some readers may consider that these measurements will result in a plane which is too large for their requirements and, therefore, underneath all the measurements in each of the drawings I have added in brackets a set of other figures for making a similar model, having a span of only 37½ in. with a length overall of 27 in. I would strongly recommend, however, that for the best spectacular flights the larger machine be made.

Competition Rules

There is only one point to be noted in connection with the dimensions of the large model; namely, that, as I believe it to be the case, in some competition there is a rule that no model shall have a greater wing area than 200 sq. in. This large machine obviously exceeds that measurement.

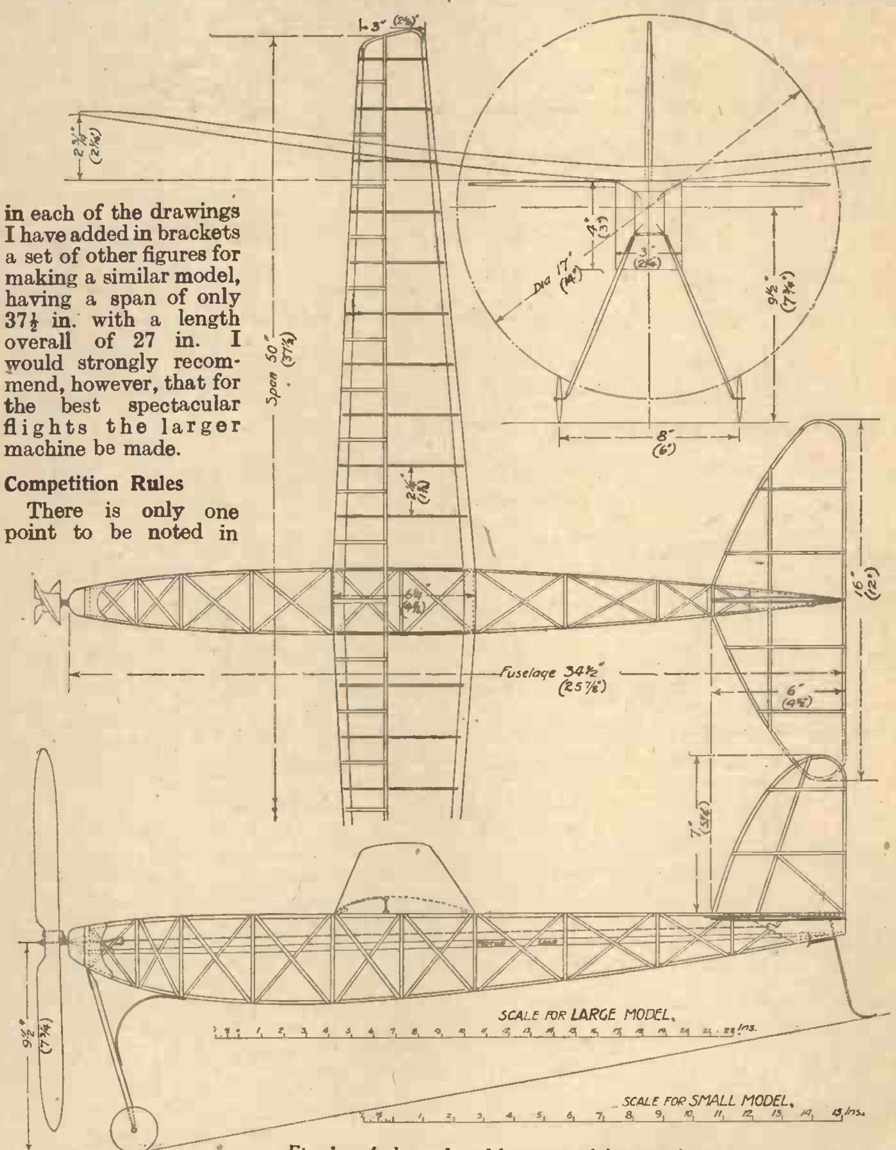


Fig. 1.—A plan, side and front view of the monoplane.

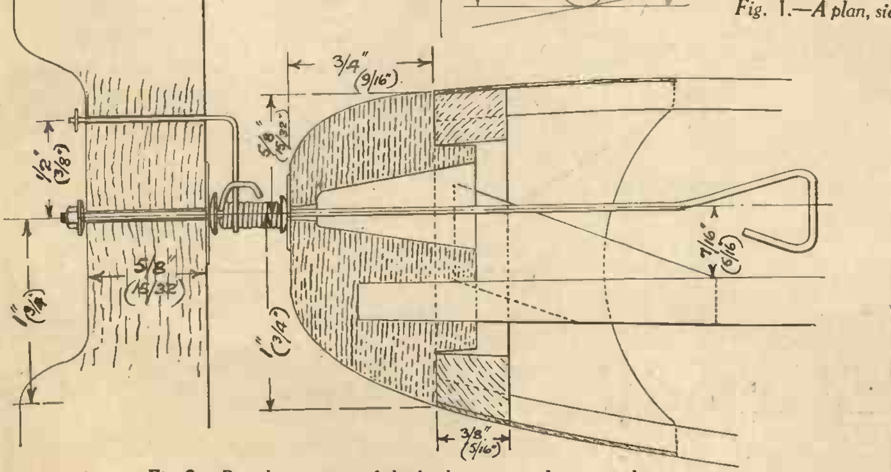


Fig. 2.—Details in section of the fuselage nose and airscrew drive.

I think that in order to give the whole of the dimensions, or specification, for each of the models I had better arrange them in tabular form. The first item, of course, refers to the S.M.A.E. rule regarding the cross-sectional area of the fuselage. This rule may be expressed by the formula $A = \frac{L^2}{100}$, A being the fuselage area and L the fuselage length.

Fuselage Construction

It will be seen from the above table that the four longerons of the fuselage are, in the large model, $\frac{3}{16}$ in. square at their centres, but they are not intended to be left square, although they are first cut so and carefully glasspapered. They are then reduced to triangular cross section, the chamfer thus

DURATION MONOPLANE

The Construction Described and Illustrated.

formed being placed on the inside of the fuselage. All the vertical struts of the sides and the horizontal ones of the top and bottom, which, as will be seen, are cut from $\frac{1}{32}$-in. thick sheet balsa, are notched into the longerons, as are also the diagonal bracings of the same thickness. Then on each side of the chamfer the longeron is still further slightly reduced in between the diagonal bracings. A perspective sketch in Fig. 5 shows this clearly.

The reader may omit this cutting away between the bracings if he so desires, and, indeed, he may prefer not to notch the bracings and struts in, but it makes for better and more perfect construction. I believe some aero modellists omit diagonal bracings and put in heavier struts, but the construction which I show in Fig. 1 makes for an infinitely stronger structure just like a latticed girder.

At the nose end of the fuselage a strong and rigid rectangular frame is introduced to which all the longerons are cemented. This frame forms a socket into which the balsa nosepiece, carrying the propeller, fits with a spigot. This is shown in Fig. 2. Around this frame and extending backwards on the longerons are four plates of $\frac{1}{32}$-in. balsa. At the tail end also are four such plates shown in Fig. 1 and some of them in Fig. 3. Into these plates the spars of the tail unit are cemented. Mr. Boys, on seeing my drawing (Fig. 1), suggests that the four struts under the leading edge of the plane and the four under the trailing edge should all be made of a little heavier section, say $\frac{3}{16} \times \frac{1}{16}$ or $\frac{3}{32}$ in., because they have to take the stress of the rubber bands by which the wing is held on to the fuselage. With this suggestion I, of course, concur.

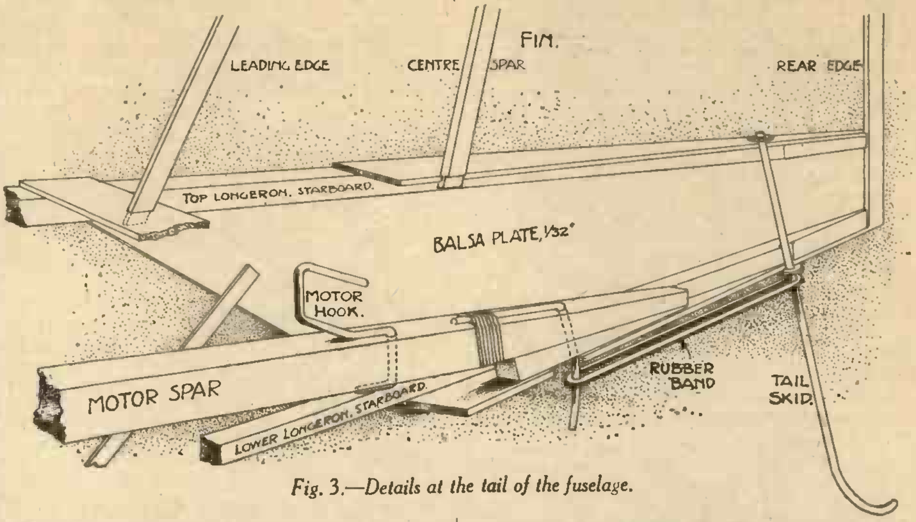


Fig. 3.—Details at the tail of the fuselage.

The Main Wing

The dimensions of the spars at the entering and trailing edges are given in the table above, which are, of course, the square measurements. They are to be planed, tapered and glasspapered to the sections shown in Fig. 4, the channel at the back of the front spar being cut throughout the length. The main spar is a built-up affair, the top and bottom members being continuous strips of balsa measuring $\frac{3}{16} \times \frac{1}{32}$ in. The front and rear spars must be carefully steamed and bent to give both the dihedral and the taper to the wing. The angle of the dihedral is shown in the front elevation of Fig. 1. At the wing tip the end piece is formed from two pieces of $\frac{1}{32}$-in. balsa cemented together with the grain of one piece running diagonally to the other. After cementing the total thickness is reduced to a full $\frac{1}{32}$ in. by glasspapering. This making of a ply end is to give additional strength. The ribs are all cut from $\frac{1}{32}$-in. balsa.

Cutting the Ribs

I recommend the reader, in order that he may get uniform reduction in the length of and general overall size of the ribs, to make a full-size plan drawing of one half of the wing, and besides marking off at $2\frac{1}{2}$-in. intervals the line to represent each rib to on this line draw the rib in profile: that is to say, draw it as shown in Fig. 4. He should then make a tracing of each rib separately, numbering each tracing. These

LARGE MODEL

$L = 34{\cdot}5^2 \text{ in.} = \frac{1{,}190}{100} = 11{\cdot}9 \text{ sq. in.}$

Model has 12 sq. in.
Area of wing, 231·25 sq. in.
Weight, approx., 3·25 oz.
Loading, 2 oz. per sq. ft.
Span, 50 in.
Chord mean, $4\frac{5}{8}$ in.
Tail area, 56 sq. in.
Fin area, 31·5 sq. in.
Length overall, 36 in.
Air screw dia., 17 in.
Air screw pitch, 25 in.
Rubber, 1 oz.
Fuselage—
Longerons, $\frac{3}{16}$ in. sq., tapering to $\frac{1}{8}$ in. sq.
Struts, $\frac{3}{16} \times \frac{1}{32}$ in.
Diagonal bracings, $\frac{1}{8} \times \frac{1}{32}$ in.
Wing spars—
Front, $\frac{1}{2} \times \frac{3}{16}$ in.
Rear, $\frac{3}{8} \times \frac{1}{8}$ in.
Propeller spindle, No. 18 steel.
Propeller driving hook and coil, No. 22 steel.

SMALL MODEL

$L = 25{\cdot}575^2 \text{ in.} = \frac{669{\cdot}5}{100} = 6{\cdot}69 \text{ sq. in.}$

Model has 6·75 sq. in.
Area of wing, 131·25 sq. in.
Weight, approx., 2·5 oz.
Loading, 2·66 oz. per sq. ft.
Span, $37\frac{1}{2}$ in.
Chord mean, $3\frac{15}{32}$ in.
Tail area, 31·5 sq. in.
Fin area, 16·9 sq. in.
Length overall, 27 in.
Air screw dia., 14 in.
Air screw pitch, 20 in.
Rubber, $\frac{1}{2}$ oz. approx.
Fuselage—
Longerons, $\frac{1}{8}$ in. sq., tapering to $\frac{3}{32}$ in. sq.
Struts, $\frac{1}{8} \times \frac{1}{32}$ in.
Diagonal bracings, $\frac{3}{32} \times \frac{1}{32}$ in.
Wing spars—
Front, $\frac{3}{8} \times \frac{7}{32}$ in.
Rear, $\frac{15}{32} \times \frac{3}{32}$ in.
Propeller spindle, No. 20.
Propeller driving hook and coil, No. 22.

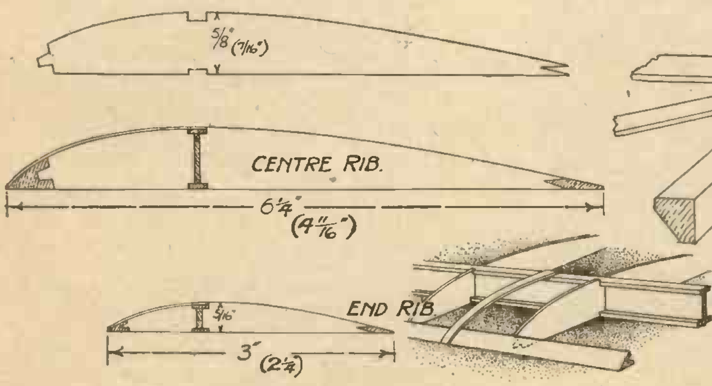


Fig. 4.—Details of the wing ribs.

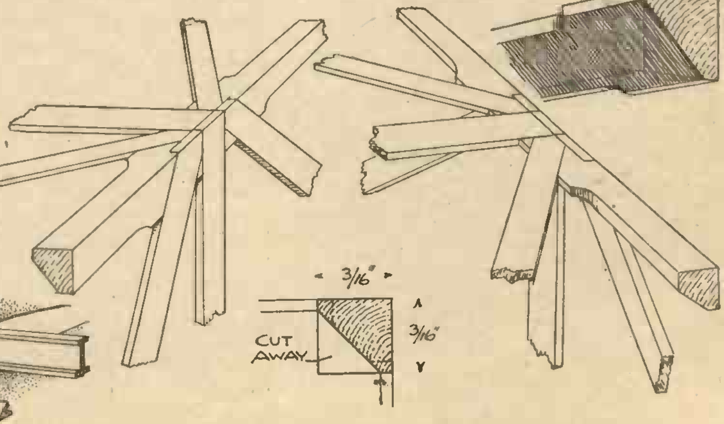


Fig. 5.—Details of the fuselage construction.

bits of tracing paper are then laid down upon a double thickness of balsa wood and with a nice, keen-edged safety-razor blade, preferably broken off at an angle in order to get a fine cutting point, cut round on the line upon the tracing through both the thicknesses of balsa. It is a good plan to tack the tracing to the upper balsa with a touch of paste to hold it in position. After cutting is complete the paper is removed and the number copied on to both of the ribs thus produced. Cutting should include the notching for the main spars, the rear spar and the shaping to fit into the entering edge spar. Any slight irregularities due to wavering of the razor should be corrected afterwards with glasspaper. When all the ribs are cut lay them up in piles, one pile for each half of the wing, placing them one above the other in the order of numbering and with the straight underside of all the ribs in line. By looking down upon each pile it will be readily seen whether each rib from the top, or smallest one, downwards gradually increases in size with regularity, and, incidentally, any degree of out of truth of any one rib can be detected.

Building up the Wing

Now mark off on the spars the 2½-in. intervals between the ribs and cement them all to the front spar. When the cement has set fix the rear spar, and, lastly, fix in position the upper and lower members of the central spar. Between these last and between each of the ribs a piece of $\frac{1}{32}$-in. plywood must be cut rectangular, or nearly so, excepting for the taper on the wing, and cemented all round, as shown in Fig. 4. Perhaps the easiest way in which to deal with this web in the central spar would be to cut one long tapering piece for each half of the wing and then cross-cut it to the required lengths.

This completes the construction with the exception of the secondary ribs, which are merely thin and narrow strips of balsa steamed and bent and placed at every intermediate position between the main ribs. Their purpose is merely to support the covering material on the top front edge. As will be seen from the drawings, they only extend from the front spar to the central one.

Cement

I have not previously said anything regarding the adhesive to be used for making all the joints throughout the machine. This cement should be of the cellulose type; either Durofix or Necol are both good. One mere touch of the cement on the wood is not sufficient when making a joint, as would be the case if one were using glue or secotine. It is necessary before assembling, say, the fuselage, to apply on every part where a joint is to be made at least one good coat of cement. Every end of strut and bracing should be so treated. Personally I should prefer to take some of the cement and thin it slightly with a little amyl acetate. Paint this with a brush upon the surface to be jointed, let it dry thoroughly and then apply cement in full strength: again allow to dry and when the joint is about to be made put on a third application of the cement. The object of the thinned first coat is to ensure that the cement soaks thoroughly into the grain of the wood. If these precautions are observed no joint in the machine will be any weaker than the wood itself on each side of the joint. I would suggest that where the end of a piece has to butt up to another, such as where the ribs fit on to the main spars and have not a very big holding surface, the cement be applied freely so as to almost form a fillet in the angle.

Paper Covering

The material with which the fuselage, wing and tail unit are all to be covered is Japanese tissue, cemented where necessary and afterwards doped to render it taut. It is advisable not to apply too much of the dope, or distortion of the surfaces, due to shrinkage, may result.

Wheels and Undercarriage

The undercarriage struts are the only wooden portions of the machine which are not made from balsa wood. These may be of either birch or split bamboo. They are shaped to streamline cross section. The wire at the top, which is continuous for both the struts and the two pieces for the axles, is lashed to the wood with very fine tinned iron wire and touched with solder.

For the wheels two discs of balsa are cut ⅛ in. thick. These are glasspapered away all around the centre, where the full thickness is left, to about $\frac{1}{32}$ in. thick at the edges. The centre is bushed with a round bit of very hard wood or bamboo, drilled to make an easy fit on the wire. They are kept in place by a small washer soldered on.

The Air Screw

This will be carved approximately to shape with a razor blade, but the final shape will best be given to it with glasspaper glued on to a strip of wood and used as a file. Several of such strips should be prepared with both No. 1 and No. 0 paper. The pitch angle at the tip of the blade will be approximately 26 degrees. This will apply both to the large and the smaller propellers, whichever machine is made. The mechanical arrangement for free-wheeling of the propeller will, I think, be obvious from Fig. 2. The device is the usual one adopted by aero modellists. Care should be taken to thoroughly solder the spiral coil, which ends in the driving hook, to the propeller spindle.

When taking the machine out for flight it is just as well to have a duplicate or spare propeller, and to facilitate changing them I have shown a nut screwed on the end of the spindle. Each spare propeller should be fitted with the angular pin which engages with the driving loop or hook.

E. W. T.

THE SOCIETY OF MODEL AERONAUTICAL ENGINEERS

Competitions to be held during 1934: PILCHER CUP (Duration), Blackheath, August 12th at 3 p.m.; Three Prizes. SIR JOHN SHELLEY CUP (Power Driven), Fairey's Great West Aerodrome, August 26th at 3 p.m.; Three Prizes. LADY SHELLEY CUP (Seaplane), Danson Park, Bexley Heath, September 15th at 3 p.m.; Three Prizes. C.S.S.A. CUP (Speed), Golders Green, September 30th at 10 a.m.; Three Prizes. FRESHMEN'S COMPETITION, Wimbledon, October 6th at 3 p.m.; Three Prizes. VISITORS' OPEN COMPETITION, Wimbledon, October 6th at 3 p.m.; One Prize.

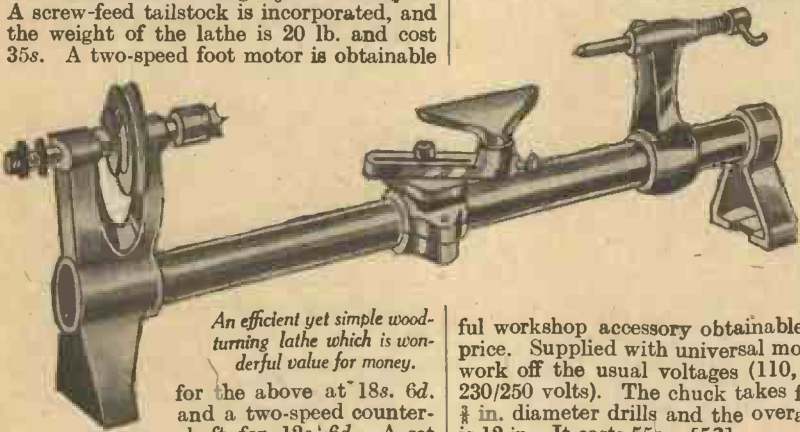
There is also the OPEN PHOTOGRAPHIC COMPETITION for photographs of model aeronautical subjects. *Extract from Competition Rules:* All fuselage models entered for competitions or record breaking must be fitted with a body complying with the following formula: Minimum value of maximum cross sectional area

$$= \frac{(\text{Overall length of Model})^2}{100}$$

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

A Wood-turning Lathe

THE lathe shown on this page is a really fine piece of workmanship. It has 3-in. centres, 14 in. between centres, and a 1¾-in. bright tubular steel bed, the total length of which is 24 in., overall length 26½ in. The headstock spindle is fitted outside with washers and nut to take sanding or grinding wheels. It is also fitted with a two-speed grooved pulley for ¼ in. or 5/16 in. belting, the inside diameters of the pulleys being 1⅝ in. and 2¾ in., and the outside diameters being 2⅛ in. and 3¼ in. A screw-feed tailstock is incorporated, and the weight of the lathe is 20 lb. and cost 35*s*. A two-speed foot motor is obtainable for the above at 18*s*. 6*d*. and a two-speed countershaft for 12*s*. 6*d*. A set of six turning tools cost 4*s*. 3*d*. [49]


An efficient yet simple wood-turning lathe which is wonderful value for money.

The "Albec" Chain Wrench

THE sketch at the bottom of this page shows an extremely useful wrench for gripping pipes, etc. One of the advantages of this tool is its smallness, which makes it very suitable for home use. It is obtainable in three sizes, the 5-in. costing 1*s*., 8-in., 2*s*. 3*d*., and the 11-in., 4*s*. 6*d*. [50]

An Ingenious Bolt Anchor

A BOLT anchor is now obtainable on the market, which enables exceedingly strong fixings to be obtained for bolts in practically any kind of really hard material, such as rock, brick, concrete, etc. The anchor is all metal, and is therefore unaffected by atmospheric conditions. Thus it can be fixed in water should this be necessary, this feature being a great asset. The bolt anchor is made in sizes ranging from ¼ in. to 1¼ in., and the depth to which they should be fixed varies according to the kind of material in which the fixing is to be made. The ¼-in. size costs 6*s*. dozen, the price varying for the other sizes. [51]

Midget Scribing Blocks

THE design of the block shown permits of its use as a depth gauge with an ordinary scriber fitted, but a special flat-end rod, other end J-shaped, can be supplied at 6*d*. for 9 in. and 1*s*. for 12 in. This applies to both plain and sensitive adjusting blocks, the scribers and depth gauge rods being interchangeable. The price of the scribing block shown is 4*s*., but with a 12-in. scriber in place of the 6-in., 3*d*. extra. [52]

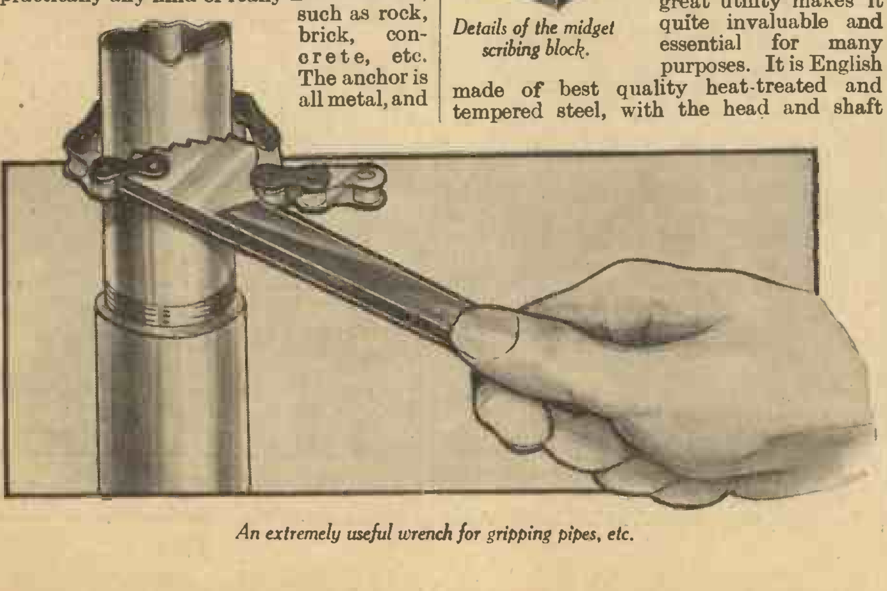
An Electric Hand Drill

DRILLING holes by means of an ordinary hand drill is generally a tiresome task, but this job can be made an easy one by using an electric drill similar to that shown in the sketch. It is a very useful workshop accessory obtainable at a low price. Supplied with universal motors they work off the usual voltages (110, 200/220, 230/250 volts). The chuck takes from 0 to ⅜ in. diameter drills and the overall length is 12 in. It costs 55*s*. [53]

A Handy Combination Tool

A COMBINATION tool that acts as a hammer, hatchet, nail extractor and case opener is now on the market, and its general handiness, low cost, and great utility makes it quite invaluable and essential for many purposes. It is English made of best quality heat-treated and tempered steel, with the head and shaft

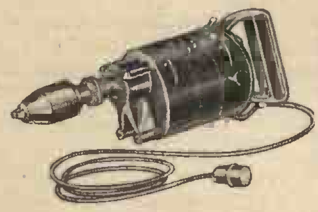

Details of the midget scribing block.


An extremely useful wrench for gripping pipes, etc.

in one solid piece, and a well-riveted polished wooden handle. It is 1½ lb. in weight, and will withstand the hardest usage for many years, in fact, with fair use will prove practically indestructible, and costs only 3*s*. 9*d*. [54]

A Triple-grip Adjustable Spanner

A TRIPLE-GRIP adjustable spanner known as the "Albec" and shown on this page should prove an ideal tool for the handyman. It is an extremely strongly made spanner which grips three faces of the nut and thus ensures a firm hold. The spanner takes up to ½ in. Whitworth and costs 3*s*. 9*d*. [55]



This reasonably-priced electric drill will make a useful workshop accessory.

A strongly-made spanner which grips three faces of the nut.

The "Wesco" Oil-can

ONE of the latest developments of the oil-can is shown in the sketch on this page. It has a solidly-made container which holds approximately ½ pint of oil.

A broken view of the "Wesco" oil-can showing how the oil is ejected.

The oil is fed under pressure by depressing the trigger above the handle. It is obtainable in a copper lacquer finish or in enamel and is marketed at 4*s*. [56]

The Instantus Standard Size and Thread Table

OUR readers will find extremely useful the Instantus Standard Size and Thread Table which has been compiled by Cyril Best for engineers, draughtsmen, and mechanics. It costs only 6*d*., and consists of a fourfold card 17½ in. long and 2¼ in. wide, which folds up to a vest pocket size of 2¼ in. by 4¼ in. This ingenious table gives fractional sizes, and equivalent wire gauges, millimeter sizes, decimal sizes, tapping sizes for B.A., Whitworth, brass, and millimeter, threads per inch, and clearing size for B.A. and Whitworth, brass and millimeter, as well as gas, clearing sizes. It is printed on a durable cloth-centred card, giving at a glance approximately 3,000 references. [57]

MODELLING RAILWAY FREIGHT

(*Continued from page* 381).

Suitable Freight

In the drawing I give sketches for twenty different articles to a proper scale for 00 gauge, many of them entirely novel in character. These are as follows: (1) A large casting for a well waggon, consisting of an iron pipe fitting. It should be painted red oxide and fixed down with fine ship's cable. (2) A galvanised iron tank made from a passe-partout tape spool or a piece of dowelling, covered with galvanised iron paper or painted aluminium colour, with a black circle on one end for a manhole. (3) A barrel made from a wooden bead bought at a department store. The bead is forced on to a match stick, the ends cut off and the hoops drawn in Indian ink. (4) A case of machinery from a bit of stripwood with battens of very thin wood stuck around it and the planks lined on. Observe the white paper label. (5) A roll of lino from a piece of thin dowelling covered with brown paper wired on. (6) Case of glass. (7) Bale of jute. (8) A drum of cable made from two ends of a Kodak spool fixed on a short piece of the core, paper sides lettered in ink, yellow and white paper being used; the wood slats on the circumference are formed of a piece of thin three-ply wired on and lined in ink. (9) Milk churn. These can be made from Halma men or from tapered dowelling, wire handles, the whole painted aluminium. (10) Container. There are so many types that it would be well to copy the lettering from a photo. Imitation strapping is fitted. (11) A cart wheel. (12) A wheel from a toy tractor. (13) Iron field gate. These are very easily made, but do not make them too big. They are soldered up from wire and painted flat white. (14) Loads of timber from stripwood wired together; the ends should be square but uneven. (15) A ship's boat, made from a piece of soft wood properly shaped and sheeted with brown paper, a line of gold paper stuck around it and the body painted white. (16) Bundles of iron pipe from lengths of cage wire. (17) Logs of timber from bits of garden trees sawn evenly. These keep their appearance for years. (18) A box of oranges. Two square wood ends, thin strips for the slats, filled with suitably coloured beads. (19) Large Stanton pipes made of cardboard or from small cylinders taken out of disused dry pocket batteries. (20) Sacks of flour from putty, shaped and set hard, with small wood pegs stuck in, painted white and lettered with red ink.

Ready-made Commercial Lines

I have not troubled to sketch the various articles which can be bought as ready-made commercial lines. But there are large numbers of these which serve ideally. I may mention Tootsietoy motor cars, which are made in America and sold in all the fancy shops here; earthenware sinks from Reeve's empty water-paint containers, these being of white porcelain gloss. They may be packed inside each other with finely-cut straw. Screened coal is also excellent, if sieved through a piece of mosquito netting and washed. The same applies to granite chips or bird grit. A model ship's propeller is also good if not too large, and may be loaded on a well waggon. By using Merco brick paper it is also possible to make a good-looking load of bricks by covering a piece of correctly sized stripwood with the paper. Bricks are always loaded on waggons carefully stacked.

No doubt there will be scores of other items which will present themselves to enthusiasts. One important item that should be mentioned is that of loading proper goods on correct waggons. For guidance in this particular I can only refer the reader to actual observation and the study of railway literature like brochures giving illustrations of freight waggons, as well as the various magazines. The same remark applies to the correct slinging and binding down of large loads, which is of great importance.

TRANSMITTING FILMS BY TELEVISION

(*Continued from page* 351).

Real High Definition Television

Complete details of the whole scheme have been furnished in the television supplement of "Practical Wireless," but the tele-cine side will be described here to indicate the path taken in this section of the progress of television. The first indication of the experiments was furnished by the demonstrations given to the British Association meeting held at Leicester in September, 1933. The gathering of scientists was initiated into the intricacies of 120 line horizontal scanning, standard British talking films being used. In March of this year, however, a 50 per cent. increase in the scanning lines materialised, and in Fig. 8 is shown one of the tele-cine projectors actually employed, while Fig. 9 gives a schematic diagram of the process as far as the transmitting side is concerned.

First of all the machinery controlling the feed of the film from the spool produces a continuous movement, and there is no shutter action at all. Located behind the "gate" is an arc lamp and lens which throw a beam of light on to the moving film so that the moving individual pictures can be focussed on to a small top area of a rotating disc. This disc is driven at the high speed of 3,000 revolutions per minute, and a circle of ninety minute holes, having a 4-degree angular separation, is punched near the outside edge.

The rate of the film feed gives twenty-five pictures passing through the gate in one second, and, as the disc rotates 50 revolutions per second, two complete revolutions of the disc take place for every single film picture passing down the gate. During the course of the movement, therefore, the picture is scanned or broken up into 180 horizontal lines. The disc is housed in a dustproof metal casing and the variations in light due to the scene on the picture pass right through the disc scanning holes as each hole makes its horizontal movement across the picture. Immediately behind the scanning section of the disc is another lens (seen clearly in Fig. 8) and a single photo-electric cell and amplifier (not shown in Fig. 8). The light variations focussed on to the cell are converted into voltage variations and amplified to be transferred to the receiving end by an ultra-short wave radio link.

At the same time a single small projection lamp and associated photo-electric cell, located at another section of the scanning disc, produce the synchronising impulses which are transmitted on the radio television channel to be filtered out at the receiving end to give the necessary formation of the image area on the viewing screen.

Finally, concurrent with the production of the television and synchronising signals, the talking film is passed through a standard sound head (seen near the bottom right-hand edge of the arc casing in Fig. 8) so that the sound can be "picked up" from the track at the edge of the film just inside the sprocket holes and transferred to the receiving end for reproduction in the loud speaker.

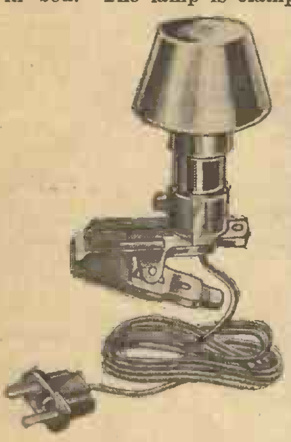
(*To be concluded next month.*)

The LATEST Novelties

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

An Ingenious Book Lamp

THE splendid little lamp shown in the illustration on this page is ideal for that laze in an easy chair or for reading in bed. The lamp is clamped to a book, and no other light is necessary in the room, unless it is particularly desired. The shade of the lamp clips on to the bulb and swivels ingeniously. It is obtainable in four colours—red, green, oak and mahogany. The lamp uses a low-power 15-watt bulb with small bayonet cap fitting, and these bulbs can be obtained separately from the makers if so desired. The lamp and bulbs cost 9*s*. 6*d*. [52.]



A small lamp which can be clamped to a book which is ideal for reading in bed.

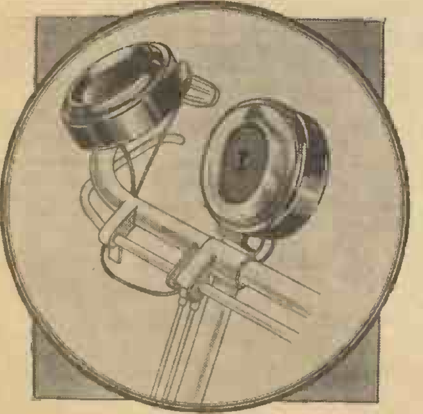
An aluminium line and surface level suitable for laying brickwork, pipe-lines, etc.

A Line and Surface Level

THE surface level shown, and known as the Rabone Aluminium Line and Surface Level, weighs only ½ oz., and can be used on a line, as shown in the sketch, which makes it suitable for laying brickwork, pipe lines, ascertaining gradients, etc. It can also be used as a surface level if so desired. It costs 1*s*. 10*d*. [53.]

A High-frequency Cycle Horn

THIS high-frequency horn for cyclists is a thoroughly efficient and attractive accessory, highly finished in ebony black and chromium. It is fitted to the cycle under the handle bar expander bolt, and for machines which do not allow of this fitting, a clip for handle-bar fixing can be supplied at 3*d*. each. It is operated by a standard pocket lamp battery, is entirely weatherproof, instantaneous in action, and being of a high-pitched and penetrating tone, it is unlikely to be ignored. This model, which is known as Model No. 2, is compact, the neatly combined battery container and switch taking up no more room than the ordinary cycle bell. The whole fitment takes up little space on the cycle, the added weight is negligible, whilst the consumption of current is very small. It is obtainable for 5*s*. 5*d*. complete with battery, or 5*s*. without battery. [54.]



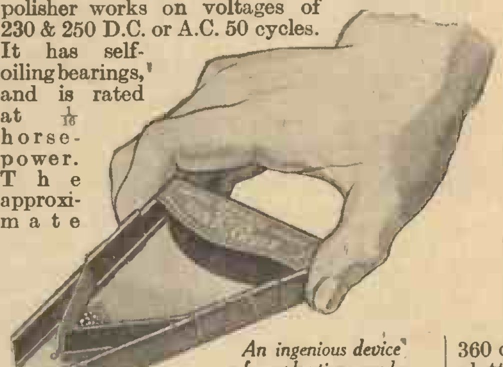
This high-frequency horn for cycles is a thoroughly efficient and attractive accessory.

The "Everyman's" Seed Sower

THE sowing of seeds is always a tiresome job, and invariably they are not planted systematically in the earth. An ingenious device which has recently appeared on the market facilitates this job, as will be seen from the sketch. The adjustable arm allows various sizes of seed to be used. It costs 1*s*. [55.]

An Electric Grinder and Polisher

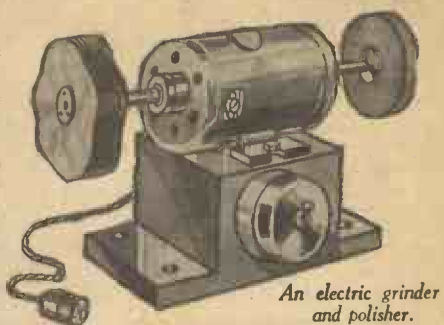
THE electric grinder and polisher shown is obtainable complete with a 3 in. × ½ in. emery wheel and 4 in. × ¾ in. by 38 folds calico buff, as well as 6 ft. of twin flex and plug. The spindle is $\frac{5}{16}$ in. in diameter, and the polisher works on voltages of 230 & 250 D.C. or A.C. 50 cycles. It has self-oiling bearings, and is rated at $\frac{1}{16}$ horse-power. The approximate consumption averages ½ ampere, and the wattage 100. It costs 52*s*. 6*d*., or on a 36-in. floor pillar, 60*s*. [56.]



An ingenious device for planting seeds systematically.

The "Home Finder"

CAN you see the number of your door in the dark? If not, you should certainly fit one of the signs shown on the illustration on this page over your doorway. This sign consists of a bronze metal-finished casing containing a B.C. holder and 5-watt lamp, as well as chains and fixing hooks. A glass panel is attached, on which is engraved the number, name, or both, of your house, and being illuminated from the top throws into prominence the wording only. Anyone can fit the sign in a short time by means of a plug switch and a few yards of twin cable, it only being necessary to replace the hall switch with same, and if the sign is not required to be lit to take out the plug. The sign and number costs 17*s*. 6*d*., the number only 12*s*. 6*d*., the plug switch 2*s*. 6*d*., and twin rubber wire costs 4*d*. a yard. [57.]



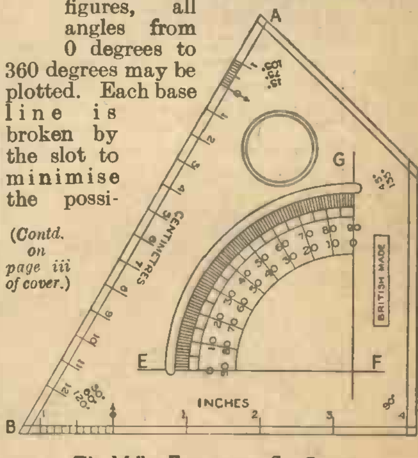
An electric grinder and polisher.

A Four-in-one Set Square

THE device shown below combines in one instrument the functions of a 60-degree set square, a forty-five-degree set square, a protractor and a scale. Made of first quality specially seasoned celluloid, it is simple to manipulate, convenient to carry inside most geometry text-books, and will not break unless wilfully misused. The protractor consists of a graduated arc slot E.G. with two base lines, E.F., F.G., and two sets of figures. By means of the appropriate base lines and set of figures, all angles from 0 degrees to 360 degrees may be plotted. Each base line is broken by the slot to minimise the possi-

(Contd. on page iii of cover.)

An illuminated sign for fitting over the doorway of a house so that the number may be seen in the dark.



The Miller Four-in-one Set Square.

What the Clubs are Doing

Club Reports for inclusion in this feature should not exceed 250 words in length, and should be received not later than the 10th of each month for inclusion in the subsequent month's issue.

NEWCASTLE MODEL AERO CLUB

AT the Annual General Meeting, held recently, the following Officials were elected: President, A. L. Rimer; Vice-President, C. W. Lutman; Secretary, D. G. Brown; Treasurer, A. E. Brough; Assistant Treasurer, R. Embleton; Committee: Messrs. Pierson, Nicholson, Whillis, Arnold, Markham, Phillipson, Cook, Walker.

It was arranged that one Open and two Closed Competitions be held during the forthcoming year, the first of which is to be held on May 5th. The Competition is to be an Open one for Fuselage models, the aggregate time of duration for two hand-launched and two R.O.G. flights to be taken.

The Newcastle Model Aero Club's Workshop.

Full particulars regarding the Club and the Competition may be had from the Secretary, 39 Fairfield Road, West Jesmond, Newcastle-upon-Tyne.

STREATHAM COMMON MODEL RAILWAY CLUB

ALL meetings of this club are held at 201 Gleneldon Mews, Streatham High Road, S.W.16, on every evening from 6.30 p.m. to 10.30 p.m. We welcome any readers of "Practical Mechanics" to any of our meetings.

Meetings during May are as follows:—

Mondays, Wednesdays and Thursdays are devoted to Track Nights; Tuesdays and Saturdays to the Workshop; and Fridays to lecture and visits. A full list of lectures, etc., can be obtained from the Secretary.

The latest issue of the Club Magazine "The Rocket" is now available, and can be obtained from the Secretary, price 5d., post free.

The latest issue of "Concerning Ourselves" will be sent post free to all interested. It is a four-page publication giving particulars of the Club, subscription rates, etc., etc.

On March 15th we had a very interesting talk by Mr. Burroughs from the West Essex Model Railway Club on the "Tiptree, Kelvedon and Tollesbury Light Railway." This is the first lecture we have had since we started the "inter-change of talks" between other model railway clubs. We should be pleased to do the same to any other Model Railway Club living reasonably near London.

For any other particulars, please apply to the Secretary, Brooke House, Rotherhill Avenue, Streatham, S.W.16.

INSTITUTE OF SCIENTIFIC RESEARCH

ON March 3rd a meeting of the above section was held, at which R. S. Gander, Esq., gave an interesting lecture entitled "Evolution of Life." He first outlined the formation and gradual development of life on the earth, then dealt with the evolution of man from monkeys, and concluded with an account of the development of man himself.

On March 17th a visit was paid by the entire Club to Crossgates' Automatic Telephone Exchange. A description of this visit, however, appears in the report of the Radio Section in PRACTICAL WIRELESS.

The next meeting of the Physics and Chemical Section will be on May 5th, at which F. Underwood, Esq., will give a lecture entitled "Egyptology."

Forthcoming lectures are to be on such subjects as "The Manufacture of Ammonia," "Electricity in the Home," "Time and its Measurement," etc., and forthcoming visits are to such places as the printing works of the *Yorkshire Evening Post*, Leeds General Post Office, Leeds Broadcasting Studio, etc.

Readers of PRACTICAL MECHANICS are cordially invited to attend both meetings and visits of the Club, further details of which can be obtained from the Hon. Secretary, Mr. D. W. F. Mayer, 20 Hollin Park Road, Roundhay, Leeds 8

BOOKS worth READING

The Aircraft Modellers' Guide

BY HOWARD LEIGH. *Price* 2*s.* 6*d.* 107 *pages, fully illustrated. John Hamilton Ltd.*, 32 *Bloomsbury Street, London, W.C.*1.

This book, which should be on the bookshelf of every model aeroplane enthusiast, is divided into two sections, the modern and the historical. The modern section contains a description of thirty of the fastest machines, and the historical section deals with twenty of the machines used mostly for aerial combat during the Great War. A brief summary is given of each plane on its history and performance, and also drawings are supplied to enable a scale model to be made of each.

Motorless Flight

Edited by J. R. ASHWELL-COOKE. *Price* 7*s.* 6*d.* 149 *pages, well illustrated. John Hamilton, Ltd.* 32 *Bloomsbury Street, London, W.C.*1.

Gliding as a sport is rapidly gaining in popularity, and Mr. Ashwell-Cooke (Chairman of the London Gliding Club) has recently produced the above book for all who aspire to become soaring pilots. The book consists of nine parts, each written by an expert on the subject. Apart from being a book of instruction, it deals with other phases of this sport, as will be gathered from the following chapter headings: The English Gliding Movement, General Considerations, The A.B.C. of Gliding, Gliding and Soaring Flight Tuition, Construction: Repair and Maintenance of Aeroplanes and Gliders, Automobile and Aeroplane Towing, Elementary Aerodynamics, and Meteorology. A list of gliding clubs with the secretary's name and address is also given at the back of the book.

Converting a Business into a Private Company

By HERBERT W. JORDAN. 50 *pages. Price* 1*s.* 6*d. Jordan & Sons Ltd.*, 116–118 *Chancery Lane, W.C.*2.

This practical little book, full of useful information, answers the question frequently asked as to the precise advantages which carrying on a business as a company possesses over personal ownership. It explains shortly and clearly, in language easily read and easily understood, the process of "conversion" for the business man. It describes step by step the exact procedure which has to be followed from the time the owner of the business has arrived at the decision to turn his business into a company until the completion of the transfer of the business to the company. A typical case is taken and dealt with under such heads as "The Formation of a Company," "Cost of Formation," "Memorandum of Association," "Articles of Association," "Transfer of Business to Company," "Further Documents," and "Obtaining Additional Capital." The price of the Tenth Edition is 1*s.* 6*d.* nett, by post 1*s.* 8*d.*, and the book may be had of the publishers or any booksellers.

MODELLING HISTORIC LOCOMOTIVES—Part I.

(*Continued from page* 379.)

power. After that certain time the broad gauge stood still, although it was not until long after the broad gauge was abolished that the engines of the standard 4 ft. $8\frac{1}{2}$ in. gauge equalled those of the broad in the matter of speed, cylinder size and boiler heating surface, all combined. In fact, in this country it is only in recent times that the heating surface has been exceeded.

Great Western Design

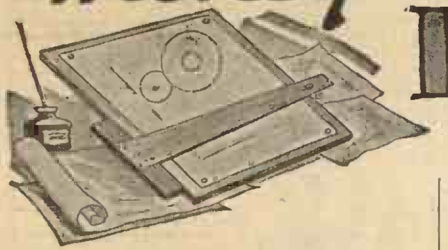
There is a third reason why I have decided to follow Great Western design: I have a very great admiration for the work of Robert Stephenson, son of the great George Stephenson. In his "Planet" class of engine, of which I shall give a drawing later, Robert Stephenson introduced his system of outside sandwich framing and, although he departed from it in, what are known as, his "Long boiler" engines, he reverted to it later and introduced it to Daniel Gooch (afterwards Sir Daniel) on the Great Western Railway in the "North Star," also to be shown later in a drawing. Other engines followed the "North Star" from the Stephenson works, and so successful were they that Gooch and his successors adopted the sandwich frame and made it their standard practice. Engineers of other railways used it, but to nothing like the extent nor for such a long period as those of the Great Western. As recently as 1889 the late William Dean built at Swindon twenty engines of the 2–4–0 class, all with the same type of frame. Of these engines, through the courtesy of Mr. C. B. Collett, the present Chief Mechanical Engineer at Swindon, I shall be able to give the reader a drawing. Mr. Collett informs me that no less than ten of these locomotives are still running, reboilered, of course; and thus we have a link between the present day and the year immediately following the "Rocket" of 1829, for the "Planet" engine was built in 1830, over 100 years ago! Surely a great testimonial to the soundness of Robert Stephenson's abilities as a locomotive designer.

Size and Power of Engines

But it is time that I proceeded with the main object of these articles: the tracing of the gradual increase in size and power in the engines which, from time to time, were designed and built to meet increasing traffic demands. I would merely add here that of only one example which I shall give, after the "Rocket," do I know of the existence of a perfectly correct model, excepting, of course, the full-size replica of the "North Star" which the Great Western Company themselves built about ten years ago, and which is now in the Railway Museum at York. So there is a field for the activities of model makers even if only old Great Western engines are copied. The correct model referred to is illustrated in Fig. 2. Space will at present allow of side elevation drawings of the engines only being reproduced, but should any reader decide to build and need end elevations as well I will gladly give them if he will advise the Editor of his wish.

At the conclusion of the series I propose to give a brief list of noteworthy engines of lines other than Great Western, engines of outstanding merit in design and efficiency, and of none of which are there any models to perpetuate their proportions and appearance. Should any of these appeal to the intending model maker I can, in many cases, put them in the way of obtaining drawings and/or other data from which to work.

Money Making IDEAS



SUGGESTED BY OUR READERS

A Safety Device for Lorries, Cars, etc.

"I am a fitter of twelve years' experience. Having witnessed several bad accidents owing to the engines of heavy motor lorries stalling on steep hills, and when the driver has released his brakes it has run backwards with disastrous results, I would like your patent expert's views upon an idea of mine for preventing such disasters. My idea is absolutely sure in action, can be engaged by the driver at the bottom of a hill, and can be put out of action by moving a small lever by hand or foot. It will hold the heaviest lorry perfectly still in the event of the engine stalling. It can be applied to private cars, is not costly to produce and is light in weight." (J. S., Pontefract.)

The idea of providing means of preventing motor road vehicles from running backwards on a steep hills should the engine or transmission gear fail is not broadly novel. In the early days of motor road vehicles it was common practice to provide a mechanical sprag to guard against the above contingencies, but it is not thought to be in use to-day. One such construction of mechanical sprag comprised a ratchet wheel fixed on the rotating axle or hub of the driving wheel, the ratchet wheel being adapted to be engaged by a pawl carried on a fixed part of the frame so as to prevent the axle or wheel rotating in a backward direction.

As the inventor has not given any details of his invention, or even the way he proposes to effect the object in view, it is not possible to advise him whether his invention is such as to be likely to be patentable.

An Improved Type of Envelope

"I have thought of an idea which I think is an improvement on the usual type of envelope. It is only necessary to pull up a tag when opening the envelope. No tearing with fingers, or paper knife being necessary. I do not think it will be very difficult or expensive to manufacture as it only consists of a length of twine and a paper tab." (M. Downing, London, N.1.)

The improved envelope failed to function in the manner intended possibly due to a fault in the twine. However, the sample is sufficient to illustrate the possibility of the invention; unfortunately the idea is known to be very old from personal knowledge. It was probably first Patented about fifty years ago and since then many Patents have been applied for, but none so far as is known has been a commercial success. The inventor is advised not to spend any money in either protecting the idea or trying to commercialise it.

If he is still anxious to verify the advice as to novelty, he is advised to search amongst prior Patent Specifications for the past fifty years.

Automatic Machine Game

"I have an idea for a new automatic machine game, and although the game itself is quite different from any adopted to automatic machines, the mechanism for the coin in the slot, delivery, and propelling the balls, is practically identical with some of the models already on the market. Is it possible to obtain a patent for this, and if so would it be advisable to apply as a novelty or an improvement to existing patents?" (L. Lance, Lancing.)

A coin freed machine for playing a game is fit subject-matter for Letters Patent, provided it is novel and the use of the machine is not contrary to law; that is to say, under Section 75 of the Patent Act the Comptroller has now power either to refuse the grant of a Patent for an invention any particular use of which would, in his opinion, be contrary to law, or to require, as a condition of granting a Patent, the insertion in the specification of such disclaimer as respects that particular use of the invention or any such other reference to the illegality thereof as he thinks fit.

Without further particulars of the invention it is not possible to advise the inventor as to whether his invention is a patentable one, nor to express any opinion on the novelty without first making a search amongst prior Patent Specifications of coin freed machines. If, as would appear, the invention consists primarily in the game and not the actual mechanism, it is probable that the use of the mechanism would be an infringement of an existing Patent or Patents.

A Cigarette Ash Holder and Stand

"I have produced a little gadget which clips on to a cigarette holder and collects falling ash at every angle up to vertical. It is also a complete 'stand' so that the holder may be rested on a table, etc., without danger of burning. Its usefulness is obvious and I would like to have your advice regarding the patenting such a gadget." (W. L., Abonkin.)

Provided the suggested "gadget" is novel, it should form fit subject-matter for protection by Patent. It is not, however, thought to be broadly new and before the inventor applies for a patent he is advised to make, or have made, a search amongst prior Patent Specifications relating to such devices, and since it is believed that a cursory search would be sufficient, the expense should be less than that of filing an Application for Patent with a Provisional Specification.

A Danger Light for Cars

"I have thought out a simple danger light for cars that reflects the word Stop in red on the road at the back of the car. The words measure 3 feet by 18 inches. This could be manufactured at less than a shilling. Could you tell me if there is any value in it." (T. R., Peckham.)

The object of the inventor is apparently to project a word such as "stop" on to the surface of the road at the rear of a motor car to give warning to vehicles approaching from the rear. It is very doubtful if there is any commercial value in this invention. Unless an invention can be protected in some way the commercial value is usually small. In the present case it is not thought to be possible to obtain a patent which would be of much value, since, besides novelty, subject matter is essential for a valid patent. It will be obvious that the only subject matter of this invention must reside in the particular means or apparatus employed to effect the purpose in view, and on this point the inquirer is silent.

There can be no invention *per se* in projecting a lighted transparency on to a surface, whether that surface be a road or a sheet or screen, as is more usual.

A further drawback to the use of the invention over the existing illuminated signs for the same purpose, is that it would only be visible at night, and then probably only on such roads that reflected light.

Detachable Heels for Shoes

"I enclose details of a prov. patent of mine, the idea being to replace worn heels, especially those of ladies' shoes—spares of which could be carried in a handbag, and attached when needed. I have tried several shoe manufacturers and they have all turned it down, without giving any reason. I have been considering whether it would be worth while making them myself and disposing to repairers. My wife has tried them (made very crudely) and they were successful.

"Your advice on whether it is worth while proceeding with it, and how to go about it, would be appreciated."—(E. Hines, Manchester.)

The Applicant has apparently filed two Applications for Patents, for his invention relating to detachable rubber heels and has failed to interest shoe manufacturers in the invention. Had the inventor obtained competent advice before incurring the expense of applying for Patents, he would have been advised to make a cursory search amongst prior Patent Specifications for such articles, and it is more than probable he would have found that even the exact construction is no longer novel. Be this as it may, it is known from personal knowledge that no broad Patent for such devices can be obtained at the present time. It is possible that a Patent might be obtained for some small constructional detail, if novel, and more useful than known devices, but the commercial value of such a Patent must be extremely small, and it is unlikely that any shoe manufacturer would place it on the market.

Seeing Through Fog.

"Enclosed are a few particulars of an instrument designed for the purpose of seeing through fogs. As can be seen, it is supposed to work in the infra-red region of the spectrum and is electrical in nature. Do you think the device would work? The diagram is only a theoretical one."—(J. H. Rees, Carmarthenshire)

The proposed instrument for utilising infra-red rays for the purpose of seeing through fogs discloses *prima facie* subject-matter for protection by Letters Patent. The inventor is, however, advised to submit his invention, in confidence, to an expert in such matters for an opinion on the practicability of the invention. As the invention at present is only in the theoretical stage, it would be as well to have expert opinion before either constructing apparatus to prove the correctness of the theory, or attempting to obtain protection. It appears feasible, but on such a highly specialised subject only the opinion of an expert in the subject is of any real value.

REPLIES TO QUERIES & ENQUIRIES

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

A Chemical to Ignite Gas

"COULD you please name the chemical or chemical combination which, when held in ordinary coal gas, becomes hot enough to ignite the gas? I believe this chemical is the same as in the element part of a petrol vapour heater sold as a means of keeping a motor engine from freezing." (L. T., Beds.)

The property referred to is possessed by finely divided platinum. Platinum sponge is used on certain gaslighters. This is made by igniting ammonium chloroplatinate. Platinum black is also used. This is made by dissolving zinc in chloroplatinic acid.

Splitting Oxygen and Hydrogen

"Can you tell me the best method to split water into oxygen and hydrogen by electricity? Also what voltage is required? What would be the effect of compressing the resultant gases, say in a ratio of 4½ to 1?" (A. D., Watford.)

The electrolytic decomposition of water is simply accomplished with either carbon or platinum electrodes partially immersed in acidulated water. On passing a current of electricity, hydrogen is liberated at the cathode (the negative pole) and oxygen at the anode. The voltage should not be unduly high, nor should a heavy current be passed, otherwise the electrolyte will very quickly boil. Published figures relating to the current passed and temperature rise are not available, but it may be assumed that half an ampere at 12 to 20 volts should not be exceeded. I have found it possible to boil a pint of water in about half a minute at 200 volts pressure and an ammeter deflection of 2.

There would be no chemical effect by compressing the mixed gases in this ratio, although if a spark were passed through the mixture under this compression the explosion might be more violent.

English Correspondent Required

I. D. Peterson, Egevang 2 Brk, Copenhagen, Denmark, would like to correspond with an English boy or girl about seventeen years of age.

Making a Spot Light

"Could you give me any information on how to make a Spotlight which would work with a 500 or a 1,000-watt Projector type lamp, for use at an amateur theatrical show?

"What I have in mind is to use a 6-inch condenser lens with a tubular type vertical lamp. Do you know any firm who make these lamps who would supply details, and also who make the complete spotlight?

"If you could kindly give me any particulars, I would be much obliged, so what I want to know is: How are the reflectors fixed and focussed with regard to the lamp and the lens?

"What size should the casing be? How should it be wired up?" (F.F., Bolton.)

A single plano-convex lens is required, and this should be not less than 3 in. in diameter; the case for the light may be a large biscuit tin, painted black inside, or a box built up from sheet asbestos and small angle irons. The tin is suitable for lamps up to 500 watts, and the asbestos box for anything over this; the lens is mounted in the bottom of the box and the top covered with a piece of heavy cloth; if the lid is replaced, then a ventilating chimney must be made in the uppermost side. The lamp is mounted in a suitable holder, on a block of wood at the focal point of a concave mirror; the spot is focussed by moving the lamp and mirror to and from the lens. The lamp and mirror are both mounted on the same block of wood. Connection should be made to a power plug through good quality flex; a switch may be placed in circuit near the box. To change the size of the spot, card screens with various holes in them should be placed in the path of the beam inside the box; a sliding arrangement can be made for this similar to the apparatus on a lantern. To change the colour of the beam a slide should be mounted outside the box in a position where the heat from the lamp will not distort the celluloid.

Messrs. Kodak Ltd. supply pure colour celluloids.

The B.T.H. Company supply all types of projector lamps up to 3,000 watts. Messrs. Electradix Radios supply complete spot outfits and lamps, etc.

Colourless Varnish Correction

In our February issue, page 247, appeared a small par. under the above title. One of the commodities for making the varnish was stated to be Rectified Alcohol. This was a printer's error, and should have read Rectified Spirit.

Smoke and Fire Stage Effects

"I wish to produce quantity of *smoke* and a little *fire* in a play which is to be staged by an amateur dramatic society.

"The fire is seen through a glass door, and the smoke is to pour through the door when it is opened; the whole to last for about three minutes.

"Could the smoke be produced by chemical means? As the smoke must clear away before the next act." (A. R., Glamorgan.)

FIRE. The most convenient way of producing a stage fire is to make a large mound of common salt on a metal tray. This is saturated in methylated spirit and ignited. The spirit burns with an intense yellow glare, which under the conditions correspondent mentions could be made to resemble an alarming conflagration. This method is quite safe, but it is worth while taking the additional precaution of standing the tray in a larger tray containing water.

SMOKE. Ammonium chloride fumes suggest themselves, as they readily disperse. Two saucers are obtained and immediately before the "fire" placed near the door and in close proximity to each other. Into one is poured strong hydrochloric acid, while the other contains a small quantity of ammonia. Dense white fumes will be evolved having no objectionable odour, and the supply may be curtailed at any moment by removing the saucers and contents.

A Small Hand Warmer

"Having been a regular reader of your interesting magazine since it was first published, I would be very much obliged if you could give me a little information regarding a small hand-warmer which I possess. This warmer has a tank containing petrol impregnated cotton-wool.

"Above an opening in the top of the tank is a small framework holding an asbestos-like material, which, on the application of a flame, glows for about twenty-four hours.

"The trouble is, that this material deteriorates with use, and finally crumbles away.

"Ordinary asbestos is, however, no use at all, so I have come to the conclusion that it must be some chemically prepared substance.

"I would, therefore, be very much obliged if you could tell me where I could buy, or how I could prepare, some of this material, and the approximate cost." (A. T., Cheshire.)

Although I have seen the advertisements for the hand-warmers querist mentions, I have not actually seen the articles, nor in spite of extensive inquiries have I succeeded in obtaining information regarding them. However, it seems to me that their action depends upon the property of certain platinum salts glowing when in contact with a mixture of combustible hydrocarbon vapour and air, and I feel fairly sure that the actual substance which glows is platinised asbestos. If querist really wants to make the material, I recommend that he soaks a little divided asbestos in a solution of ammonium chloroplatinate $(N_4H_8)PtCl_6$, packs sufficient on the gauze framework, and then ignites it in a Bunsen flame. With a little experimenting you should succeed in your object, providing that the expense of the chloroplatinate is no bar.

Nicotine from Cigarettes

"I shall be glad if you can tell me whether (i.) nicotine is extracted from tobacco before making into cigarettes; and (ii.) the percentage of nicotine contained in cigarettes?

"Also, would it be a practical proposition for an amateur to attempt to extract the nicotine (experimentally), and, if so, could you suggest a suitable method?" (E. R., Fulham.)

Nicotine is contained in all tobacco, and therefore occurs in cigarettes. It is combined with citric and malic acids, and occurs in tobacco leaves in proportions varying from 0·6 to 8 per cent. It is extracted by macerating the leaves with milk of lime and distilling. The milk of lime throws the nicotine out of combination with the acids, and it passes over with the distillate, whence it is recovered by ether extraction.

There is nothing about the extraction process which should present any difficulty to the amateur, providing that he has the necessary apparatus, of which the simplest form would be a Liebig condenser attached to a large flask containing the lime and tobacco leaves at its inlet end, and a small receiving flask at its other. Heat is applied to the large flask and nicotine and water pass over to the receiver. When the process is completed the contents of the receiver are shaken up with about a quarter the same quantity of ether. The etheric layer is then separated with a separating funnel and gently warmed over a water bath until all the ether has evaporated, leaving behind a fairly pure quantity of nicotine alkaloid (Poison, on Part 1 schedule). Nicotine, although an oil, is soluble in water, hence the reason for the ether extraction from the aqueous distillate.

Patent Advice

By A. MILWARD

The services of a professional Patent Expert are available free to every reader. He will advise you on the validity, novelty, and value of any idea you may have. No charge is made for this service, but the Query Coupon appearing in our advertisement pages must be enclosed with every query.

SOME EARLY PATENTS FOR INVENTIONS

(continued)

On June 18th, 1639, a Dutch Patent was granted to William Wheler for an invention relating to water-scoop wheels for raising "water to great heights by hand, horse power, wind, water or weights," and this invention formed the subject of English Letters Patent No. 127, dated June 24th, 1642.

On June 6th, 1637, King Charles I. appointed a Commission, consisting of Sir Richard Wynne, Sir Thomas Halton, Sir Henry Spiller and Lawrence Whitaker, Esq., to inquire upon oath whether Nicholas Page, or Sir Nicholas Halse, was the first inventor of "certain kilns for the drying of malt, etc." It would appear that Letters Patent were granted on April 8th, 1626 (No. 33), to Nicholas Page for fourteen years for "kilnes for the sweet and speedy drying of Malte and hoppes by the use of Seacole, Turfe, Broome, Furze, brakes (bracken), heath or any other fuell and that without touch of Smoake and very usefull likewise for baking, boyling, roasting, starching and drying of Lynnen and divers other the like conveniences all at one time and the same time with one and the same fire." It appears that another Patent for the same invention had also been granted to Sir Nicholas Halse on July 23rd, 1635 (No. 85), and the Commission was appointed to ascertain which of the Patentees was the actual inventor.

Edward Somerset

Usually credited with being a prolific inventor, but it would be truer to say an egoist, with a vivid imagination, was Edward Somerset, sixth Earl and Second Marquis of Worcester (1601–1667). In 1663 he published his fantastic work, "A Century of the Names and Scantlings of the Marquis of Worcester's Inventions," which he had written in 1653. Amongst these inventions, No. 84 is a calculating machine, and No. 68 an hydraulic machine for driving up water by fire, which is usually considered to be the first suggestion of a steam pumping engine, but there does not appear to be any real evidence that he actually ever made this invention. His description is obscure and no drawings are extant, and his engine was probably based on an invention of Salomon de Caus in 1615, or Della Porta in 1601.

It is, however, recorded that a pumping engine of about 2 horse power was set up for use in Vauxhall in 1656, but there is no clear description of this engine extant, and it has been suggested that it was not a steam engine at all, but a kind of water wheel for raising water worked by man power and forming the subject of invention No. 100 in his "Century of Inventions," which the Marquis described as "the most stupendous work in the whole world."

One of the early pioneer inventors was Sir Samuel Morland (1625–1695), who in 1670 invented the speaking trumpet, one of which is preserved at Cambridge. He was also the inventor of a capstan for heaving up ships' anchors, a plunger pump in 1675, by which water was raised to the top of Windsor Castle, and two arithmetical machines for working the four fundamental rules in arithmetic. These machines were manufactured by Humphrey Adamson; besides these inventions, he endeavoured to use high-pressure steam for the propulsion of vessels. He became blind some three years before his death.

Thomas Savery

A notable Patentee was Thomas Savery (1650–1715), a military engineer, who was granted a Patent No. 347, dated January 10th, 1696, for "Navigation improved or the art of rowing ships of all rates in calms, with a more easy, swift and steady motion than oars can." This invention comprised improved paddle wheels and means for rotating them by a capstan. Thomas Savery, however, is more widely known by his second Patent No. 356, dated July 25th, 1698, for "The Miner's friend, or an engine to raise water by fire." This invention embodied the first practical application of pumping by steam power. Steam was admitted to a vessel displacing water therein through a check valve, when the vessel was emptied; the steam was cut off and that remaining in the vessel was condensed by allowing a jet of cold water to flow over the outer surface of the vessel to create a vacuum and so cause water to be sucked up past a valve, after which the steam was again admitted. It is recorded that "Mr. Savery, June 14th 1699 entertained the Royal Society with showing a model of his engine for raising water by help of fire, which set to work before them, the experiment succeeded according to expectation."

There can be little question that to Savery belongs the credit of producing the earliest commercially successful steam engine, and he is generally credited with being the first to make use of a vacuum in such engines.

In this connection there is a delightful story of how the use of a vacuum was accidentally suggested to Savery and goes somewhat as follows: One day after drinking, Savery threw the wine flask which he had presumably emptied upon a fire; the flask, however, was not quite empty and a little liquid that remained was soon converted into steam and filled the flask, which Savery then took off the fire and plunged it neck downwards into a basin of cold water, when the water immediately rushed up and filled the flask, due to the vacuum produced by condensation of the steam. This story appears to be as mythical as those of the boiling kettle of water with which the Marquis of Worcester, and, at a later date, James Watt, experimented.

(To be continued.)

PRINCIPLES OF THE WATER PUMP

(*Continued from page* 369.)

is also carried round and is thrown out by centrifugal force into the outer casing, while a continual supply of water is sucked to the centre of the vanes through the inlet pipe.

The principle of the hydraulic ram is illustrated in Fig. 6. A small head of water is first obtained by damming the river and water from the upstream side is led through a long straight pipe in the direction of the arrow. When the velocity of water in this pipe reaches a certain value it shuts the outlet valve suddenly. Now the water flowing in the long pipe has considerable momentum and finding the outlet door suddenly slammed in its face, so to speak, it rushes up through the valve in the branch pipe and into the air chamber until its momentum is exhausted. The valve below the air chamber then closes and the air—which was compressed in the chamber by the sudden inrush of water—begins to expand and drives the water out through the delivery pipe. Meanwhile the flow in the main pipe having stopped, the outlet valve opens again.

OVERHAULING A LAWN MOWER

(*Continued from page* 355.)

about 1 in. × ¼ in. section, and made to clip with one bolt on to the rim of the wheel. Apply a liberal quantity of fairly fine carborundum grinding paste thinned with oil to the extreme edge of the bottom blade. Rotate the cylinder, stopping occasionally to replenish the abrasive and to slightly adjust up the bottom blade as necessary. Continue the process until all of the rotating blades give evidence of having made contact over their entire length with the bottom blade. A word of warning must here be inserted, calling attention to the danger in touching the revolving blades, and any feeding of grinding paste should be done with the cutters at rest. One hand must necessarily hold the machine down, and a convenient point out of harm's way to do so is on the wooden roller.

Free the blades of the grinding medium by wiping dry, finally cleaning with a rag damped with paraffin. Washing off must be avoided, as it will result in the substance entering the bearings.

Now remove the bottom blade and sharpen the edge with an oil-stone or reaper-file to the angle shown in Fig. 4. The edge should be like that of a scissor blade. Look at the faces of the rotary blades, on the edges that pass the bottom blade first. Should they appear at all rounded off, bring to a sharp edge by stoning along the face, taking care to maintain the original plane of the grinding.

Replace the bottom blade and adjust up so that edges of the moving blades just touch evenly. After making sure that the bolts and adjusters are screwed up, the machine is ready for use.

The foregoing remarks as regards sharpening apply to both types of machine with the exception that a driving handle is attached to one of the gears. This is provided for on some makes of drum-type machines. Half bearings are usually fitted to the cylinder spindle ends. Wear on this type of bearing is taken up by filing the faces of each half. The adjustment of the cylinder in relation to the bottom blade is by means of screws, which raise or lower the bearings.

After grinding has been carried out, it may be necessary to readjust the meshing of the gear train. Allowance is made for this usually on the drum bearings, and by moving the position of the intermediate gear spindle.

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ONE of the many troubles that beset many listeners is interference caused by "man-made static" consisting of high-frequency radiations produced by various types of electrical apparatus. Post Office engineers have been investigating the subject for some time and have come to the conclusion that in 80–90 per cent. of the cases dealt with, the disturbance is "mains carried," and can be cured by an efficient condenser unit fitted at the source. The Belling-Lee Suppressor has therefore been designed in accordance with the Post Office specification, and includes safety fuses. Full particulars and diagrams showing how it should be fitted are given in a booklet recently published by Messrs. Belling-Lee Ltd., Cambridge Road, Enfield, Middlesex. The book can be obtained upon application for 3*d*. post free. [48.]

George Adam's Catalogue

MR. GEORGE ADAM'S catalogue which we reviewed on page 3 of the cover of the April issue under the heading "For the Home Metalworker," item No. 42, is not free as there stated. It costs 6*d*., and stamps to that value should be sent with all applications for it.

THE LATEST NOVELTIES

(*Continued from p.* 390)

bility of a zero error. Lines are drawn parallel to the edges, so that the instrument may be accurately used, even if the corners become rounded. In technical work the usual vertical and sloping lines are obtained merely by placing the edge B.C. or C.D. on a T-square. The angle A is the standard angle for sloping lettering. It costs 1*s*. 6*d* and is obtainable from most dealers. [58]

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