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Practical

MECHANICS

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CONTENTS

CONTRIBUTIONS

The Editor will be pleased to consider articles of a practical nature suitable for publication in "Practical Mechanics." Such articles should be written on one side of the paper only, and should include the name and address of the sender. Whilst the Editor does not hold himself responsible for manuscripts, every effort will be made to return them if a stamped and addressed envelope is enclosed. All correspondence intended for the Editor, should be addressed: The Editor, "Practical Mechanics," George Newnes, Ltd., Tower House, Southampton Street, Strand, London, W.C.2.

FAIR COMMENT

THE editorial Leader in our January issue under the heading "Forward into Space" has now taken on the form of a prediction. At that time, it did appear that Russia was far in advance of other nations in the project of launching an astronaut into orbit. Now only two months later America has taken a tremendous step forward by her success in sending a man into orbit three times round the earth.

Proud in this achievement and unlike Russia, with the close link-up of those forgotten marvels, radio and television, all the world was allowed to see and hear. The scientists and technicians whose patience and skill make such a feat possible, are the kind of men who mark the pages of history although often little is known about them.

Much has been learned from the success of Colonel John Glenn's flight, as also much has been confirmed. Exactly how a human being would react physically to being hurtled round the earth at over 17,500 miles an hour could only be assessed by scientific calculations from simulating these conditions as far as humanly possible on the ground. The final stage of the flight, when the capsule started its re-entry into the earth's atmosphere, was a stage which had already been put to practical test when Comdr. Alan Shephard was launched into space and later recovered from the Atlantic. Prior to this, two monkeys, Able and Baker, had made the same flight and were lifted from their capsule alive and well.

As the capsule slows down the friction generates heat so intense that the nose cone starts to glow and the astronaut would literally fry if he were not given some form of protection. To combat this a beryllium heat shield, shaped like a broad, shallow dish is attached to the blunt forward end and lined with several inches of fibre glass resin compound.

Beryllium is considerably lighter than steel and has an unusual capacity for absorbing large quantities of heat. The fibre glass resin provides another heat barrier, through planned, controlled deterioration of the surface into gases and molten liquids under the influence of intense heat. The heat is drawn off and dissipated away from the capsule by a melting and stripping off process. Despite these necessary precautions Colonel Glenn reported that he had some uncomfortable moments during his descent, when he thought his heat shield had completely disintegrated and fallen away. His fears could have been well founded as can be seen from this report of a preliminary test made in September 1959 . . .

"NASA scientists watched as a full-scale model of the Mercury capsule, complete with heat shield, was boosted 100 miles into space on an Atlas rocket launched from Cape Canaveral. The capsule re-entered the atmosphere at 250,000 feet travelling at 14,000m.p.h. Because of a malfunction during launching, the Atlas did not drop its booster stage and caused the capsule to enter space under the planned velocity of 17,250m.p.h. This failure meant it spent more time in the dense atmosphere and encountered a higher temperature than was supposed. It was recorded that the resisting air a few inches ahead of the descending capsule reached a temperature close to 10,000°F for a few seconds."

The May 1962, issue will be published on April 27th, 1962. Order it now!

'Shoot' Underwater Pic's this Summer!

A "Snorkel" Diver's Camera case for less than 15s.

WITH the increasing popularity of "Snorkel" diving, more and more people are seeing for the first time the unexpected beauty in our shallow coastal waters and quite naturally the desire to photograph this watery wonderland arises in many of us. The ability to do this is presented to us in two ways. In the use of a special watertight camera or the enclosure of a normal camera within a watertight housing. Both these methods can prove expensive but unless the intention is to visit deep water with the aid of breathing apparatus, the cost of a suitable housing for most 8mm. and 35mm. cameras need be no more than 15s. and the effort of one evening's work. The components are shown in Fig. 2.

The housing is basically a rubber envelope with a perspex window, the camera is mounted inside in such a way that with few if any improvisations, all controls are available to the operator and remain effective in water down to ten feet and below. My own housing was used successfully with a Bolex C8 cine camera Paxette IIM and Ilford Sportsman 35mm. cameras.

The Casing

The housing consists of two main parts, the case and the mounting bracket with window. For

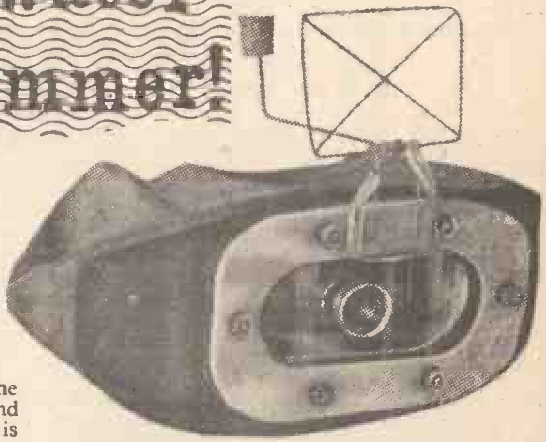
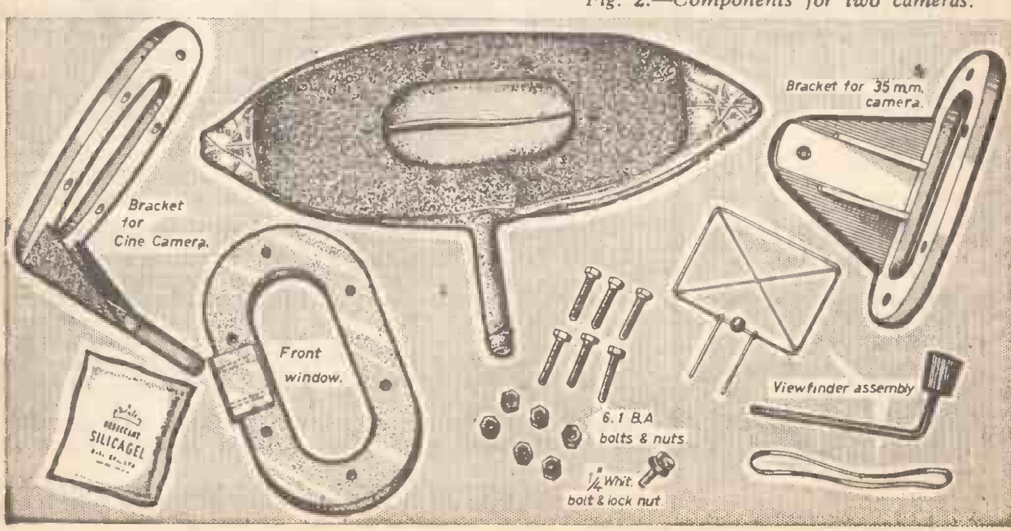


Fig. 1.—The complete assembly.

the case an ordinary rugby ball bladder is used. In this bladder a hole is cut large enough to permit entry of the camera and bracket. This hole is subsequently sealed by the perspex window.

The first thing to do is to obtain the bladder and decide the size of hole for camera entry. The size of this hole depends on the size of bladder panel width and the size of camera. The bladder I bought had four panels each 3¾in. wide. The hole is to be cut in the centre of one of these panels and there should be at least ¾in between the edge of the hole and the seam of the panel. From this we can deduce that in the case of a bladder with 3¾in. wide panels, the maximum width of hole is 2¼in. However for most 8mm. cameras and almost all 35mm. cameras this is more than ample. If the camera is larger than usual and there seems to be some doubt

Fig. 2.—Components for two cameras.



about the width of hole, it will be found that if the hole is cut longer, maintaining the $\frac{3}{4}$in. border, the rubber will stretch considerably to accommodate any size of camera that does not exceed the inflated dimensions of the bladder. Great care must be taken in inserting the camera, because the slightest tear will prove disastrous. This is one of the reasons for reinforcing the hole edge. The camera can be put into the bladder any way round that is found convenient, once inside it can easily be turned to face the hole.

Mark on one panel of the bladder, the horizontal and vertical centre lines and the shape of a hole, $\frac{1}{2}$in. smaller in length and width than the previous mentioned hole. (This second hole is simply to permit the turning of the bladder inside out.) Now cut out this hole carefully. It will be found helpful to inflate the bladder prior to piercing to avoid putting holes where they are not wanted.

Obtain a strip of rubber patching as sold for use on motor-car inner tubes. Two pieces will be required each $1\frac{1}{2}$in. wider and longer than the dimensions of the first hole. In the centre of one of these pieces mark and cut out the second hole, then apply the patch in the normal way to the inside of the bladder making sure that the edges of the hole coincide. Lightly dust with french chalk (or talcum powder) when dry, then turn the bladder back the right way. The second patch should have the first hole marked on it together with the clamping bolt centres. A suitable bolt pitch line for 1B.A. bolts is $\frac{5}{16}$in. from edge of the first hole and for a first hole of up to 4in. by 2in., six bolts will be required. Also on the second patch the second hole should be marked and cut. This patch should now be stuck in position on the front of the bladder, as soon as it is dry the first hole can be cut through the three thicknesses of rubber, and the bolt holes can be punched with a $\frac{3}{16}$in. punch. A rubber gasket cut from an old car inner tube or similar material, will be required. It should be $\frac{3}{4}$in. wide and symmetrical about the bolt pitch line, the bolt holes should be punched in it.

Mounting Bracket

For the mounting bracket the sketch is self explanatory (See Fig. 6). The original bracket was made from scrap pieces of $\frac{1}{2}$in. thick plastic, but any suitable material can be used. If it is made from metal the ribs shown on the sketches will not be required, if the metal is a ferrous one the bracket should be painted. The window should be made from $\frac{1}{4}$in. thick clear perspex. The original was made from $\frac{1}{8}$in. perspex with a $\frac{1}{8}$in. thick plastic reinforcing flange $\frac{3}{4}$in. wide stuck to it, because these materials were readily available. All external edges of the bracket must be rounded off to prevent chafing of the rubber.

The viewfinder is made from old bicycle spokes to the dimensions shown in Fig. 5. The viewfinder is mounted on the perspex window by sliding the two supporting legs into the two holes provided in the mounting boss, it is retained in position by an elastic band slipped over the lower bar of the frame and anchored on the underside of the mounting boss. To set the viewfinder, mount the camera on the bracket by means of a $\frac{1}{4}$in. Whitworth bolt through the hole provided in the bracket and into the tripod bush in the camera using a lock-nut to tighten it (Fig. 4). Then bolt in position the front window with the gasket behind it and fit the viewfinder in position. Sight the viewfinder of the camera on to some object about 15ft away, then holding the camera firm with one hand bend the wire supporting the bead of the external viewfinder until the view in its frame agrees with the view in the camera's own viewfinder.

Testing

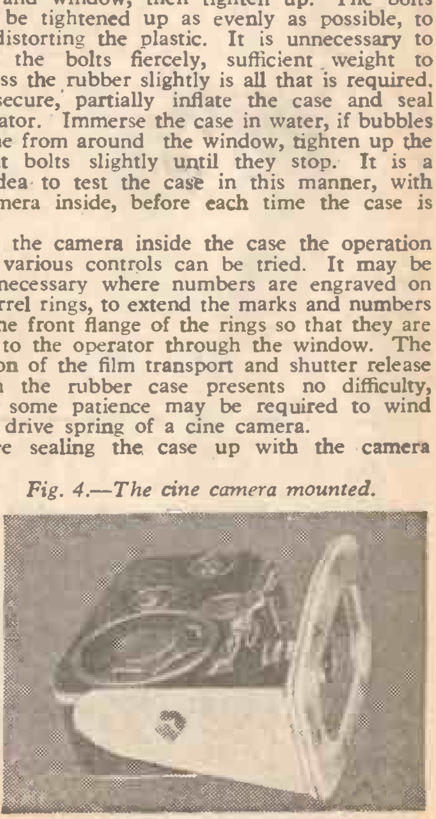
The case can now be tested without the camera inside. Insert bracket, put bolts in position, fit gasket and window, then tighten up. The bolts should be tightened up as evenly as possible, to avoid distorting the plastic. It is unnecessary to tighten the bolts fiercely, sufficient weight to compress the rubber slightly is all that is required. Once secure, partially inflate the case and seal the inflator. Immerse the case in water, if bubbles do come from around the window, tighten up the adjacent bolts slightly until they stop. It is a good idea to test the case in this manner, with the camera inside, before each time the case is used.

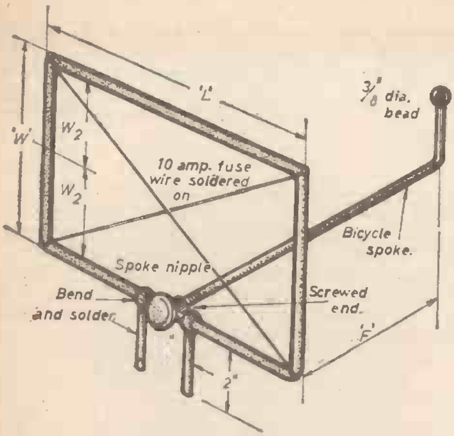
With the camera inside the case the operation of the various controls can be tried. It may be found necessary where numbers are engraved on lens barrel rings, to extend the marks and numbers on to the front flange of the rings so that they are visible to the operator through the window. The operation of the film transport and shutter release through the rubber case presents no difficulty, though some patience may be required to wind up the drive spring of a cine camera.

Before sealing the case up with the camera

Fig. 3.—Camera inside the casing and bolts in position.

Fig. 4.—The cine camera mounted.





F = Focal length of camera lens.
L = Length of negative produced.
W = Width of negative produced.

Fig. 5.—Viewfinder details. These dimensions should be multiplied by a suitable factor to give a frame of reasonable size. E.g. for 35mm. cameras multiply by 2 and for 8mm. cameras multiply by 12.

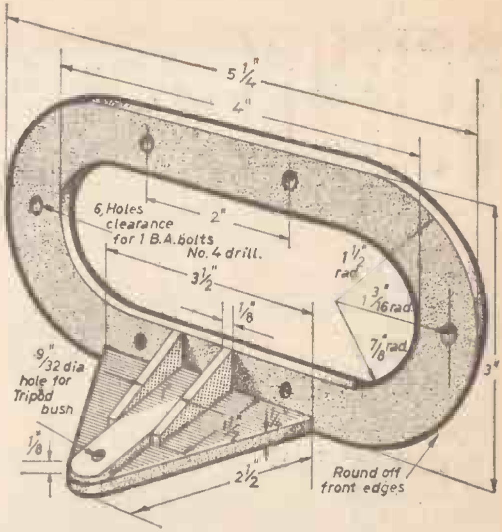


Fig. 6.—Details and dimensions of bracket for 35mm. camera with central tripod bush.

inside, put inside a small packet of silica-gel, this will absorb any condensation that may occur when entering the water, due to the sudden change of temperature. Silica-gel can be obtained from any good photographer's shop.

Never put the camera into the case in warm sunshine and never leave the camera and case in the sun. When using a cine camera, avoid filming in anything but a gentle swell because camera movement induced by the water may not be noticed until the film is screened.

Where possible use a faster filming speed than normal. When filming fish, do not be tempted to follow their movement with the camera but hold the camera steady and let the fish swim in and out of the filmed area as they will.

Never leave the camera inside the case for any length of time after a diving session.

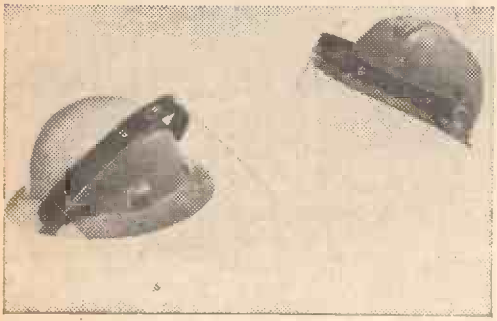
Focusing the camera remains quite normal providing the distances are estimated visually, if the distances are measured in any way however, the camera should be set at ¾ x the distance measured. For normal use the lens should be set at about 15ft, beyond this distance definition falls off rapidly unless the water is very clear. An exposure meter can be accommodated in a glass fruit preserving jar and normally the readings obtained will yield good results but allowances must be made for light reflected from particles suspended in the water.

As a guide here are some settings that have been used successfully:—

Shutter speed—1/50. Clear sun. Midday. Kodachrome ASA.10. Surface fairly calm.

Water Depth—15ft	Sandy bottom	...	f4·5
15ft	Rocky bottom	...	f2·8
30ft	Sandy bottom	...	f2·8

SCIENCE NOTES



LATEST addition to the Safety Products Ltd. range of personal safety equipment is a combination of their Hard Hat and Face Shield.

Basically there are two models, that shown on the right of the illustration is the VA/1, consisting of a peak style Hard Hat which is available in either plastic or fibre glass.

The detachable wrap-round face shield, consists of a cellulose acetate vizor of ·060in. or ·080in. thickness by 8in. in depth, fitted to a swivel top band of vulcanised fibre by a bayonet-slot fixing that gives complete security and obviates accidental removal such as from " popping-off " of press studs. This band in turn, is fixed to the peak style hat by a patented " plug-in " plastic recessed block which slides into a socket that is riveted solidly to the hat.

The hat shown on the left of the illustration is the VA/2, a full brimmed type hat that is available in plastic only. The vizor and swivel top band are exactly the same as for the VA/1 but in this case is fitted on to the brim by means of a cleat with swivel fitting for the band, thus, the face shield can be raised up and over the hat as desired. The plastic versions are available in standard colours of white, grey and yellow whilst the moulded fibre glass models can be supplied in a variety of colours.

Further details and prices may be obtained from Safety Products Ltd., Holmethorpe Avenue, Redhill, Surrey, England. (Redhill 4304.)

New Method of Making Gears

A NEW method of making gears by the hot-knurling technique developed by Soviet specialists is now being introduced on a wide scale at the largest engineering works in the Soviet Union. A metal Blank is placed in a special stand where it is heated to 1,000 deg. centigrade by high frequency current. By means of a special knurling device made of alloyed steel, teeth are formed on the hot surface of the blank. It is claimed that the hot knurling technique is five to ten times more efficient than cutting. Gears made by the new method are stronger and more resistant to wear.

New Telephone Kiosks on Trial

THE photograph below shows a prototype of the new telephone kiosk, designed by Mr. Neville Conder. These are now on trial at various selected sites in London. The kiosk shown is near the Royal Exchange in the City of London.

LATHE GADGETS

Part 4

TOOLPOST DRILLING AND MILLING SPINDLE (2)

By L. C. MASON

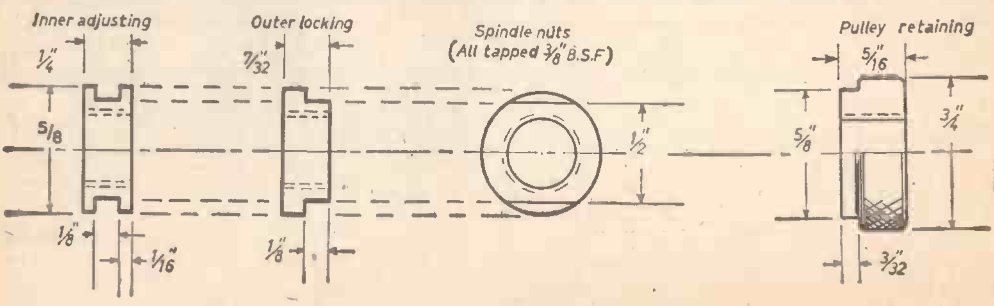
COLLETS for continual use in commercial production work are normally made from a tough and springy grade of steel, but for occasional amateur use mild steel will generally be found satisfactory. It would be convenient from one point of view to turn up a set of collet blanks next from ¾in. rod, larger end outwards, so as to make use of the already set topslide, to ensure the tapers of collets and spindle nose matching. However, if this order of things is adopted, it will be found difficult to hold the blank and make sure it is running truly for drilling the rear clearance hole. It is probably better therefore, to turn them small end outwards, when all the outside turning and drilling the rear hole can be carried out at the one setting (Fig. 2). The topslide requires to be set over 20° the other way, of course, and with the stem of the collet blank turned to size, the spindle offered up to the taper on the collet with a smear of marking blue in the hole (Fig. 3) will soon show what adjustments to the angle of the topslide are required to obtain a matching taper on the collet.

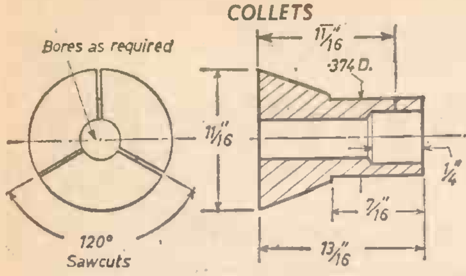
Turn the collet outside complete before drilling the ¼in. rear hole, then drill the hole and part off a trifle full on length. Chuck the collets individually by the parallel stem and face the large outer end. Opportunity might be taken here to index round in three positions and mark lines on the large end face indicating where the sawcuts are to come. The small bores in which the work is gripped cannot be machined till the retaining cap is completed, so that is the next job (Fig. 5).

This could be machined out of one piece, but it was found easier on the whole as two were required, to bore and screwcut the double thickness piece. The end of each after parting off can then be counterbored to receive whichever fitting is required—a turned washer for the collets or a chuck adaptor with a tapered stalk. Each was silver-soldered into its cap.

When the collet cap is finished, the collets can be bored to sizes as required. Re-chuck the spindle in the four-jaw to hold it quite truly, insert a collet blank in position and screw on the cap. Centre drill first, then follow up gently with a drill nearer the size of the bore required. Open the hole up gradually to reaming size, and ream carefully to nominal size. Bore the smaller collets first, then if any mishap should occur in the drilling, the blank is still usable by boring out for one of the larger sizes. The bored collets are gripped endwise in the machine vice on the cross slide for slitting with

Fig. 1.—Details and measurements for the spindle nuts and pulley retaining nut.





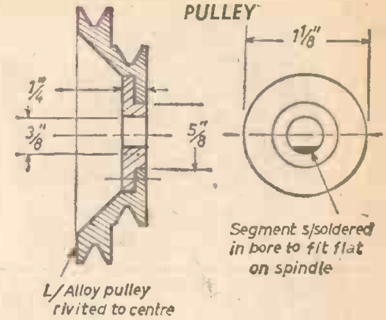
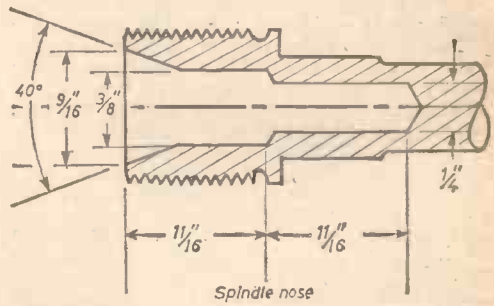


Fig. 2 (Above).—Pulley and collet details.

Fig. 3 (Right).—The spindle nose.



a $\frac{1}{32}$in. thick slitting-saw. The thickness of the saw is not of great importance, but the slits should be clean edged and all the same length.

The pulley can be of any design that fancy takes, but was made in two pieces as shown, partly to take advantage of material to hand and partly to provide a centre of harder wearing material than the light alloy. The centre piece takes the form of a double thickness disc, riveted in a recess in the light alloy pulley itself. A small segment cut from a piece of $\frac{3}{8}$in. mild steel rod forms the driving key, and is silver-soldered in the bore of the pulley centre after filing to size. The pulley proper is shown dished; this economises on space somewhat when assembled so that it overhangs the end bearing, or if mounted on the spindle the other way round, provides an alternative line for the belt for convenience in mounting the motor.

The retaining nuts are simple slices of mild steel rod, tapped $\frac{3}{8}$in. B.S.F. and faced flat (Fig. 1). The thicker of the two which goes next to the bearing flange has a pair of $\frac{1}{8}$in. wide flats filed at two opposite points on its diameter. This one is used to adjust end play on the spindle. Shape up a small spanner to fit from $\frac{1}{8}$in. mild steel plate and case-harden it. The outer lock nut has two plain flats, so that it can be tightened with a small adjustable spanner. The pulley is clamped outside these by a knurled finger nut, finger pressure being quite adequate to retain the pulley.

Methods of driving will largely depend on individuals' own equipment. The set-up shown uses a 1/20h.p. ex-government 30V universal motor, mounted on the cross slide behind the spindle. Power is provided by a tapped output transformer, the motor power and speed being regulated to the job in hand by varying the supply voltage. On the full 30V the motor has power enough to drill $\frac{1}{4}$in. holes through $1\frac{1}{2}$in. thick mild steel. Drilling is not so speedy as with a more powerful drill of the Wolf Cub type, but the necessarily gentler feed probably makes for accuracy in drilling.

The belt is a miniature rubber V belt, as supplied for sewing machine use, and transmits all the power available even when run extremely slack. Round leather belt of $\frac{3}{16}$in. diameter is also suitable as to size, but a new piece has to be run much tighter than the rubber belt to avoid slip, and care is needed in making the joint so as to avoid vibration when running at fairly high speeds. Probably a stretchable plastic belt would be much better, although this has not been tried as the rubber belt has given every satisfaction so far.

Fig. 4 (Below).—Components of toolpost drilling and milling spindle, including collets and drill chuck adaptor.

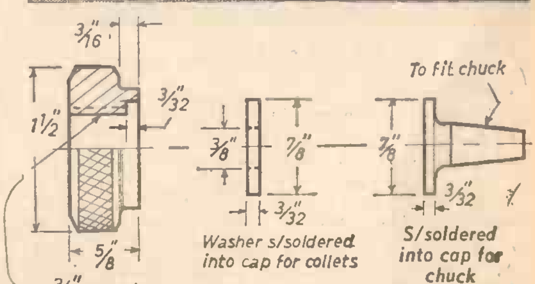


Fig. 5.—Nose cap and washer details.

chemical magic

EXPLAINED BY D. A. WATT

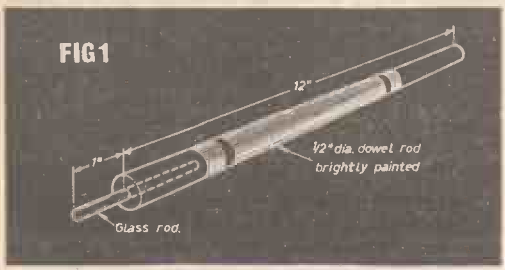
THE recent series of articles on home-made laboratory apparatus may have roused your interest in chemistry but did it also raise the question "Would I really use it if I made it?"

Why not try these interesting experiments of a mystifying nature which could be used to form the basis of a magic show to entertain your friends? All the necessary chemicals are readily obtainable and, of course, the apparatus required can be purchased if preferred.

Before considering how best to present such a show let us first look at some suitable experiments. For convenience each one will be considered under five headings as follows:

(1) Audience View. (What the audience sees.)
(2) Materials. (List of apparatus and chemicals required.)
(3) Procedure. (How effect is obtained.)
(4) Explanation. (Why the particular result is obtained.)
(5) Suggestions and Precautions.

Experiment (1) "Merlin's Fire Wand."



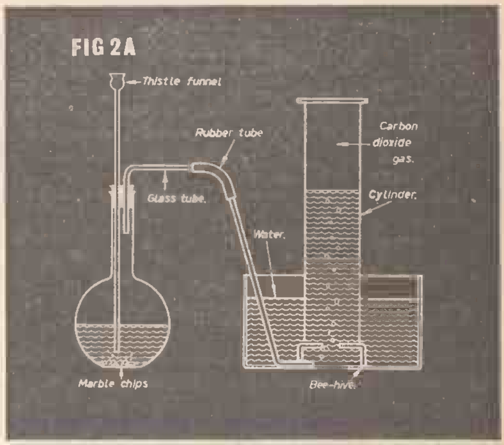
Merlin's Fire Wand.

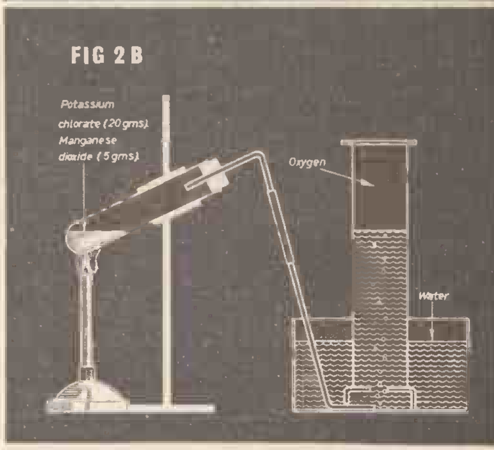
Audience View

The wick of a candle is touched by the end of a brightly decorated wand. Immediately there is a flare and the candle lights.

Materials.

Equal quantities of sugar and potassium chlorate, a large candle with a fluffy wick, concentrated sulphuric acid and a special wand. The wand consists of a piece of dowel rod of suitable diameter about 12in. long with a piece of glass rod fixed in one end as shown in Fig. 1.





The Vanishing Flame.

Procedure.

The sugar and potassium chlorate are each ground separately in a mortar and the two powders mixed. The candle wick is well ruffled and some of the mixture is interspersed in the wick. The glass rod at the end of the wand is dipped into concentrated sulphuric acid. When this is brought into contact with the wick it produces an instantaneous flare which will light the wick.

Explanation

Dehydration and oxidation of sugar is accompanied by flames. The heat generated decomposes the potassium chlorate releasing oxygen thus promoting vigorous combustion of the sugar.

Precautions

The sugar and potassium chlorate must be powdered separately, if mixed and then ground an explosion may occur.

Experiment (2) The Vanishing Flame

Audience View

A lighted candle stands on the table and the demonstrator places two large, stoppered measuring cylinders, or wide-mouthed flasks, besides each. Removing the stopper from one cylinder, he pours an invisible gas over the candle flame and it is immediately extinguished. He then pours another invisible gas from the second cylinder and the candle relights.

Materials

Apparatus to generate carbon dioxide gas and oxygen (see Fig. 2 (a) and (b) respectively); two 500 c.c. cylinders or similar vessels with rubber stoppers; a candle; marble chips; dilute hydrochloric acid; potassium chlorate; manganese dioxide.

Procedure

The first cylinder contains carbon dioxide which is produced by the action of dilute hydrochloric acid on marble chips and is collected by the downward displacement of water as indicated in Fig. 2a.

The second cylinder contains oxygen which is generated by heating potassium chlorate in the presence of the catalyst manganese dioxide as shown in Fig. 2b. Again the gas is collected by downward displacement.

Explanation

Carbon dioxide does not support combustion and will extinguish the flame. Provided the oxygen is poured over the wick before it has cooled unduly, the wick will relight as oxygen promotes combustion.

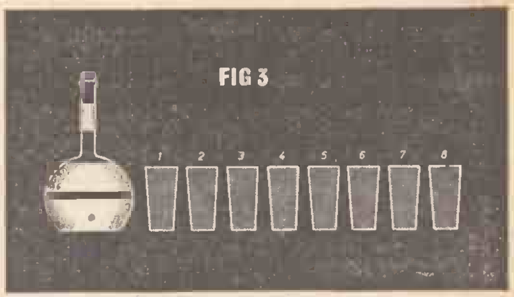
Suggestions

The cylinders should be completely filled with gas and tightly stoppered. If the experiment fails it will most likely be due to insufficient gas in the cylinder or delay in getting the oxygen to the wick.

Experiment (3) Magic Water

Audience View

The demonstrator places a large beaker full of clear liquid on the table. He takes a short piece of Pyrex rod or tubing and places it in the liquid. It disappears as it enters the liquid. He slowly rotates the beaker a few times, puts in his hand and lifts out a small Pyrex beaker.



Magic Water.

Materials

A two litre and a 100 c.c. beaker; Pyrex rod or tubing; 590 c.c. of carbon tetrachloride and 410 c.c. of benzene.

Procedure

Mix the two liquids in the large beaker and place the small beaker inside making sure that it is completely submerged. Cover the large beaker to prevent evaporation of the liquid. When ready to perform the experiment proceed as indicated above.

Explanation

A mixture of these two liquids in the proportions given has the same refractive index as Pyrex, therefore Pyrex becomes invisible in the liquid.

Experiment (4) Mystery Water

Audience View

"Water" from a brightly decorated decanter or jug is poured into a series of eight glass tumblers with many mysterious colour changes.

Materials

An opaque jug or decanter, preferably highly decorated; eight clear glass tumblers; tannic acid (5gms); a few c.c.'s each of the following; concentrated ammonia, concentrated sulphuric acid, saturated solution of ferric chloride, and a saturated solution of oxalic acid.

Procedure

(a) **Preparation.** Place the tannic acid in the jug and almost completely fill with distilled water, stirring or shaking vigorously. Arrange the tumblers in a row as shown in Fig 3. We will consider them to be numbered 1 to 8 in order as shown.

The tumblers are treated as follows:

(1), (3) and (7) are empty.

(2) and (4) each contain 5 drops of the ferric chloride solution.

(5) contains 15 drops of oxalic acid solution.

(6) contains 10 drops of ammonia.

(8) contains 5 drops of sulphuric acid.

(b) **Performance.** Pour "water" from the jug into the first tumbler — no colour change, "water" appears. Pouring into the second tumbler appears to produce "ink." Again "water" appears when pouring into the third tumbler and "ink" appears in the fourth.

chemical magic

Now return the liquid from all four tumblers back into the jug. When poured into either tumbler (1) and (2) " ink " appears to come out. Pouring into tumbler (5) produces " water," and into (6) " wine " appears.

Again return all the liquid to the jug. On pouring into tumbler (7) " wine " appears, but when pouring into (8) " water " appears to form.

Explanation

Chemical reactions between liquids are accompanied by colour changes.

Note.—Ferric chloride may be difficult to obtain, but any standard chemistry text book will give a method of preparation.

Experiment (5) " Speedo " Coffee

Audience View

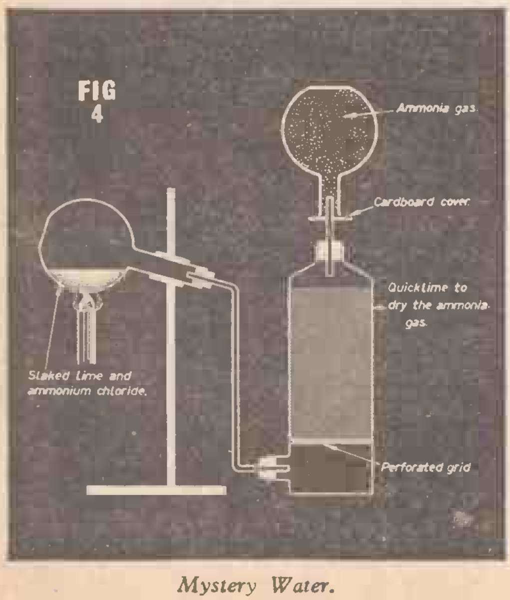
On the table is a glass of water. A glass rod is used to stir the water vigorously whereupon it turns to " wine." The rod is placed on the table. When picked up again and the " wine " stirred it immediately changes to " coffee."

Materials

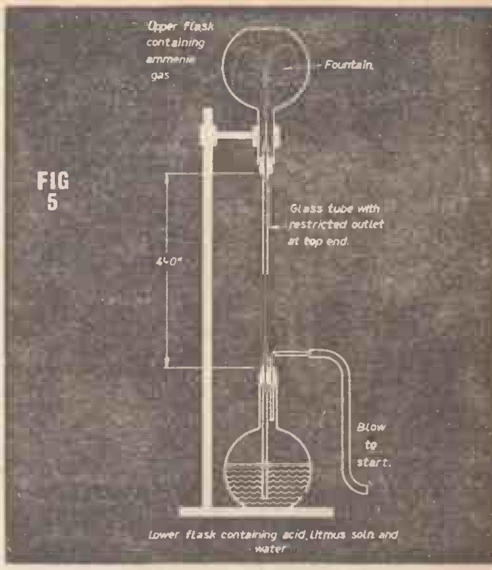
Seven inches of glass tubing sealed in the middle; a few crystals of potassium permanganate and a small amount of tannic acid.

Procedure and Explanation

Prior to the demonstration one or two crystals of potassium permanganate are concealed in one end of the tube and tannic acid in the other.



Mystery Water.



" Speedo " Coffee.

Potassium permanganate dissolves in water giving a wine colour (rapid stirring being required). When the tube is picked up the second time the other end is used to stir the solution allowing the tannic acid to react with it, producing a coffee colour.

Precaution

Using too large quantities of chemicals may result in failure.

Experiment (6) The Magic Fountain

Audience View

A red liquid rises up a glass tube from a flask and sprays with audible force into an inverted flask at the same time changing its colour to blue.

Materials

An ammonia generator as shown in Fig. 4, the apparatus shown in Fig. 5; 10 c.c. dilute hydrochloric acid and 50 c.c. of litmus solution.

Procedure

Prior to the performance ammonia is generated as indicated in Fig. 4 and collected in the flask. This is the upper flask of Fig. 4.

The acid and litmus solution are placed in the lower flask and it is filled with water. The apparatus is then assembled as shown in Fig 5.

Blowing into the rubber tube will cause a few drops of liquid to be forced up into the upper flask starting the fountain. It will continue until the flask contains as much water as it formerly contained of ammonia.

Explanation

Ammonia gas has a great solubility in water (about 800 volumes of gas in 1 volume of water). Therefore the first few drops of water dissolve

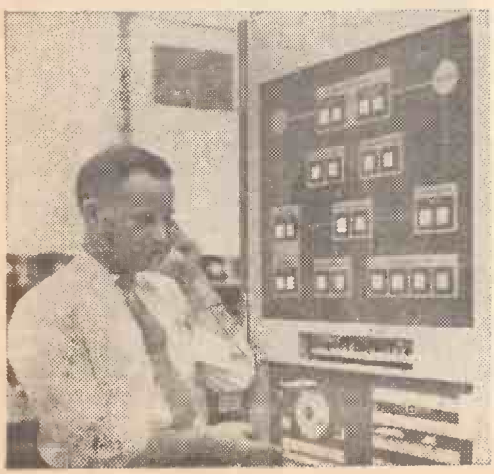
(Continued on page 329)

AN ELECTRONIC TELEPHONE EXCHANGE

By S. C. FRASER

(Below left).—The administration centre of the world's first electronic telephone central office. Speaking on the test phone is Daniel Danielson, of Bell Laboratories, who played a part in the development of the new system.

(Below).—Testing the circuitry of a logic-loaded brain, officially known as the central control, of the experimental Electronic Central Office.



RECENTLY, the world's first electronic telephone was put into operation. Through the use of tiny gas tubes, a vast memory system, and thousands of transistors and other solid state devices, which operate in millionths of a second, the new exchange performs electronically all the functions in handling telephone calls. It also makes possible a variety of new services to the subscriber which will double the flexibility of everyone's telephone.

The new exchange, which was developed by the Bell Telephone Laboratories in America, is undoubtedly the forerunner of similar exchanges which we will be getting in England. In view of this, just how an electronic telephone exchange operates, should be of interest.

Everyone who had the opportunity of examining the operation of Bell's electronic telephone exchange in Morris, Illinois, would have the same reaction—that it resembles human activity in several striking ways.

For example, it has electronic "eyes and ears"—called scanners—that watch for people to remove their phones from the hook and dial. It has "electronic note pads", barrier grid tubes, to record dialled numbers and other information regarding calls. It has a "brain"—the common control—with an extremely large, fast, photographic memory called a flying spot store. This "brain" tells it what to do next at every stage in the completion of a phone call. The electronic exchange also contains a "nervous system", called a central control logic, which co-ordinates the other units and finally directs its "hands"—the signal distributor and network markers—to set up the proper connections between telephone callers.

Each function of this electronic "human" is accomplished by dozens of high-speed elementary actions. Because it is so fast, these dozens of actions take place a thousand times more quickly than they do in present dial telephone systems.

This is how it all works: The "eyes and ears" (scanner) checks the condition of every telephone line ten times a second, day and night. When a caller picks up his telephone, the scanner detects the action and reports it to the "brain" (common control). The "note pad" (barrier grid store) shows that this is a new call, because its record shows that a tenth of a second ago the phone was in the "on-hook" position. The "note pad" also reports that it has no record of anyone trying to reach this line, so the "brain" decides that the subscriber wants to dial. The exchange sends a dial tone to the subscriber, letting him know that the system is on the job, ready to handle his call. At the same time, space is reserved in the barrier grid store for the digits to be dialed.

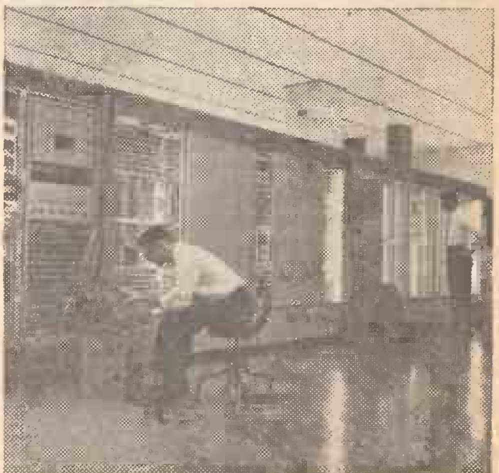
The scanner now speeds up, looking at this subscriber's line 100 times a second so it won't miss any of the dial pulses. Since each operation of the electronic exchange is performed in a few millionths of a second, the system goes ahead and does millions of other jobs while the subscriber is dialling his number.

Assume that this subscriber has the special service known as abbreviated dialling", which allows him to reach several of his frequently called numbers by dialling just two digits instead of seven. When he requested this service he gave the telephone company the directory number for each phone he wanted to have represented by a two-digit code. This information was listed in the electronic exchange's photographic "memory".

Now, the subscriber dials the two-digit code which represents a frequently called number. The exchange first checks to see if this subscriber has abbreviated dialling service. It finds that he does, and it recognises the two-digit code as shorthand for the directory number. The "brain" then commands the memory to report the complete directory number.

Central control next sends a command to the switching network to set up a ringing circuit to the wanted telephone number. It makes a point, too, of feeding the subscriber's earpiece with the called ringing tone. Someone picks up the receiver at the called number, which the scanner detects in a tenth of a second. The "brain"

The voices of telephone customers are carried through neon gas tubes that make up the "switching network" shown above.



Equipment cabinets of the Electronic Central Office being checked out by engineer.

Engineers prepare to install a cathode ray tube in the flying spot store, a photographic memory device capable of storing 2¼ million bits of information.

orders the switching network to connect a talking circuit and drop the ringing circuit. This happens so fast that it is all done before the person answering gets the phone to his ear.

A complex automatic telephone switching system, in an electronic telephone exchange, simulates the brain in the twin functions of "logic" (solving problems) and "memory" (the storage of information).

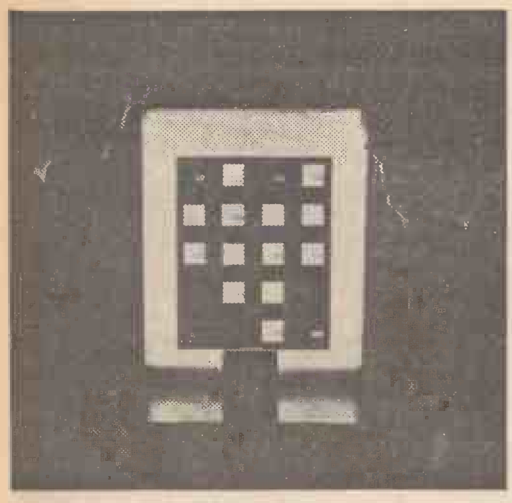
Early dial telephone systems had distributed memory and logic—in relays that were used to connect subscribers together. In later dial systems memory and logic were provided more efficiently. Separate relay units were provided expressly for temporary memory functions, such as recording numbers as they are dialled, and other relays are used solely for logic operations (problem solving).

It is the philosophy of the new electronic exchange system not simply to substitute electronic devices for relays, but rather to solve call-handling problems on a completely new basis. The solutions to these problems are found in "answer" stored in the photographic memory. The "answers" are found a thousand times faster than with older systems, and can be easily changed to meet varying needs of the telephone business.

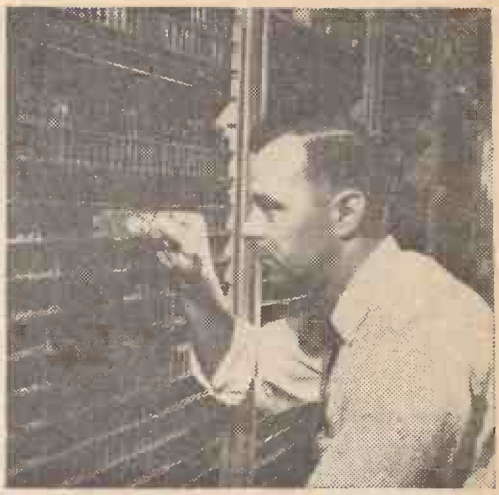
In the search for a memory system having a tremendous capacity and almost instantaneous access to stored items, Bell Laboratories engineers seized the idea of storing information on photographic plates. A cathode ray tube, somewhat similar to a TV picture tube, produces a small spot of light which can be positioned to read out stored information from the plate. For each position of the spot of light, 67 different items of information can be read out.

In the flying spot store 2¼ million items of information, or bits, are stored, and any item can be read in a few millionths of a second. All the 2¼ million bits can be read in one-ninth of a second.

The "note pad"—the barrier grid tube—is a special type of electron tube. It is also somewhat like a TV picture tube, except that the target is not a phosphor screen but a bit of mica. A beam of electrons is shot at the mica target, and where the beam strikes an electrical charge is placed. A charge (or lack of charge) in any particular place



A photographic memory plate being examined in a darkroom.



Technician inserting printed circuit board in place.

on the mica represents an item of information. The item can be read quickly and then erased, leaving the space ready for new information.

The end result of this complex electronic "brain" is to direct the closing of switches to connect one telephone with another. The switches in the electronic telephone exchange described here are neon gas tubes. When a connection is made the tubes "fire", showing an orange light. Light from blue fluorescent lamps shining on the tubes ensures quick firing. Also, the neon tubes are carefully temperature-controlled for reliable operation.

Temporary changes in telephone services are put into effect by "note pad" entries made via a teletypewriter in the administration centre of the exchange. When an order has been given to the exchange, the machine "acknowledges" these commands by repeating them on the teletypewriter. An attendant checks to see that the command has been repeated correctly, then he types a full stop. This serves as an "execute" order, whereupon the electronic exchange system does what it has been told.

The success of an electronic telephone exchange, according to Bell Telephone Laboratories, is the transistor. Transistors are devices made from solid pieces of semi-conducting material—such as silicon and germanium—that control or amplify electrical current. They perform essentially the same functions as vacuum tubes, but are much smaller in size, lower in power consumption and usually less expensive.

Without the transistor, electronic switching in its present elegant and practical form would have been unfeasible. Over 12,000 transistors handle the enormous task of amplifying, pulsing and, for fractions of a second, "remembering", in those sections of the Morris, Illiniois, electronic exchange system that perform logical functions.

An indication of the importance of transistors and other semiconductors to electronic switching can be gained from an inventory of the major elements used. Of the more than 200,000 essential electronic parts that make up the electronic telephone described, some 118,000 are semiconductor devices.

BOOKS Received

"Moon Atlas" By V. A. Firsoff. Thirty-two pages and maps.

Published by Hutchinson of London. Price 63s.

THIS book serves a dual purpose. It is a general Atlas of the Moon, with maps, photographs of progressive phases, a gazetter and a descriptive text, and can be used for identifying the surface formations of this natural satellite. It also embodies and presents the results of prolonged research, by the author in the form of a three-colour map of the formative fractures of the lunar surface and associated features and a set of spherical projection photographs which eliminate the foreshorting at the moon's limb and disclose some novel aspects of these poorly known regions. This atlas is a necessary reference work for all who wish to keep in touch with man's next great adventure.

"Industrial Electronics Made Easy" By Tom Jaski. 288 pages and illustrations.

Published Gernsback Library Inc., New York.

THIS is an ideal guide for any technician in or interested in entering industrial electronics. The author tells just what industrial electronics is, and compares maintenance techniques with home entertainment servicing. He analyzes induction, dielectric, microwave, and supersonic generators—and explains the techniques for transducers, control systems and servos.

There are descriptions of counters, recorders, and other readout and display devices used in industrial electronics. Finally there is a discussion of the techniques and instruments used in industrial electronics maintenance.

By JOHN SIMON

THIS guitar is made with a solid body and is therefore essentially electric. It has only one pick-up, which will give a very good range of tone. The total cost should not exceed £3, and the finished guitar will be well comparable with those on the market at £15 to £20.

The body may be of any shape, and Fig. 11 will enable the constructor to draw the desired shape with a ruler and compass. It is best to do this directly on to a piece of mahogany, or similar hardwood, anything from 1in. to 3in. thick. It may then be roughly cut with a draw-knife, and finished off with a spokeshave and rasp. The edges both back and front should be bevelled with a rasp.

The depth of the pick-up is such that a hollow must be made in the body for it, ¾in. deep. This can be done with a chisel.

Three holes must be cut to hold the three potentiometers. These should be drilled from the back, with a diameter large enough to hold the whole control, which will be approx. 1¼in. dia. This hole should be drilled to within ¼in. of the front of the body. Through this ¼in. of wood a hole should be drilled to take the threaded portion of the control, so that it can all be secured with a nut in the front.

Next a hole must be drilled, in a line down the centre of the body, 5in. from the fingerboard end. It is to be drilled at an angle of 60°, as shown in Figs. 1 and 2.

A hole is drilled at the end of the hollow for the pick-up nearest the three controls, to take the wires from the pick-up, ¼in. dia.

The Fingerboard—And " Arm," are made of one piece of wood. It should be of obeche or a similar wood. It should be 1in. thick, 24in. long and 3in. wide. The small bridge is seven inches from one end, and from the other end to this point the arm should be cut with a saw down each side, to taper from 2½in. to ⅛in. at the small bridge. From ¼in. behind the small bridge the sides may diverge from ⅛in. to the full 3in. at the end.

This last 7in. must be made to slope back at a greater angle, and is done by sawing along the dotted line XY in Fig. 6 with a fine saw, screwing and gluing the wedge " A " cut off on to the other side as shown; 4½in, from the end of the fingerboard nearest the main bridge, a wedge must be cut off as in Fig. 5, to slope the whole fingerboard back a few degrees, and to fit round the body of the guitar. The fixing holes should be drilled as shown.

The " pegs " or worm-drive screws for tightening the strings can now be fitted by measuring off the six rods and drilling holes for them.

The underside of the " arm " may be rounded with a spokeshave. The amount it is curved will depend on individual taste.

The frets may be made from " 00 " gauge railway track. It may be cut into suitable lengths, and set into the fingerboard by means of a slot, cut with a saw, and fixed with a strong glue. The track is fitted with the narrow side uppermost, and between $\frac{1}{32}$in. and $\frac{1}{16}$in. above the surface of the fingerboard. All the frets must be the same height above the fingerboard. See Fig. 12.

The Main Bridge is shown in Fig. 3, and is self explanatory. The small bridge is shown in Fig. 4. It is made of a strip of metal bent round at each end in order to make it stand up.

The Support for the Strings is shown in Fig. 7. It is made from a piece of strong metal ¼in. thick, supported by a 13in. length of ⅛in. dia. silver steel, which can be bent without heat.

The Support for the Arm in Fig. 2 may now be made. This is a ¼in. dio. silver steel rod, which is bent into a loop at each end (without heat). The bolt is fitted through the hole previously drilled at 60°. A bush of copper or brass tubing about ¼in. long should be fitted round the bolt up against the body of the guitar. One loop of the rod may then be fitted just over the top, and the other end screwed to the "Arm" as shown in Fig. 2. Another bush should then be fitted over the first, and up against a washer which is also over the first bush. A nut can then be screwed on, and tightened. As it is tightened it will pull the fingerboard back due to the slope of the bolt. This may sound a little "Heath Robinson", but is very satisfactory When finished the whole unit may be boxed in with a moulding of plastic wood or papiermâché.

The Pick-Up is shown in Figs. 9, 8 and 1. It should not be made until the rest of the guitar has been made and assembled (without gluing the fingerboard to the body) as the strings need to be fitted and tuned in order to adjust the pick-up during assembly.

Having obtained three of the horseshoe magnets as listed, the bottom of the hollow should be lined with about ⅛in. of Plasticene.

Each pole of each magnet may now be wound to capacity with 27s.w.g. copper enamelled wire. It is necessary to have the same number of turns on each pole, so that each turn will have to be counted. Each pole will then have a resistance of approx. 3Ω.

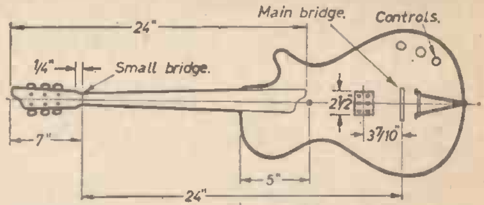
The magnets should be wired in series as shown in the circuit in Fig. 10, and the connections to the potentiometers made as shown. The output from the controls may be connected directly to the input of an amplifier, if it has a sensitivity of 2 millivolts or thereabouts, but otherwise it will have to be connected through the transformer.

Having finished the winding, and connected the three magnets to the amplifier by way of the controls, they should work. It is now necessary to make each string sound from the loudspeaker at the same volume. This is done by pushing the magnets into the Plasticene, so that each one is the same height, ¼in. below the strings. Keeping them the same height, they may be moved from side to side until the sound from each is at the same volume. The three controls may help to do this. It is very important to adjust this accurately, and it may not be easy.

When the constructor is finally satisfied, the three magnets must be held securely. The best way to do this is to pack them with plastic wood, being careful not to "jog" them. The whole unit may later be boxed in with any thin wood available, and then painted black.

The wires from the pick-up to the controls may be set into a groove in the back of the body, so that the whole of the back can be polished.

Fig. 1.—Body details.



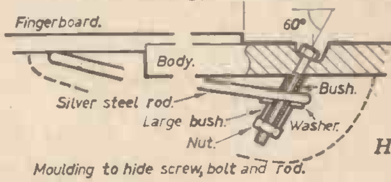


Fig. 2.—Hole drilled at 60°.

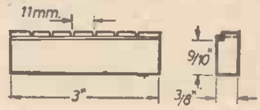


Fig. 3.—The main bridge.

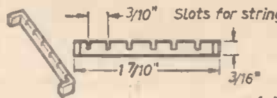


Fig. 4.—The small bridge.

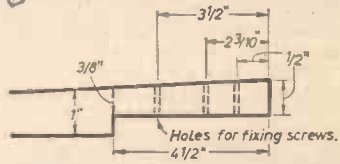


Fig. 5 (Above).—A wedge must be cut away.

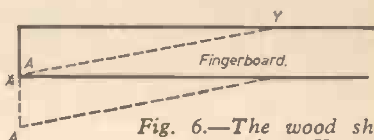


Fig. 6.—The wood should be sawn from X to Y.

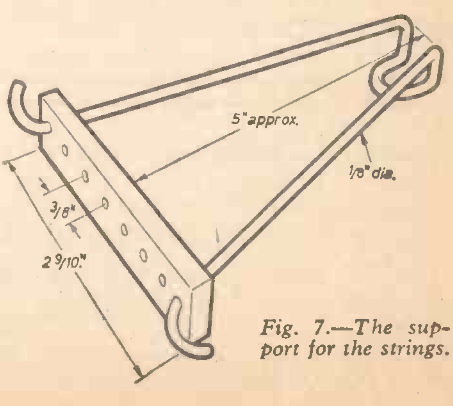


Fig. 7.—The support for the strings.

MAKING AN Electric Guitar

CONTINUED

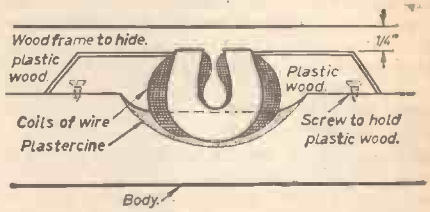
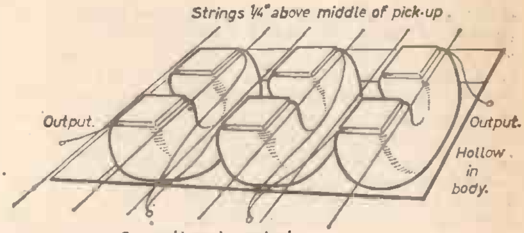


Fig. 8.—Fixing the magnets.



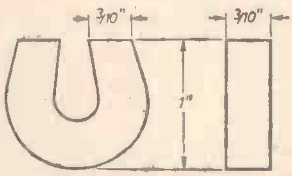


Fig. 9.—Measurements and layout of magnets.

Polishing the Body cannot be done until the pick-up is completed, because of the danger of scratching it. The "arm" can be removed, including of course the strings and the string support. The whole body should be well sanded, and finished off to a very smooth finish, before the polish is applied. If the body has been made of mahogany, then it is better to polish with a white (French) polish. This is best applied with a soft clean brush, allowing each coat to dry well before the next is applied. After about three coats, it should be rubbed down with a fine sand paper, or wet pumice powder. This should be repeated twice. and then about ten final coats put on. It may then be finished off with a wax polish.

List of parts

1 length 24in. x 3in. x 1in. obeche or similar hardwood.
3 horseshoe magnets—"ECLIPSE"—Fig. 9, mahogany, 14in. x 2in. x 18in.
1 set of worm drive "pegs".
2 "00" gauge railway track.
2 10Ω variable resistances.
1 20Ω pot.
Some 27s.w.g. copper enamelled wire.
Small tin Cascamite powder glue for frets.
3in. ¼in. dia. bolt.
1 13in. length of ⅛in. dia. silver-steel.
1 13in. length of ¼in. dia silver-steel.
Some Plasticine.
Small tin of plastic-wood.
O.P. Transformer, ratio approx. 100-1.
Length of shielded 'mike' cable.

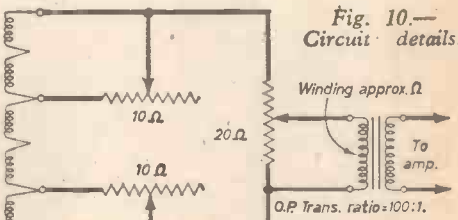


Fig. 10.—Circuit details.

Fig. 11 (Below).—The body shape and dimensions.

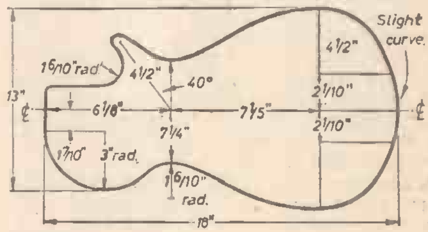
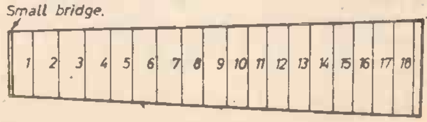


Fig. 12.—(Right) Distances from main bridge to each fret:

1=22·66in.	6=16·96in.	11=12·71in.	15=10·09in.
2=21·38in.	7=16·02in.	12=11·99in.	16= 9·519in.
3=20·18in.	8=15·11in.	13=11·32in.	17= 8·984in.
4=19·04in.	9=14·27in.	14=10·69in.	18= 8·480in.
5=17·98in.	10=13·48in.		



BOUNCE-FLASH Photography

By A.E.Bensusan

FLASH is the modern photographic illuminant, but the disadvantage of having the flashgun mounted on the camera and pointed straight at the subject lies in the dense shadows thrown by the subject and the extremely rapid fall-off in the power of the flash. Conventional bulbs obey a rule which causes the light to dim according to the square of the distance. Thus, a photograph taken with the subject 16ft from the flash requires four times the exposure needed at 8ft although the distance ratio is 2:1.

The latest technique is to use "bounce-flash". This entails pointing the flashgun upwards and at an angle, directing it so that the axis of the flash strikes the ceiling at a point roughly midway between the subject and the gun. Since most ceilings are either white or, at any rate, reasonably light in tone, a considerable part of the flashbulb output is reflected down on to the subject, but in the form of soft and almost shadowless lighting.

Fig. 1.—A typical bounce-flash picture.

Some of the flash is bound to hit adjacent walls, and further gentle reflection is provided. This delicate light, coming from many directions, is quite unlike normal flash, and the effect in photographs is so subtle that it is impossible to detect that anything other than well-diffused daylight has been employed. Textural renderings are particularly fine.

Although the centre of the flash is directed at one point, the light cone from the flashgun actually covers a wide area of the ceiling. The reflection on to the subject is, accordingly, reasonably uniform throughout an extensive depth. So, fall-off is minimised and dark backgrounds are avoided.

Exposure presents little in the way of problems. The normal guide number is ascertained for the size of flashbulb, the speed of the film, and the camera shutter speed. The relevant tables are printed on the packs of all brands of bulbs. However, instead of dividing the guide number by the distance direct from the camera to the subject, the path actually taken by the flash is used. Therefore, the divisor must be the sum of the distances from the gun to the ceiling and from the ceiling to the subject.

A further consideration is that some of the light is absorbed by the ceiling and other surfaces, and due allowance must be made for that. To compensate, the lens iris should be opened up by two stops for white ceilings of average height. A little more exposure, say another stop, is required when the ceiling is dark or fairly high.

This is not as complicated as it might sound, as can be seen from the example given here. A camera loaded with 50 A.S.A. film and having the shutter set to 1/100th of a second was used in conjunction with a No. 1 flashbulb for Fig. 1. The guide number of 110 was obtained from the bulb package. The distance from flashgun to subject via the ceiling was 10ft. Dividing the guide number by the distance gave an aperture of f11, which was opened up by 2 stops to f5·6 for the photograph.

It is not practicable to hold the flashgun at an angle with one hand while the other controls the camera. The best method is to make up an adjustable bracket to fit into the shoe on the top housing of the camera to act as a flexible mounting between the camera and the flashgun. The gun may then be tilted as required and will retain its position while the photograph is taken.

Fig. 2 gives dimensions and constructional details of a neat bounce-flash bracket. Brass or mild steel are the most satisfactory materials, as

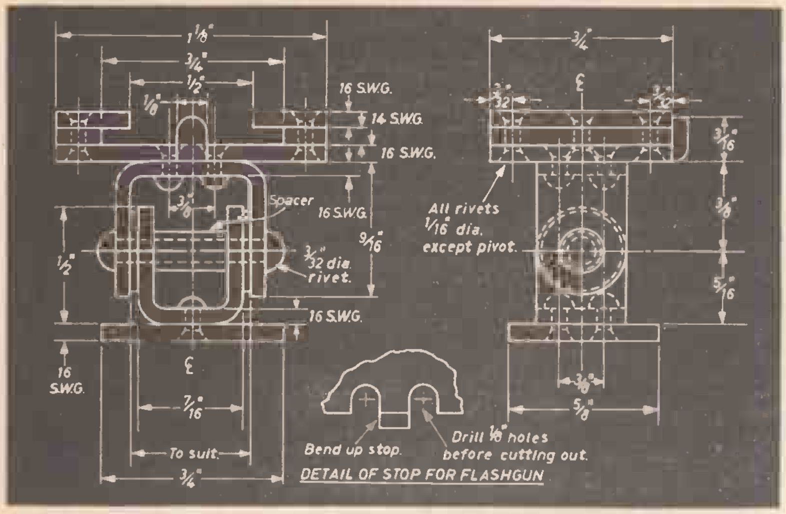


Fig. 2.—Details of the bracket and assembly of the components.

aluminium alloy, although more easily worked, is not so rigid or hardwearing at the pivot. The drawing shows assembly of the components with $\frac{1}{16}$in. dia. rivets, but the use of Araldite and similar epoxy resin adhesives should not be overlooked, for projects of this kind are more simply carried out with adhesives than with rivets or screws. In addition, joints made with these resins are practically indestructible.

If an adhesive is used, the stop for the flashgun may be attached to the front of the shoe section as a separate part. If not, it may be cut in one with the base of the shoe and bent up. Before cutting out this component from a larger piece of metal, 2 holes $\frac{1}{8}$in. dia, are drilled as shown in the inset sketch. The front of the shoe base is then cut and the holes run out into that face. The stop will bend up cleanly and easily.

The shoe is made up as a sub-unit and attached to the upper bracket. The foot is fitted to the lower bracket and a $\frac{3}{32}$in. dia. rivet threaded through the holes, trapping the two spring washers and a spacer tube in the appropriate positions. The second head of the rivet may now be formed, snapping it over until the two sub-units have the required degree of friction between them.

It is preferable to finish the bracket black, as bright metal just above the sighting eye tends to be distracting. The foot of the bracket should slide easily but firmly into the camera shoe, and it may be necessary to chamfer the edges of the foot slightly to achieve this. The flashgun, in its turn, slides into the shoe on the bracket. Most camera shoes and flashgun feet have built in leaf-type springs to ensure stability. The pocketable size of the bracket, compared with a standard flashgun, is amply illustrated in Fig. 3.

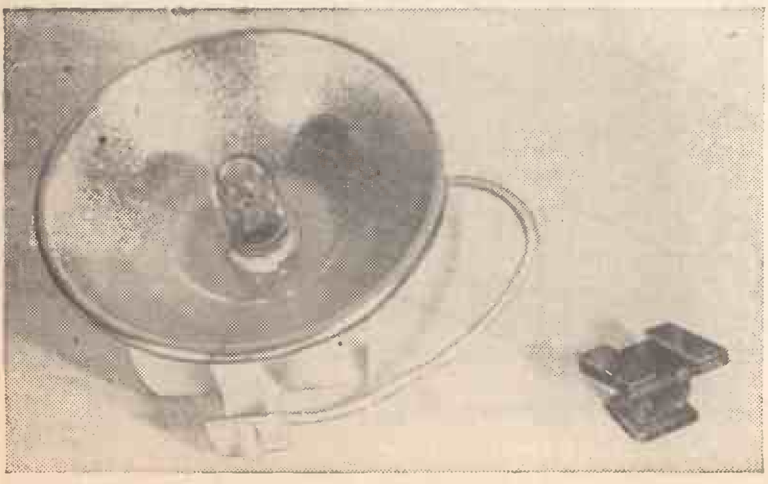
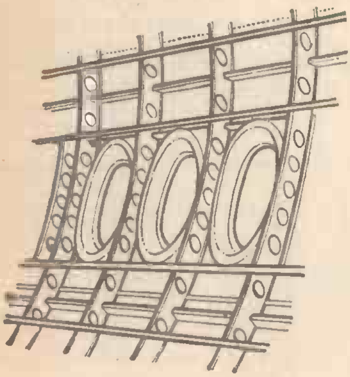


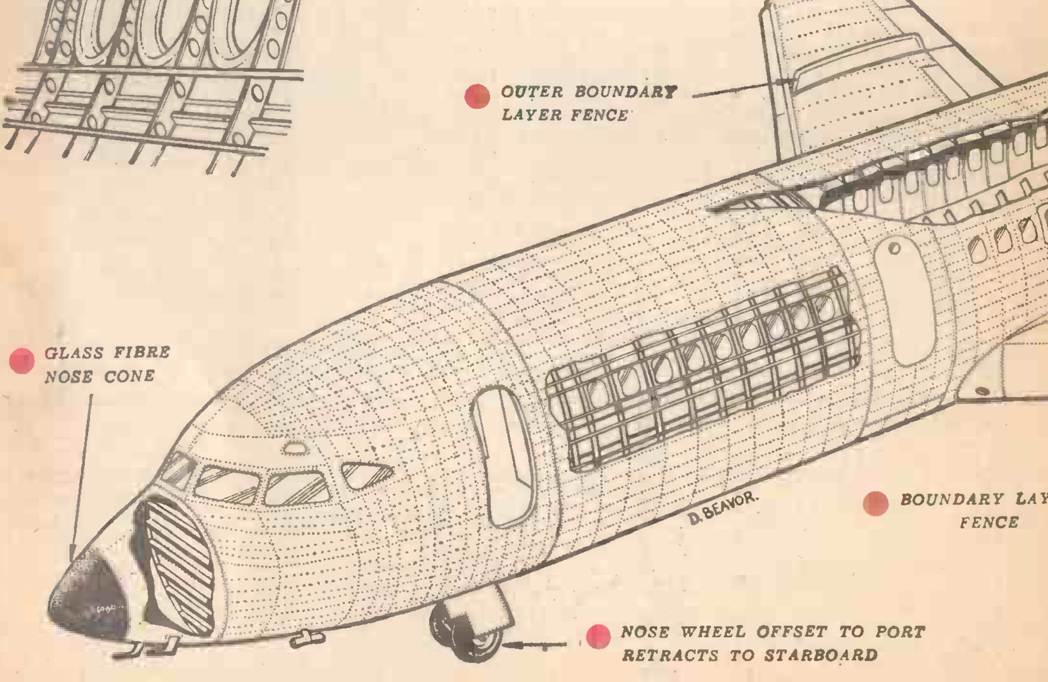
Fig. 3.—A standard flashgun alongside the bounce bracket.

THE TRIDENT

TECHNICAL INFORMATION AND ILLUSTRATIONS OF BRITAIN'S LATEST AIRLINER COMPILED BY DAVID BEAVOR



Window panel section showing main frames and stringers to which the inner and outer skin is riveted (outer skin in place). Window ports are double glazed when finished.



" Trident "

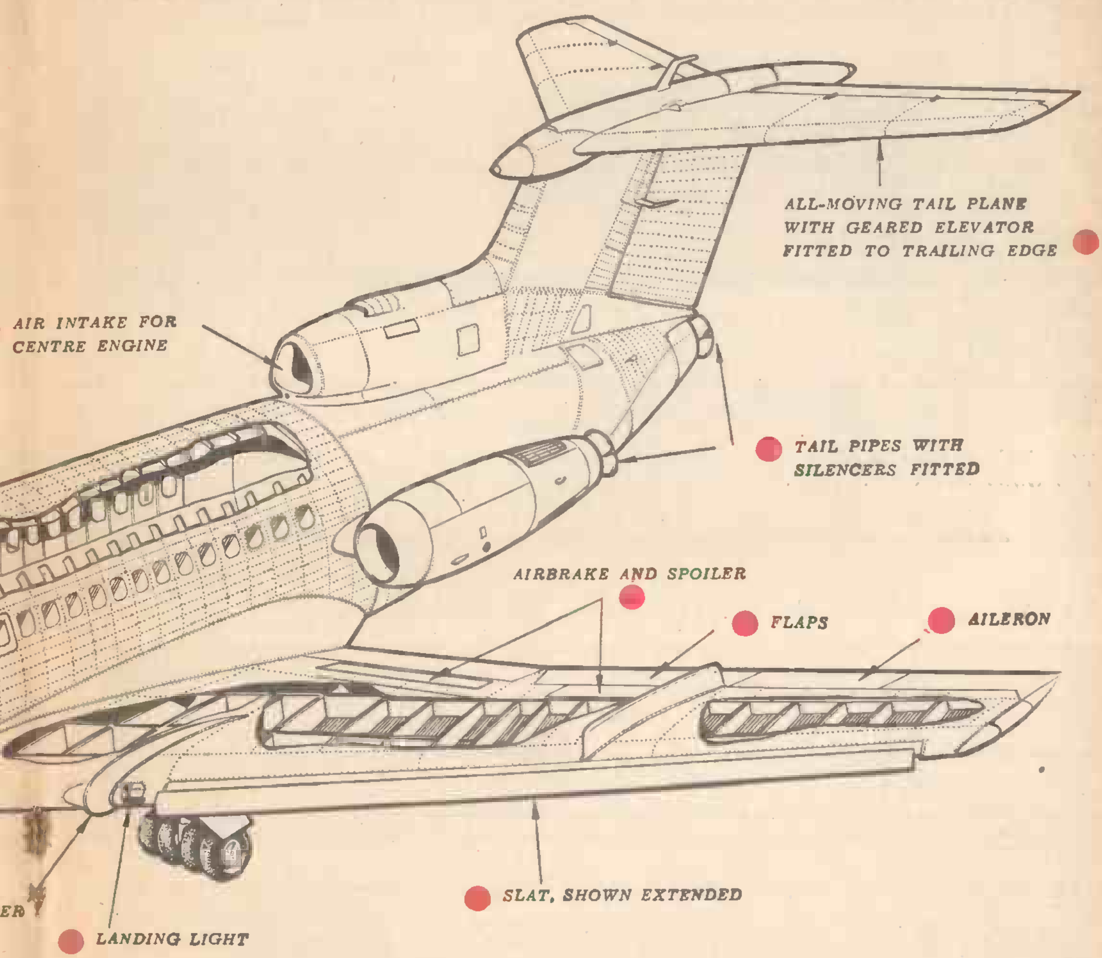
THE D.H. 121 (better known to us as the Trident) marks a new step in the British aircraft industry. It is powered by three Rolls-Royce Spey by-pass gas turbine engines, and, designed initially for B.E.A. this aircraft provides for cheap and safer travel.

The Trident will carry 77 passengers (18 first class and 59 economy class), or alternatively 101 economy-class passengers in a cabin width giving the same spacious comfort, even at six abreast, as the world's largest airliners. These passenger loads, combined with more than a ton of freight can be carried on practical stages of nearly a thousand miles. Its all up weight is 107,000lb and and it has a maximum cruising speed of 606m.p.h. although the speed for best economy is 585m.p.h. The engine arrangement has a French flavour to it and reminds one of the Caravelle.

Trident has all that is needed for a fairly short take-off, being fitted with full span leading edge slats and flaps and when in the air the all-moving tail plane, which has adjustable incidence, trims the aircraft. All the latest aids to air navigation are fitted including blind landing devices.

Designed for economy.

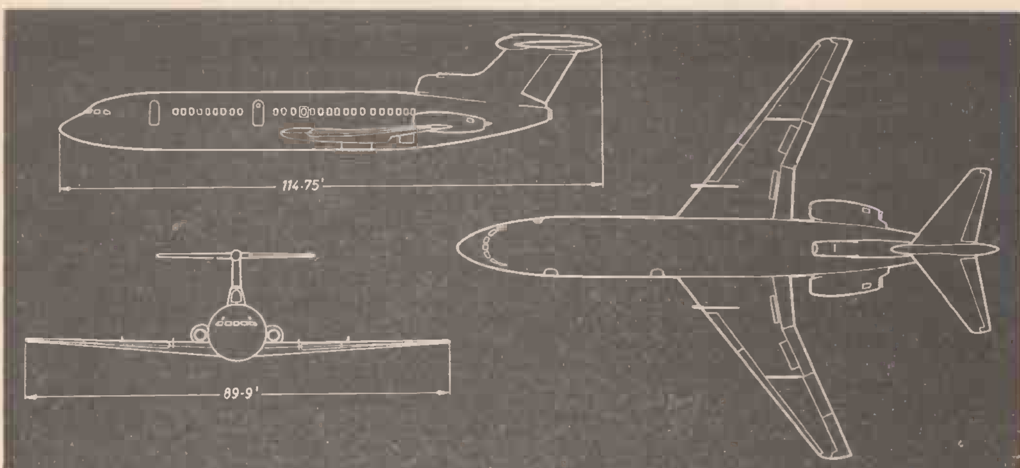
The choice of the Trident's cruising speed was influenced by the need to provide the lowest possible operating cost per aircraft (mile and per seat) mile. It is becoming increasingly apparent that the development of air transport over the next ten years must be in the direction of improved economy and it is difficult to foresee, even after that time, how a short-haul supersonic airliner would be able to achieve the degree of economy shown by the Trident. To achieve the growth of traffic so necessary for the future success of the airlines it

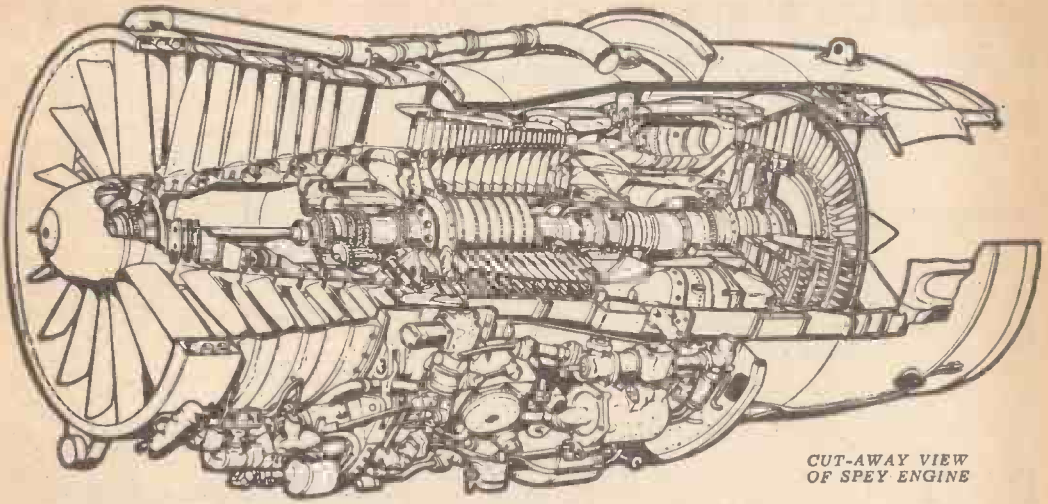


Perspective drawing showing the double skinning that is employed on the fuselage of the Trident, also wing position, undercarriage, etc.

Photograph shows close-up of undercarriage wheel arrangement on the main oleo, also main retracting arm and wheel well cover. The mechanic servicing the undercarriage gives some idea of the size.

General arrangement drawing giving dimensions.





CUT-AWAY VIEW OF SPEY ENGINE

The Spey Engine benefits greatly from the maker's experience with the Conway by-pass engine now in world-wide airline operation. The Conway attained an overhaul life of 1,600 hours within 14 months of entering service and it is expected that the Spey will reach 2,000 hours between overhauls within two and a half years.

The by-pass principle used in the Spey results in high efficiency and a good thrust-weight ratio combined with excellent fuel economy. In addition this type of engine has a rapid power response and its low jet velocity greatly reduces noise. Compressor whine is eliminated by compressor design. There are 30 million hours of accumulated experience with Rolls-Royce turbines. The Avon engine in the Comet is now running 3,200 hours between overhauls (equal to 1½ million miles of operation, or 60 circuits of the Earth). Rolls-Royce are acknowledged as the world's leading builders of airliner jet engines.

is essential that the public should be offered the lowest possible fare commensurate with modern standards of speed and comfort.

Constructional Details

The fuselage is all metal semi monocoque construction, flush riveted, with the usual pressurised interior, full span leading edge slats and flaps. The main portions of the wings are fuel tanks feeding the two outrigger engines, the centre section holds the fuel tank for the centre engine. All-moving tailplane with geared elevator fitted at the top of the fin. The two outrigger engines are set aft of the main cabin.

Dunlop wheels are used on the undercarriage; these are fitted with disc brakes and Maxaret anti-skid devise. The main wheels fold into wings and fuselage, the nose wheel folds to starboard in the fuselage. Landing lights are fitted into the leading edge of the inboard wings, with boundary fence fitted to side of light.

Aerodynamically balanced Ailerons and Elevators are servo assisted. Airbrakes and Spoilers fitted forward of the flaps are hydraulically operated.

Development

By the end of 1959 De Havillands Technical Services Department had assembled the fuselage nose of the Trident for pressure testing in the water tanks. This department also built a full size mock-up of the Trident from which the detail arrangement of the cockpit and the interior furnishings were decided; this also applied to the mock-up units in the bays and around the rear end of the aircraft.

The flying control and hydraulic rig contain a great number of aircraft parts and include all the hydraulic jacks, hydraulic pumps and motors to operate the leading edge and trailing edge wing flaps. The electrical system test rig contained the complete electrics of the aircraft which enabled a vast amount of testing to be done on the ground.

All the electrical components in the aircraft, fuel pumps, lighting, the domestic load of ovens and urns and other miscellaneous equipment, were operated from the rig which derived its power from the A.E.I. aircraft alternators and Hobson Constant - Speed drives, operated by 120h.p. variable speed commutor motors representing the aircraft engines.

Blind Flying Aid

Trident is fitted with hydraulically operated controls for lateral and longitudinal control. " Autoflare " the blind landing device is also fitted which enables the crew to land the aircraft in conditions that would normally mean diversion or flight cancellations. Autoflare also means that Trident can land in bad weather at airports with very moderate blind landing aids as well as major airports.

L.B.S.C's $3\frac{1}{2}$in. Gauge
EVENING STAR

PART 14
CONTINUATION OF VALVE GEAR DETAILS

Right-hand lifting arms and reversing shaft

The reversing shaft is a piece of $\frac{1}{4}$in. round steel faced off at each end to a length of $6\frac{3}{8}$in. Chuck in three-jaw and turn down one end to $\frac{7}{32}$in. dia. for $\frac{5}{16}$in. length. The arms are sawn and filed to the shape shown in Fig. 89 from two pieces of $\frac{1}{16}$in. soft mild steel 2in. x $\frac{3}{8}$in. soldered together as before. First drill the holes No. 32, ream the small boss $\frac{1}{8}$in. and open out the holes in the larger boss with No. 3 drill. Press one arm on the reduced end of the shaft tight against the shoulder, and the other just on the end, so that they are $\frac{3}{16}$in. apart. Line them up with a piece of $\frac{1}{8}$in. silver-steel through the holes in the small boss, then braze or silversolder them to the shaft. Quench in cold water, and clean up. Incidentally here is a tip for an extra posh finish, given to me by an ex-instrument-maker, who had a reputation for the excellent finish of his work; use fine-grade emery cloth which has had beeswax rubbed on it.

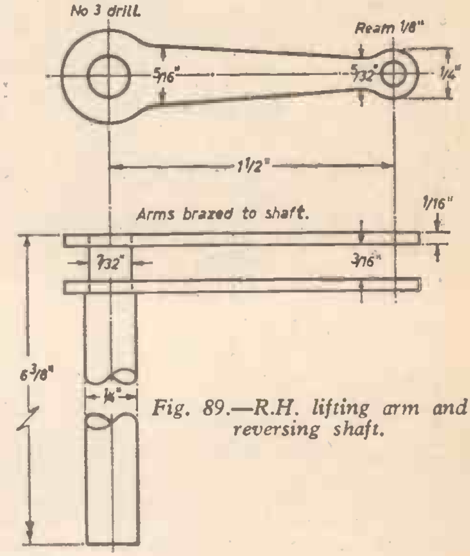


Fig. 89.—R.H. lifting arm and reversing shaft.

Return cranks

Each return crank will require a piece of $\frac{7}{16}$in. x $\frac{3}{16}$in. mild steel, $1\frac{1}{2}$in. long, sawn and filed to the shape shown in Fig. 76 (February issue). Set out and centrepop the location of the holes at 1in. centres, then drill the hole in the round end with No. 23 drill, and in the squared end with Letter C or $\frac{15}{64}$in. drill. Put a $\frac{1}{4}$in. parallel reamer in this one, just far enough to make it a very tight fit on the reduced end of the driving crankpin. Slightly recess the back of the crank as shown by milling or filing, and countersink the pin hole.

To make the crankpin, chuck a piece of $\frac{5}{16}$in. round silver-steel truly, face the end, turn down $\frac{5}{32}$in. length to $\frac{1}{8}$in. dia. and screw $\frac{1}{8}$in. or 5B.A. Part off at $\frac{1}{2}$in. from the end, reverse in chuck and turn $\frac{5}{32}$in. of the other end to $\frac{5}{32}$in. dia. leaving a full $\frac{3}{16}$in. between the shoulders. Squeeze this spigot into the small hole on the flat side of the crank, putting a nut over the thread to protect it; rivet over the end into the countersink, and file flush.

The crank is prevented from turning on the main crankpin, and upsetting the valve timing, by two transverse bolts passing through the thickness of the square end of the crank, cutting through the reduced part of the main crankpin. Make two centrepops on the side of the square end, one at $\frac{3}{32}$in. from the bottom, and the other at $\frac{1}{4}$in. above it, both dead on the centre-line. Put a piece of $\frac{1}{4}$in. rod in the hole, grip the crank horizontally in a machine-vice on the drilling-machine table, and drill both holes with No. 43 drill. Plugging the hole will prevent any wandering of the drill, and the grooves left in the plug will be the same as those which will be in the main crankpin when the return crank is fitted. Knock out the plug, and make a cut with a fine hacksaw, from the end of the crank to the hole, which will ensure a firm grip on the main crankpin when the bolts are tightened. The bolts are $\frac{3}{8}$in. lengths of silver-steel screwed 8B.A. at each end, and furnished with commercial nuts. Silver-steel, by the way, is obtainable in all the B.A. diameters (I keep a small stock of most of them, and find them handy, especially when repinning a worn valve gear) but as an alternative, the holes in the return crank could be drilled No. 41, and $\frac{3}{32}$in. steel used for bolts, with the ends reduced and screwed to take 8B.A. nuts; anything larger would look clumsy.

Assembling the valve gear

Before the return cranks can be correctly set, and the eccentric-rods made, it will be necessary to assemble and temporarily erect each side of the valve gear. Remove the expansion links from the bearings, put a die-block in the slot at one end, put the long fork of a radius-rod over link and die-block, and squeeze a piece of $\frac{1}{8}$in. silver-steel through the holes in the fork and block. File flush at each side, then slide the fork up and down, to make certain that it doesn't foul the trunnion blocks at each side of the expansion link. If it does, a slight touch with a file will soon put matters right. Only what one of my old fellow-conspirators on the L.B. and S.C.R. called "fag-paper clearance" is needed. Connect the other end of the radius rod to the top of the combination lever with one of the special nutted valve-gear pins previously described and illustrated, then replace the expansion link in its bracket.

Put the combination lever in the jaws of the valve crosshead, line up the holes in the jaws with the hole in the combination lever, and put a pin through the lot. Connect up the bottom of the lever to the cross head drop arm by aid of the union link, and pin both ends. Set the main crank on bottom centre, and put the return crank on the end of the pin in such a position that it inclines toward the cylinder, the little crankpin on the end approximately $\frac{7}{16}$in. from the centre of the axle.

Now watch your step, for this is really important. Set the main crank on front dead centre, and be sure that it *is* dead centre, not a scrap above or below. Set the expansion link in such a position that you can run the radius rod and die-block from one end of the slot to the other, without any movement of the valve spindle taking place. The link will then be exactly in mid-movement. Fix it there so that it can't accidentally shift; I usually put a wedge between link and bracket, with a small cramp over the lot. Next, with a pair of dividers, take the distance between the centre of the hole in the tail of the link, and the centre of the return crankpin. Now turn the wheels until the main crank is on back dead centre, and apply the divider points to the hole in the link tail and centre of the return crankpin as before. If they tally, it will be just as much a miracle as a golfer holing in one stroke. If they don't, which is far more likely, adjust the return crank until the pin moves half the distance that it is "out", then repeat process. When the distance between centres of hole in link tail and return crankpin tally exactly on both front and back dead centres, the return crank is correctly set, *and the distance between the divider points is the exact distance between the centres of the eccentric-rod bush and the pinholes in the fork*, so take care to avoid shifting them until the eccentric-rods are made. It's as simple as that!

The return crank can now be fixed in position. Taking great care to avoid moving it in the slightest, put a strong cramp, or a hand-vice, or anything else that will grip tightly, over the sides of the square at the end of the return crank, leaving the upper transverse hole clear. Run a No. 43 drill through it so that the drill cuts a groove in the crank pin, as it did in the plug. Put a bolt in, and screw up as tightly as possible without stripping the threads. Remove cramp, drill the other hole and put a bolt in that as well. The crank should then be as firmly fixed as the Rock of Gibraltar, yet it can be instantly removed in case of necessity, and replaced without the slightest trouble in exactly the same position.

Eccentric Rods

Two $4\frac{1}{2}$in. lengths of $\frac{1}{2}$in. x $\frac{5}{16}$in. mild steel will be required for making the eccentric rods. Scribe a line down the middle of the wide side, and make a centrepop on it at $\frac{5}{16}$in. from one end. From this, with the dividers set as mentioned above, strike off the length of the rod, and make another centrepop at the exact point where the line struck by the divider point crosses the centre-line—and when I say "exact", I mean just that. The divider points should go plumb into the middle of each centrepop when applied to both at once. On the full-size engine, the length between eccentric-rod centres is 5ft $3\frac{23}{64}$in. and when they get down to sixty-fourths in full-size to get correct valve setting, it doesn't need Sherlock Holmes to deduce what is going to happen to the setting on a $3\frac{1}{2}$in. gauge job if a $\frac{1}{64}$in. error creeps into that size! By getting the exact length of the rod in the way I described above, all trouble and source of error is avoided.

Mark off the outline of the rods as shown in Fig. 90 and proceed to cut them to shape, drilling, slotting and bushing as described for the other rods in the valve gear. Both right and left-hand rods are the same; although the boss is offset, the rod fits either side by merely turning it over. On the full-size engine, the boss contains a ball bearing. While this isn't absolutely necessary on the little one, as a bronze bush stands up to the job quite well, a ball bearing could be fitted with advantage, if one of the requisite size is available. The outside diameter should be not more than $\frac{3}{8}$ or 10mm. and the boss should be bored out to a tight push fit for the bearing. The return crankpin must, of course, be turned to fit the bore of the bearing. As most of the stress of driving the valve gear comes on the return crankpin bearing— and this is considerable when the engine is hopping along at a tidy lick with a heavy load — a ball bearing reduces the friction practically to nil and, as wear is negligible, it should last the lifetime of the engine.

Fitting the reversing shaft

First remove the reversing screw and nut, then push the shaft, with right-hand lifting arms attached, through the bearings in the brackets, from the right-hand side of the engine. Put the left-hand lifting arms through the slot in the front of the L.H. bracket, line up the bush with the shaft, and push the shaft through it, keeping the lifting arms on both sides of the engine in line, as near as you can "by eye". Drop the pins on the sides of the nut, in the slots at the top of the vertical arm, and replace the screw.

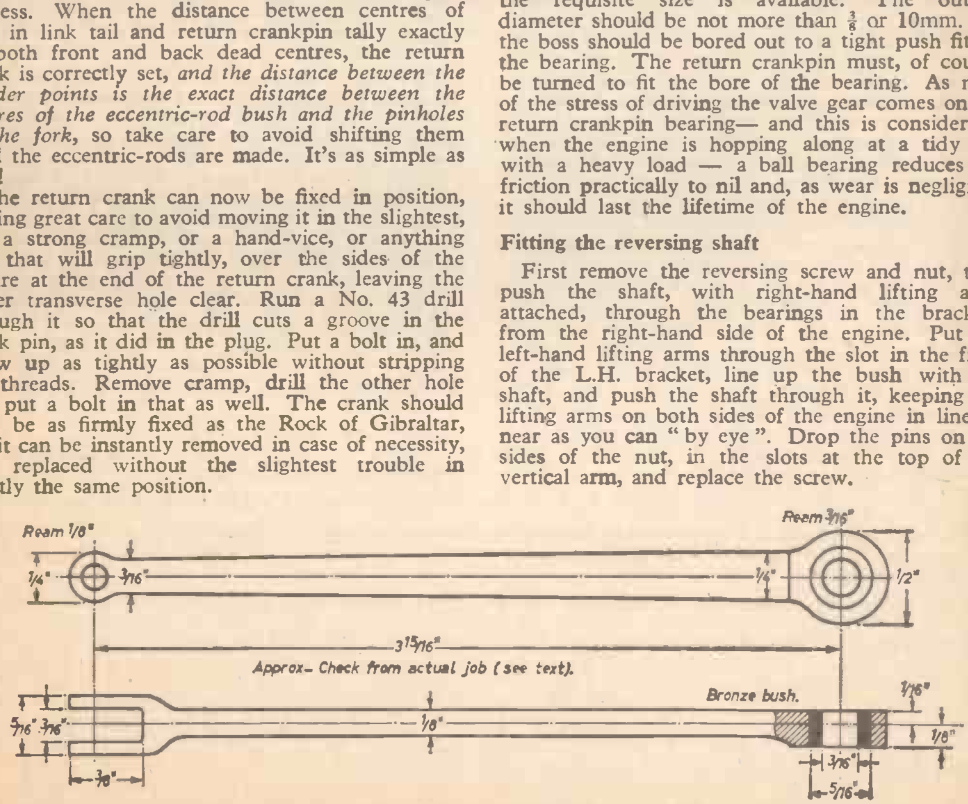


Fig. 90.—Eccentric rod.

Next, put the lifting links in place in the long forks of the radius rods, as shown in the valve gear assembly drawing Fig 68 (January issue), then the upper ends can be fitted between the lifting arms and secured by two of the nutted pins. Now turn the reversing screw until the pin in the left-hand die-block is dead in line with the expansion-link trunnions; then take a look at the right-hand side and see if that die-block pin also lines up exactly with the link trunnions. If it doesn't, adjust it until it does, so that both sides move exactly in unison when the reversing screw is turned. When O.K. drill a No. 43 hole through the boss on the left-hand lifting-arm assembly, and squeeze in a piece of 3/32in. silver-steel, which will effectually prevent any attempt by the right and left-hand lifting arms to get out of line. When the die-blocks are in the middle of the expansion links—that is, mid-gear position, there should be no movement of the radius rods when the wheels are turned by hand. If one rod moves and the other doesn't, the lifting arms have not been correctly lined up, and this should be corrected right away, otherwise the valve-setting will not be the same on both sides of the engine, and the beats will be irregular or syncopated.

Valve Gear for Slide-valve Cylinders

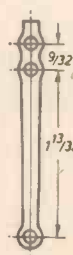
As previously mentioned, the slide-valve cylinders were arranged so that the same layout of valve gear described for the piston-valve cylinders, could be used for operating the slide-valves, by changing over the connections at the top of the combination lever, and setting the return crank to lead the main crank instead of following it. Generally speaking, this is quite correct, as can been seen from the drawing Fig. 91, but there is another factor to be considered, which will necessitate slight variation in the dimensions of some of the parts. Owing to the inclination of the cylinders, and the necessity for keeping the valve gear below the running-boards, the centre of the expansion link is well below the point where the radius rod is connected to the combination lever, and the radius and swing of the expansion links are arranged to suit. When the connection is dropped below the valve-spindle crosshead, the point of connection on the combination lever is brought 1/16in. nearer to the centre of the expansion link. This means that the radius of the link will be 4¾in. instead of 4 13/16in. all the other dimensions, and the method of construction, remaining the same. No cause for alarm!

Now, if we use the same combination lever, it would have to be lowered 1/16in. and this would not only mean excessive angularity of the union link, but would affect the vertical distance between the combination lever and the crosshead arm. This is easily got over. Simply reduce the distance between the pinholes at the top of the lever, and shorten the tail end of the lever a proportionate amount, so that the lever has a slighly greater amount of oscillation, and the top of it moves just as much as it did before. The amended dimensions are shown in Fig. 92, the construction remaining unchanged.

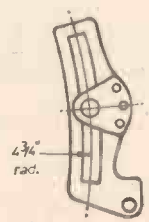
Now take the radius rod. The overall length between the end pin-holes has to be the same as the radius of the expansion link, viz. 4¾in. but owing to the lower point of connection to the combination lever, the expansion link will need to tip over a little more at the top, in the direction of the cylinder. To prevent it knocking its head against the lifting link every time it makes its bow, we shall have to shift that merchant a little farther away, 13/16in. instead of 11/16in. and lengthen the depth of the long fork by 1/8in. The amended dimensions are shown in Fig. 92, the offset of the forks and the general construction remaining as previously described. The long arms on the reversing shaft at both ends, must also be lengthened to match, see Fig. 92.

The return crank will also need shortening by 1/16in. The hole in the link tail is above the centre-line of cylinders and driving axle, increasing the angularity of the centre-line of the eccentric rod, so that the circle swept by the return crankpin cuts it above the cylinder centre-line when the pin is on front dead centre, and below it on back dead centre. This is shown in Fig. 91. With the return crank leading the main crank, the measurement is taken from the centre of the main crankpin on bottom centre, to the back dead centre of the return crankpin, and is approximately as stated. It could, of course, be calculated, but the result would be a line of decimals reaching from Tottenham-court-road-street to Timbuctoo, and life is too short for that, in my case, anyway! If the return crank is made 15/16in. between centres, and the exact length of the eccentric-rod obtained as fully described in the preceding paragraphs, the

Dimensions not shown are the same as for P-V cylinder gear.

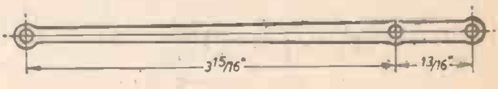


Combination lever.

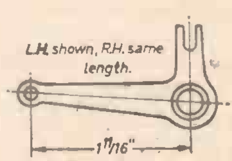


Expansion link.

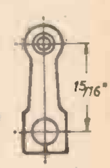
Fig. 92.—Variations in valve gear.



Radius Rod.



Reversing Arm.



Return Crank.

Dimensions needed for S-V cylinders.

engine will do the job in the approved L.B.S.C. style. Incidentally the original return crank could be used, setting it to follow the main crankpin as with the piston-valve cylinders, in which case the engine would go ahead when the dieblock is in the upper half of the expansion link, same as the Maunsell "mongolipers" (2-6-0) on what used to be the Southern Railway. This would be an advantage if the reversing screw has been made with a right-hand thread, as the engine would then go in the same direction as the reversing wheel is turned.

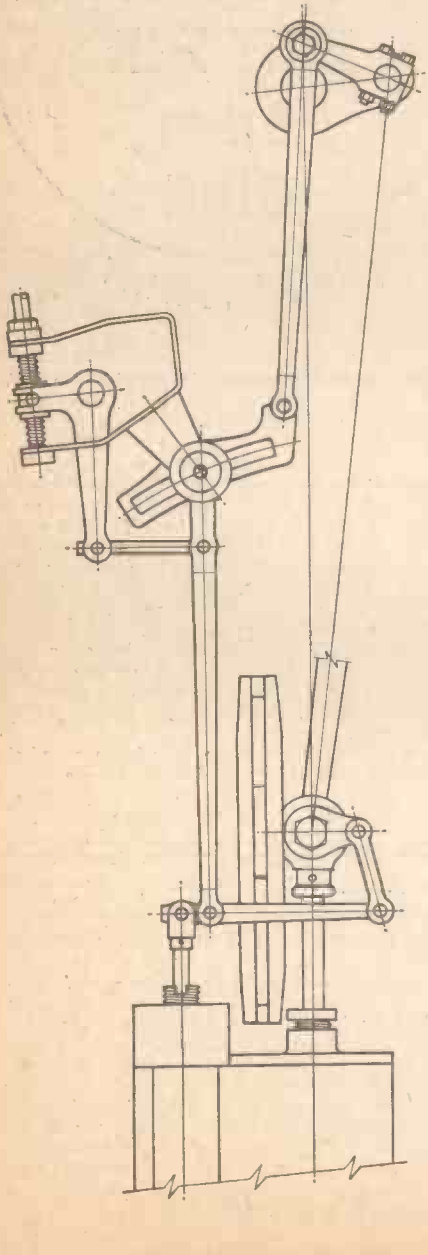


Fig. 91.—Arrangement of valve gear for slide-valve cylinders.

Exhaust pipe arrangement for double chimney

The original design of the class 9 engines called for a single chimney and blastpipe, same as the *Britannias*. However, the good folk at Swindon had been doing some experimenting with double chimneys and blastpipes, with considerable success, so they applied this type to the later class 9's, including *Evening Star*. Contrariwise, as Mary Ann would remark, I have got better results with the single chimney in 3½in. gauge size. As I've often remarked, Nature won't be "scaled", and little engines have to be designed to suit the rail gauge. Anyway, to suit the fancy of builders of this engine, I will describe both types—just take your choice!

I mentioned previously that the cylinders should not be permanently erected, but only temporarily with two or three bolts, so take them off, easily done by disconnecting the radius-rod from the combination lever, taking out the screws in the guide-bar bracket, and removing the crosshead pin. This is necessary for the insertion of the screws which hold the exhaust-pipe flanges to the frame, see Fig. 93. Scribe a circle ⅝in. dia. around the exhaust hole in the frame, drill three No. 41 holes on it at an equal distance apart, and countersink them.

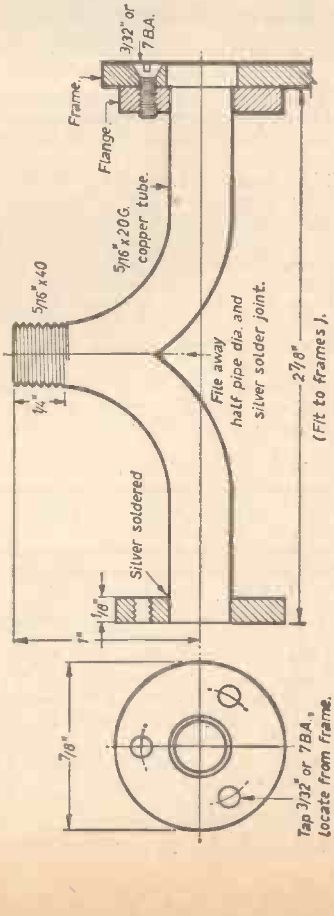
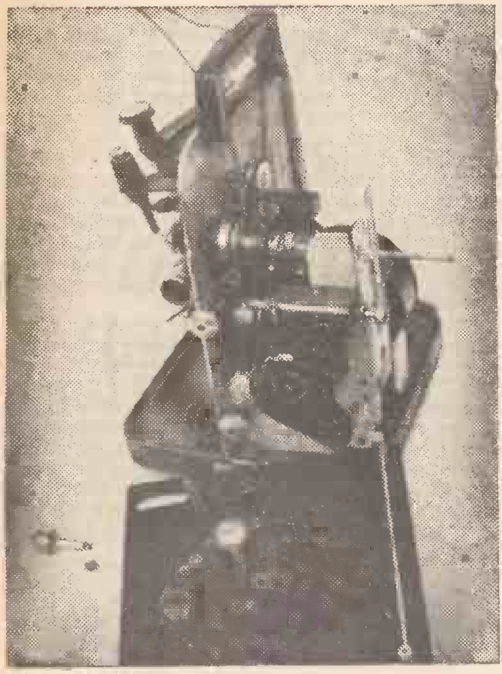


Fig. 93.—Exhaust pipes and flanges.



A SOUND SYNCHRONISING UNIT FOR 8mm CINE

By J. M. Turner

WITH the ever increasing popularity of 8mm cine photography many amateurs will have wished for a sound track to accompany their films.

For satisfactory results it is essential that the tape recorder and projector be synchronised.

The method given here was finally chosen after much experimenting as being by far the simplest and most efficient for amateur construction.

The degree of synchronisation obtained is extremely good. After a three-quarter-hour continuous run which is about the longest possible with standard equipment, the synchronisation at the end is still excellent.

The cost of the unit to be described should not be more than a pound if everything is purchased, but most of the material can be found in the junk box.

Some projectors may be designed in such a manner that it will be practically impossible to add such a unit, but this must be determined by inspecting the existing layout.

A point to bear in mind if the construction of a home made unit is being considered is the possible effect on exchange value, as a dealer will not appreciate amateur alterations to a standard projector however much the intrinsic value is increased. If an exchange deal is envisaged it is suggested that the side cover of the projector, housing the motor and associated mechanism be removed and stored until required, a temporary cover being made out of aluminium or hardboard. The actual alterations inside the projector consist only of a few additions that can be easily removed.

Principle of Operation

With the method adopted for this unit the speed of the tape recorder controls the speed of the projector by means of the recording tape. The tape is led off from the recorder after it has passed the recording head and capstan, and is taken to the projector where it passes over a pivoted brake pulley and on to a capstan wheel, the shaft of which is connected to the projector mechanism (see Fig. 1). A rubber roller is kept in firm contact with the capstan to prevent any slipping of the tape, in a similar manner to the arrangement on the tape recorder itself. From the capstan and rubber roller the tape is returned via guides to the take-up spool on the recorder.

The brake pulley is connected by an arrangement of levers to a brake pad inside the projector which bears upon a suitable wheel or pulley, and provides a smooth braking action as the pulley is moved across.

The projector is set to run at a faster speed than normal and, with the tape connected up as shown, both the projector and recorder are switched on together. As the projector is set to run fast it will take up more tape than is released by the tape recorder, thereby shortening the loop over the brake pulley. This moves the lever arm carrying the brake pulley and applies the brake with an increasing pressure until such a speed is obtained on the projector that it just takes up the tape released by the recorder. A light spring tends to keep the brake pulley in the off position.

As will be realised, the diameter of the capstan wheel is critical, and is dependent both on the speed of the recorder and the r.p.m. of the shaft in the projector, which is extended for the capstan.

The most convenient tape speed is $3\frac{3}{4}$in. per second, and the best and probably the only suitable place to obtain a drive for the capstan wheel is from one of the film transport sprockets (see Fig. 3). The shafts of these sprockets pass through bearings into the motor side of the projector, usually driven by a worm as shown.

The shaft of one of these sprockets must be extended sufficiently to pass through the cover and extend approximately 2in. If, as is probably the case, the shaft does not extend through the gear sufficiently to connect an extension with a simple shaft coupling, another method will have to be found. Fig. 3 shows how the shaft was extended. Unfortunately the film sprockets do not appear to be easily taken off their shafts, otherwise the obvious way is to substitute these.

If the apparatus is fixed in such a way as to obstruct a direct extension of either shaft, then a different arrangement will have to be made. Fig. 4 shows how this may be overcome, gear wheels being essential as there is possibility of slip with any form of belt drive. The gear ratio must be noted as this will affect the size of the capstan wheel.

If the direction of rotation of the capstan wheel is not as shown, then the rubber roller will have to be located on the opposite side of the capstan.

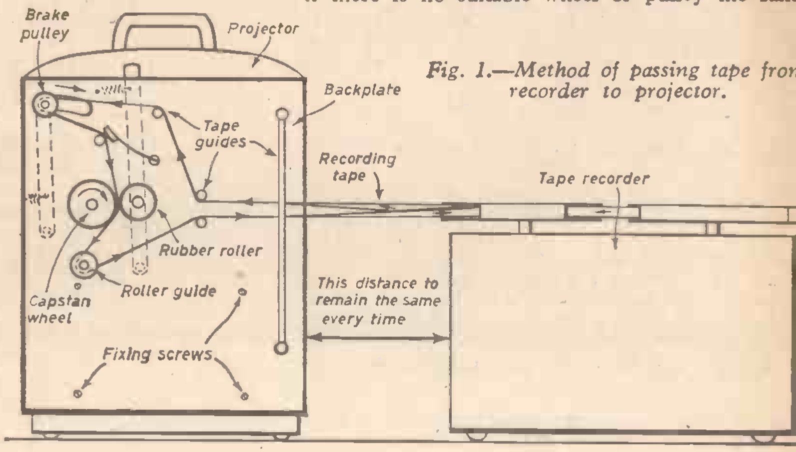


Fig. 1.—Method of passing tape from recorder to projector.

Calculation for diameter of Capstan Wheel

The size of the wheel is found as follows. Assuming that the capstan wheel is connected directly to a film sprocket without having to resort to the use of gears.

Number of teeth on film sprocket multiplied by the speed of the tape recorded in inches per second and this result divided by the number of frames projected per second multiplied by 3·1416.

The result is the required diameter in inches. i.e., assuming 16 frames per second, which is standard,

$$\frac{\text{No. of teeth} \times 3{\cdot}75}{16 \times 3{\cdot}1416} \text{ or more simply } \frac{\text{No. of teeth on film sprocket}}{13{\cdot}4} \text{ inches}$$

The most convenient speed to run the tape recorder is 3¾in. per second, and this is allowed for in the calculation. It is worth while to check the exact speed of the tape by running the tape from a marked position for, say, 10 or 20 seconds and measuring the actual tape used.

Where additional gears are used to offset the shaft as in diagram Fig. 4, the ratio of the gears will have to be taken into consideration as previously stated,

$$\frac{\text{No. of teeth} \times \text{No. of teeth on new gear 'A' Fig. 4}}{13{\cdot}4 \times \text{No. of teeth on gear 'B' Fig. 4}}$$

The capstan wheel should be made of brass or aluminium about ¼in. wide and with a polished finish to the rim. The diameter should be as near as possible to the calculated size as above. It must fit well on to its shaft and be locked in position with a grub screw, split pin or keyway, but should be easily removable to carry out any internal adjustments.

The brake is worked by simple levers and a felt pad, as shown in Fig. 2. Suitable positions for the brake pad to operate are indicated in the diagram. Different models will have different layouts, but the idea is to locate a pulley with a smooth face and turning at high revs where the brake will have the best effect.

Inspection and experimenting by slowing down with finger pressure will locate the best position. If there is no suitable wheel or pulley the same arrangement will probably work as well, or even better, with the brake pad bearing on the shaft. In this case the leverage may have to be increased

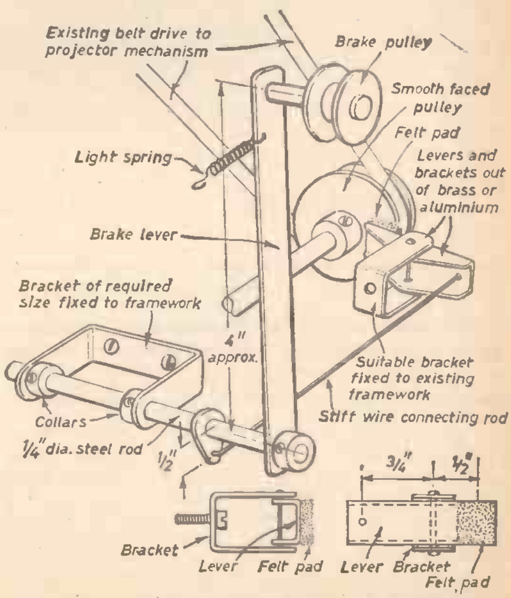


Fig. 2.—The brake is worked by simple levers and a felt pad.

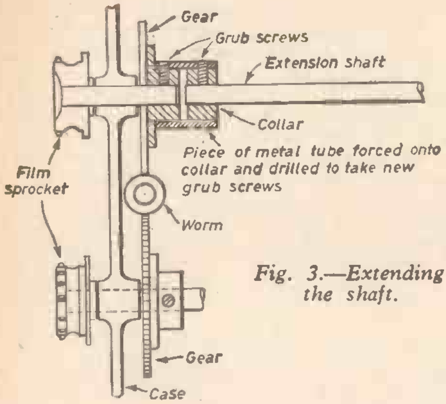


Fig. 3.—Extending the shaft.

as more pressure will be needed to give the same braking effect.

There should be no difficulty in arranging the levers and stiff wire connecting rod to suit the existing layout. The dimensions are given as a guide only and can be varied to suit.

The brake pad is a piece of felt $\frac{3}{4}$in. square and fixed to the lever with "Evostick" or similar impact adhesive. Brackets are made from stiff brass or aluminium and bolted to the existing framework in suitable positions. The $\frac{1}{4}$in. diameter steel rod projects through the outer cover approximately $\frac{1}{2}$in. to which is fixed the long lever arm which carries the pulley at the end as shown. This lever should fix on the shaft with a collar and grub screw to enable adjustments to be made. A light spring is fixed as shown to keep the brake pulley in the off position.

The braking levers should be arranged to give approximately $1\frac{1}{2}$in. movement of the brake pulley, from the extremes of no braking effect at all to full braking, where the projector runs far slower than will be required. The full braking movement should apply the brake smoothly and with no snatch.

The cover will have to be drilled to allow the capstan shaft and $\frac{1}{4}$in. braking rod to project as previously noted. The only other drillings required in the cover are for securing suitable spacers to which is fixed the backplate.

The Backplate

The backplate is a piece of stiff aluminium not less than 16 gauge and of suitable size, depending on the position of guides, etc. It has to be drilled for the capstan shaft and provided with a ball-race bearing to suit the shaft diameter. A ball bearing at this position is essential as the pressure of the rubber roller would cause too much friction with a plain bearing.

The backplate is slotted to allow for the movement of the brake pulley, which will require to be $1\frac{1}{2}$in. to 2in. Care must be taken to see that the lever arm and pulley move freely.

The backplate is fixed to the projector side on four spacers to give about $\frac{3}{8}$in. clearance between projector cover and backplate, which should be fixed vertically, the length of the spacers being adjusted accordingly.

A rubber roller is made from a rubber door stop, and provided with a metal bush. The roller can be trued up and reduced to approximately 1in. diameter by fixing on to a suitable bolt, fixing in the chuck of an electric drill and turning down using glasspaper. The roller is fixed to a pivoted arm and provided with a spring to keep the roller in firm contact with the capstan wheel. The pivoted arm can be made long enough to project above the edge of the backplate and provides a convenient way of releasing the pressure when threading the recording tape. The rubber roller should spin freely on its spindle.

The backplate will have to be drilled for the pivot with a hole or slot for the necessary movement of the roller.

A sprung felt pad was found necessary in the position shown in Fig. 1, to give some resistance to the movement of the tape as it is pulled by the capstan wheel and rubber roller. This prevents the tape wandering off the capstan wheel during operation. Only very slight pressure is needed; a piece of watch spring or thin springy brass soldered and fixed as shown and with a piece of felt $\frac{3}{4}$in. x $\frac{1}{4}$in. glued on to press lightly on the polished brass rod fixed to the backplate. The pressure can be adjusted by movement of the fixing bolt. Two tape roller guides are required, and details are given in Fig. 2; one is fixed to the backplate and one to the brake lever arm as already described. These should revolve easily on their spindles and located at the correct distance from the backplate with spacers to keep the tape centrally on the capstan wheel.

The remainder of the guides shown should be located to suit the projector and tape recorder, and are all fixed to the backplate. The long guides can be made from a polished aluminium knitting needle, No. 8 or 9 size.

It should be noted that all rollers, wheels or guides that come in contact with the recording tape should be of some non-magnetic material such as aluminium, brass or plastic, and they must all be smooth and polished.

To give a professional looking finish the backplate can be painted either to match the projector or black crackle finish. In this unit a black plastic covering was cemented on, which happily covered all the trial drill holes. Any finish is best done

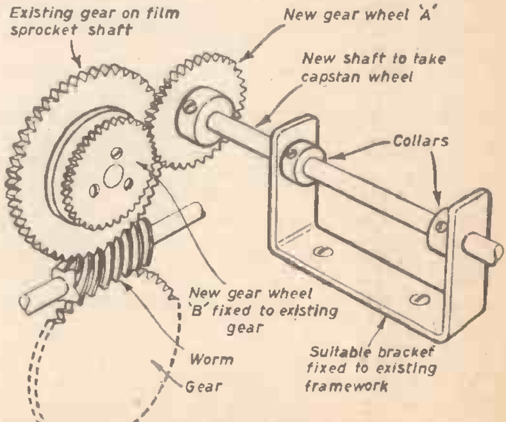


Fig. 4.—Alternative arrangement for extending shaft.

after the unit has been tested and any necessary alterations have been made.

Testing

When all the components have been made and assembled the projector can be tested. The first tests should be without the tape recorder, to check that it runs perfectly well with the additional load and that there is no fouling.

Points to watch out for are that the motor doesn't get too hot, which indicates that there is too much friction to be overcome or that there is something binding, or the brake is not releasing properly. The cooling fan must be checked to see that it is working properly. The mechanism must at no time be slowed down to such an extent that the fan does not operate efficiently, as not only will the lamp be affected, but the film also will probably be damaged. All belt drives must be checked to see that there is no slipping.

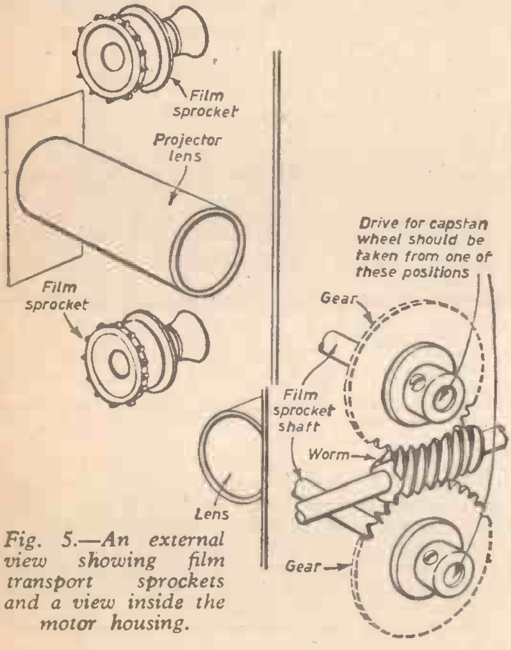


Fig. 5.—An external view showing film transport sprockets and a view inside the motor housing.

The brake lever should be adjusted and locked on to its spindle in such a position, that, with the projector set for fast running, there is no braking action at all with the brake lever fully over in the start position. As the brake pulley is moved across it should gradually apply the brake until at the limit of its travel it slows down the projector to a speed of approximately 10-12 frames per second. It must not at any point stop the mechanism completely. If the brake levers have been correctly fixed the force needed to apply the brake should barely be more than is needed to overcome the pull of the brake return spring, which should be as light as possible.

With the projector behaving correctly it can be tested with the tape recorder, but with no film. The tape recorder is positioned behind the projector as shown, and must always be placed at the same distance away, say, between 6in. and 12in. The tape is taken from the recorder and threaded as shown in Fig. 1. The brake pulley must be in the fully off position and the projector set for fast running. The projector and recorder are now switched on together. The fast speed setting of the projector will quickly take up the tape and shorten the loop over the brake pulley. The brake pulley will continue to be pulled, increasing the brake pressure until the speed of the projector matches that of the recorder.

It will be found advisable in use to reduce the speed of the projector until it is only just keeping in advance of the tape recorder. In this way the cooling fan and motor will run at the fastest revs possible and the necessary braking will be at a minimum, giving cooler and smoother running.

The final test is for synchronisation, and is best done using a continuous ring of unwanted film just sufficient to be threaded through the projector and over the empty spools. If the piece of film contains action shots, so much the better, but it can be a piece of lead-in with a few frames spliced in of a different colour. It should be mentioned here that tapes used for sound synchronising should be old tapes that have had plenty of use and have stretched about as much as they are going to.

The film and tape are threaded, and synchronisation marks are made with coloured Sellotape. Both machines are started together and a commentary is made. A few minutes are sufficient to see if there is anything seriously wrong. The film and tape are reset with the recorder at playback, sync. marks are aligned, results can be seen and heard. The cause of any serious loss of sync. should be ascertained and rectified. Apart from obvious mechanical faults, the only likely cause is that there is not sufficient pressure by the rubber roller on the capstan wheel.

A final test of not less than 15 minutes should be made. With satisfactory results achieved, sound can be added to a film. No doubt many amateurs will work out their own method, but a few remarks may be helpful.

It is a mistake to put too much talking with a film. Well-chosen music, besides being much easier to do, is to be preferred to lengthy descriptions, particularly with such scenes that describe themselves. Where a film requires only commentaries which are not critical to within a second, the best method is to run the film and record speech only, describing everything that appears on the screen and the exact point of ending. The projector can then be put away, and the tape only needed, which is completely re-recorded from beginning to end, putting in the music and final commentaries in the appropriate places.

Lip synchronising is different, and for satisfactory results the final dialogue has to be put on the tape while the film is being shown and after some rehearsal, without attempting to re-tape afterwards. The only trouble here is that the noise of the projector is also recorded, as the recorder is close to the projector. Reasonably good results are obtained by having the microphone as far away from the projector as possible and recording at a low level. Any necessary music can be taped afterwards without the projector. A commentary should be made though, as suggested above, to locate the positions where music begins and ends and the type of music required. ■

MODIFICATION *to a* MYFORD *quick-change gearbox*

THE Myford Quick-Change Gear Box is a splendid piece of machinery and a great time saver. The following detail modifications have made my gear-box more pleasant to use than before, without any radical changes in its layout.

The gear-box is supplied with a 24-tooth gear for mounting upon the standard tumbler stub, but on pages 7, 8 and 15 of the Fitting Instructions Booklet No. 712E a Myford fine-feed 12-tooth gear is shown in its place. Fitting this gear entails re-meshing the quadrant gears. This involves slacking off the quadrant clamp and the grip-screw on the input shaft housing. The quadrant must be carefully adjusted until the cluster gear and the fine-feed gear mesh "just so". And when the 24-tooth gear is replaced the whole process must be repeated.

To ease and speed the job a No. 12 hole is drilled through the feed of the quadrant along the axis of the clamp stud slot, as shown in Fig. 3. This hole is tapped out O.B.A.

The quadrant gears are assembled to engage the 12-tooth gears as accurately as possible and the quadrant clamp nut is tightened up. An O.B.A. setscrew is screwed into the hole until it contacts the quadrant clamp stud. It is lock-nutted into place and a $\frac{1}{16}$in. hole is drilled right through the quadrant feed and screw from the front machined face. Next the quadrant cluster gears are meshed to the standard 24-tooth tumble gear and another hole is drilled through the O.B.A. screw, using the original $\frac{1}{16}$in. hole as a guide, after repeating the screwing-up process. A $\frac{1}{16}$in. diameter pin is made to enter the holes in the quadrant and screw, with a head $\frac{1}{8}$in. deep to clear the change wheel guard.

The O.B.A. screw can now be quickly located in each of its two positions as the pin cannot enter the holes unless it is correctly in position. By this means the quadrant can be instantly fixed in its two alternative meshing positions.

Reversing Cluster Gear

Another point which seemed to me to need attention was the necessity of reversing the cluster gear to change from screw cutting to fine-feed and back again. Gears need lubrication and fondling oily gears take some of the pleasure out of using the gear-box. I found that the change-over could be done by sliding the cluster gear axially outward about $\frac{1}{2}$in., starting from the screwcutting position. As axial movement of $\frac{1}{4}$in. by the gear from either of its two positions could engage both fine-feed and screwcutting gears simultaneously with catastrophic consequences, some means is needed for locating the cluster gear positively in each of its two positions.

The means I use may have a technical name, for all I know, but to me it looks just like a hook upside down. It is made from a piece of steel plate $\frac{1}{2}$in. thick, $2\frac{3}{4}$in. long and $1\frac{3}{4}$in. wide. These last two distances are A, B and C on Figs. 1 and 2.

The starting point of all the work on the hook is the hole E, which is punch marked $\frac{5}{16}$in. from the end B and $\frac{5}{16}$in. in from the edge of the plate as shown. A punch mark F is made $1\frac{3}{16}$in., from the centre of hole E and $\frac{11}{16}$in. from the right-hand edge of the plate. The next operation must be done in the correct sequence. The piece of plate is mounted on the lathe face-plate, centred about F and drilled through, say $\frac{3}{8}$in. The quadrant studs are $\frac{5}{8}$in. diameter so the hole at F is opened out to a generous $\frac{5}{8}$in., say, 0·630in. Arcs KH and ML are struck, centred at E and tangential to the $\frac{5}{8}$in. hole. Arc CG is struck $1\frac{5}{8}$in. radius about E to a point $\frac{3}{4}$in. from the right-hand plate edge.

The face CN is sawn out at 45° to the right-hand edge of the plate, bearing in mind that the distance CD is $1\frac{3}{4}$in. and CE is $1\frac{5}{8}$in., which fixes point C. The open slot HKML is made by cutting into the hole F along the arcs HK and LM and the block is finished to shape by cutting along the line OG $\frac{3}{4}$in. from the right-hand edge, and along the arc CG. The open slot must slide freely over the cluster gear stud and the curve CG must be formed so that the tongue GCHK can slip between the stud and the "screwcutting" cluster gear.

The pivot-hole E is the next job. The plate is mounted upon the face plate and centred about E. The hole is drilled $\frac{5}{16}$in. right through, and opened out to $\frac{3}{8}$in. to a depth of $\frac{1}{4}$in.

This completes the work that can be done upon the hook at this stage.

The Hook Pivot Stud

The hole for the hook pivot stud is now marked out upon the quadrant. To locate the hole the curved slot is literally hooked over the cluster gear lower stud. The tail of the quadrant is swung to the right until the hook rests by its own weight upon the stud. This places the pivot hole centre roughly $2\frac{5}{8}$in. from the centre of the input shaft. The pivot stud hole is drilled right through No. 15 spot, faced out $\frac{1}{4}$in. B.S.F.

The pivot stud is made from mild steel rod and is $1\frac{1}{4}$in. long. It is $\frac{3}{8}$in. diameter for $\frac{1}{2}$in., $\frac{5}{16}$in. diameter for $\frac{5}{16}$in. and $\frac{1}{4}$in. diameter for $\frac{11}{16}$in. The head of the stud is given a screwdriver slot, and the $\frac{1}{4}$in. diameter portion is threaded $\frac{1}{4}$in. B.S.F. These dimensions will ensure that when the hook is in place upon the stud, with a $\frac{1}{16}$in. x $\frac{5}{16}$in. washer behind it, it will work freely without fouling any of the existing mechanical protuberances.

The head of the stud will lie neatly flush with the outer surface of the hook. To provide a resting place for the hook when it is swung back out of engagement another $\frac{1}{4}$in. stud is screwed into the quadrant, in a position which can be found by trial and error to keep it clear of the input wheel boss with, say $\frac{3}{4}$in. to spare.

The next task is important because it will be found that if the hook is thick enough to locate the cluster gear in the fine-feed position it will foul the input gear when swung back out of position. To overcome this trouble the input gear securing nut is slackened off and the input gear is

. . . as described by S. U. Belsey

pulled outward until the hook can pass behind it and rest upon the $\frac{3}{4}$in. stud. The periphery of the input wheel is marked off on the face of the hook and the hook and its stud are removed from the quadrant. The hook is mounted upon the latter face-plate and adjusted so that the marked off line is at a distance from the mandrel centre equal to the radius of the input wheel, at all points along its length. This is easily checked by mounting a scriber in the tool-post and bringing it up to the line. The line must track along by the scriber point as the face-plate is revolved.

To give clearance to the input wheel the hook is turned away to a depth of $\frac{1}{8}$in. to a radius $\frac{1}{8}$in., past the scribed line. This will give ample clearance between the hook and the input wheel with the hook swung back and the gear in place.

To complete the hook a $\frac{1}{4}$in. rod $2\frac{1}{4}$in. long is screwed into its upper end to screw as a handle, P in Figs. 1 and 2. For final security the changewheel guard is closed upon the handle and the handle marked upon it in both of its positions. Small clearance slots are made in the guard so that it can be closed fully. This gives an extra safeguard by positively locating the hook in each of its two positions.

When the cluster gear is in its fine-feed position the outer sleeve overhangs the tip of the stud. A spindle extension is made to screw on to the stud. The extension is made $\frac{5}{8}$in. in diameter for a distance of $\frac{3}{16}$in. and $\frac{7}{8}$in. diameter for $\frac{1}{16}$in. It has a $\frac{1}{4}$in. long by 2B.A. stud on its inner end to screw into the existing oil nipple hole, and is drilled through $\frac{1}{16}$in. The outer end is drilled and threaded to take the oil nipples, which may have to be filed slightly on the inside to allow it to screw in deeply enough to permit the changewheel guard to close.

As a finishing touch a steel disc $1\frac{3}{4}$in. in diameter is made, $\frac{1}{4}$in. thick with a centre hole a couple of thous. smaller than the cluster gear sleeve outer diameter. The rim of the disc is knurled, and the disc is pressed on to the cluster gear sleeve. The purpose of this miniature handwheel is twofold. Firstly it makes fore and aft movement of the cluster gear easy, and secondly it assists in engaging the gears, which have the usual knack stopping tooth-to-tooth instead of tooth-to-gap.

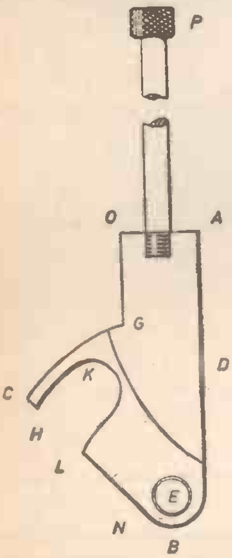


Fig. 1 (Far Left). — Side elevation of detent hook.

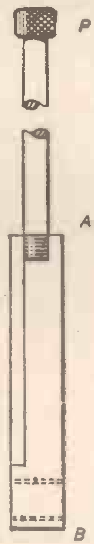


Fig. 2 (Left).—End elevation of detent hook.

Fig. 4 (Above).—Detent pivot bolt.

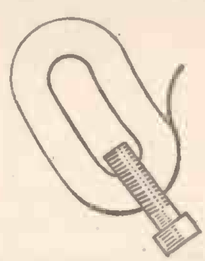


Fig. 3. — Meshing adjustment screw in position.

Roulette for all

By Jameson Errol

Practical Mechanics 'team' try their luck on the roulette wheel Jameson Errol made specially for this article. Photograph shows: left to right—Mr. Bradley (Brad), Art Editor; Miss Lauder (Merran), Secretary; Mr. Metalli (Pete), Artist; Mr. Winkley (Reg), Editor; Miss Dempsey (Betty), Editorial Assistant.

THERE is no occasion to visit Monte Carlo for that game of Roulette; it can be enjoyed within the confines of your own home if you make up the set about to be described. There is no reason, either, to consider the game a wholly gambling one; counters, matches or sweets can take the place of cash, and endless fun and amusement provided for all the family.

The necessary apparatus consists of the following components: An outer, shallow basin which rests on the table and remains stationary; an inner, circular portion which revolves within the bowl and carries the numbers and divisions into one of which the ball will eventually come to rest; a "table" made of green baize or other suitable material and designed for the allocation of stakes; a rake for clearing losing counters quickly from the table; and the small ball which can be bought at most large stores.

THE BOWL (or Stator)

This should be the first thing to be made and consists of a plywood circular base on which the outer rim is built up. Its size is entirely at the option of the constructor but around 12in. outside diameter is reasonable for family play. Fig. 2 (left) furnishes a plan and section of the bowl. It will be seen that the total diameter is $13\frac{1}{4}$in. and that the inner diameter of the rim is $7\frac{5}{8}$in. The $\frac{3}{8}$in. plywood base is marked with compasses and cut, slightly outside the line, with a coping or fret saw; it can be finished to a perfect circle with glass-paper. If the constructor is in possession of a disc sander, the edge may be accurately finished by boring a $\frac{7}{64}$in. hole in the centre of the circle, screwing it to the table of the sander with a $\frac{3}{4}$in. No. 4 wood screw, and gently revolving the ply against the running disc.

Construction of the rim can be attempted in a variety of ways according to the skill of the maker and the machinery and tools at his disposal. Since it is $2\frac{13}{16}$in. wide and $\frac{3}{4}$in. deep it must be built up in sections; not only will this obviate the use of an extremely wide board (difficult to obtain free from warp) but the varying grains met with around the perimeter would not lend themselves either to turning up on a lathe or cutting with a coping saw. Fig. 3 gives details of rims built up from six, eight and twelve segments respectively. Note carefully that the less the number of segments the wider they must be before trimming in order to cover the given diameters. The type of wood used is largely optional although a fine grain should be chosen in preference to a coarse one.

The segments should be well glued and screwed to the plywood base from the underside using counter-sunk No. 8 screws. If the bowl is being cut entirely by hand, the two arcs—$3\frac{13}{16}$in. and $6\frac{5}{8}$in. radii—should be marked with dividers after assembly of the segments. Note particularly that the centre used *must* be plainly marked as it will later become the centre for the spinning wheel.

Cutting will undoubtedly present *some* difficulty however it is attempted, the extent of that difficulty depending largely upon the powered or hand tools available and the skill and ingenuity of the workman. The fortunate possessor of a lathe with bowl-turning attachment is the best off; he with no power tools whatever, the worst. The author does not own a lathe but does possess a 12in. disc sander. The wooden base of this sander was removed from the face-plate and the bowl base—with segmented rim attached—was fixed in its place; speed was reduced to about 900 r.p.m. and both inner and outer edges of the rim trued up with a wood-turning gouge. While still on the machine, the face of the rim was slightly sloped, for it will be seen (Fig. 2) that while the outside perimeter is finished $\frac{3}{4}$in. thick, the surface is sloped inwards down to $\frac{5}{8}$in. thick.

Glasspapering is essential and cannot be overdone; in particular, the sloping surface of the segments must be perfectly smooth as must be the inside $\frac{5}{8}$in. deep rim.

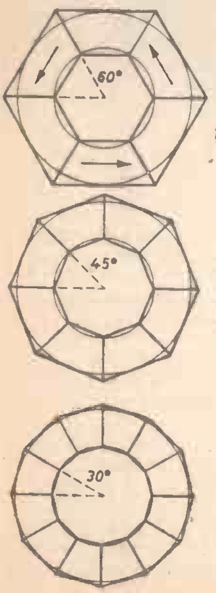
The bowl must now be fitted with a guard which will prevent the ball from flying off the edge. This can be of plastic, metal, very thin ply, or even thick cardboard 2in. wide and a little under $\frac{1}{16}$in. thick. It will need to be about 42in. long. Drill $\frac{7}{64}$in. holes at 3in. intervals staggered $\frac{3}{16}$in. and $\frac{3}{4}$in. from the bottom edge to accommodate No. 4 R/H screws.

THE WHEEL (or Rotor)

This is best made from $\frac{1}{2}$in. thick oak or similar good hardwood. It is cut $3\frac{3}{4}$in. diameter and afterwards finished to a very precise measurement for the following reason: Its outer perimeter has to be divided into thirty-seven exactly equal parts and this is extremely difficult unless a definite circumference divisible by 37 is aimed at. The author chose to work in millimeters and selected a circumference of 592 mm (approximately $23\frac{19}{64}$in.). But before marking these, attention should be paid to the top of the wheel which, as will be seen from Fig. 2, slopes for $1\frac{1}{2}$in. from the circumference towards the centre. This slope is very slight—about $\frac{1}{32}$in.—but must be incorporated to counteract any tendency for the ball to rest on the surface and fail to fall into one of the cups when it comes to rest.

The best way to mark the divisions is to make up a length of gummed paper about $\frac{3}{8}$in. wide and approximately 2ft long and mark on it, with a fine mapping pen, thirty-seven divisions each 16 mm. wide. Damp both ends and place it around the edge of the wheel—the two ends should meet exactly—and from it mark the divisions by dots on the extreme edge of the wheel. Now, with ink compasses, inscribe a circle of 3in. radius and another with a radius of $2\frac{1}{4}$in. With a thin bevelled rule and Indian ink, carry straight lines from the dots towards the centre as far as the inner circle.

Colouring and numbering must follow a definite sequence as follows: All the divisions, except one,



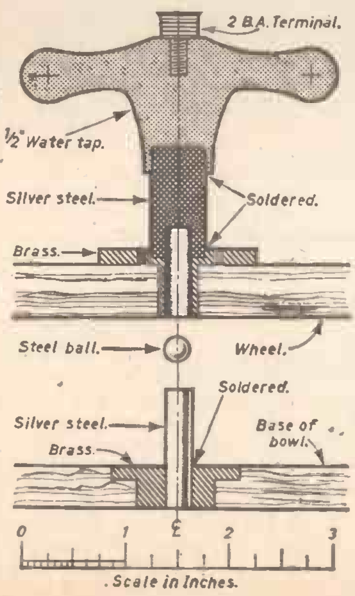
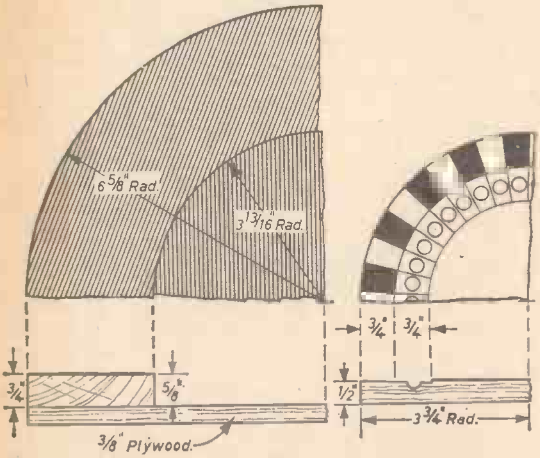
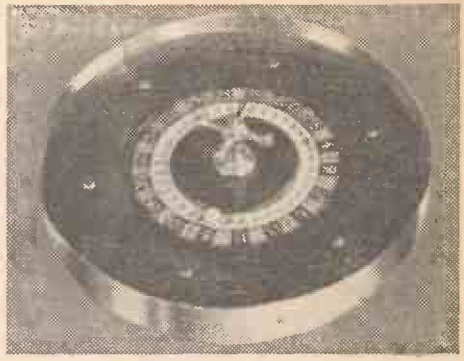


Fig. 3.—Build up of the rim in 6, 8 or 12 segments. Arrow shows way of grain.

(Top) photo the finished crosshead.

Photo (right) pivot showing $\frac{1}{4}$in. steel ball.





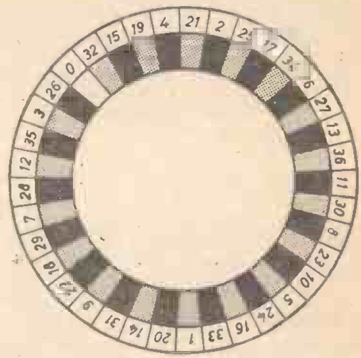


Fig. 2.—Part plans and sections of (left) the bowl or stator and (right) the wheel or rotor. (Top right) The finished wheel. (Bottom right) Numbering sequence.

are coloured alternately black and red, the thirty-seventh being coloured bright green. Poster paint is the best medium to use. Note that, with the green division at 12 o'clock, it should have a black division on its left and a red division on on its right. The numbering should be done with white poster ink or Process white.

Boring the shallow cups in the thirty-seven inner divisions is the next job. The centres are marked with a fine punch, and the holes drilled with a ½in. drill but only to a depth as will form a cup ¼in. deep. If this depth be exceeded, it may be found that when the wheel is slowing down the ball falls into one of the cups and is carried round because it is seated too firmly for the decreased centrifugal force to dislodge it. The cups may be finished off with a burr of suitable size and shape.

When the whole of the painting and boring is done, the top of the wheel should be given a coat of copal varnish to preserve it from wear and accidental scratching. At this stage the bowl, too, may be coloured dark oak or ebony with a good quality wood dye and brought to a high polish. Six flat-headed (about ½in. dia.) brass pins may now be fixed in the centre of the rim surface equi-distant as clearly seen in Fig. 10. These serve to deflect the ball when it is in motion and thus ensure that its course, and final destination when it comes to rest, is entirely unpredictable.

The Mechanism

The wheel is revolved by means of a cross-head, and the top of an old water tap provides an admirable substitute. To this is sweated a short piece of silver steel which, in turn, is firmly attached to a brass bush screwed to the upper surface of the wheel. This bush—and part of the silver steel—is hollowed centrally to a depth of 15/16in. to receive a ¼in. steel ball and the pivot attached to the base of the bowl. When inserting the shank of the bush, be very careful to drill from the exact centre of the wheel; this point will already have been marked by the compasses when inscribing the division circles. It is a good plan, too, to check that the ⅜in. drill or centre bit (whichever is used) cuts a hole exactly the size of the bush shank; centre-bits, in particular, do vary, and if the shank is not a tight fit in the hole, endless trouble will be experienced when finally fitting the wheel inside the bowl.

The lower part of the mechanism consists of a somewhat similar brass bush through the centre of which passes a pivot—barely ¼in. in diameter—which engages with the side of the boring in the upper bush and the lower part of the ball. Thus, if a fractional clearance is given between the bottom of the wheel and the sunk bush in the top of the base of the bowl, the wheel actually revolves on a ball bearing and is steadied by the pivot. This pivot, is best reduced by running it in the drill and applying gentle pressure with fine emery cloth; it should be so close a fit that when it is withdrawn it makes a 'plop' of exhaust air.

Prepare a piece of ¼in. silver steel 1⅛in. long by grinding one end to a sharp point, taking care that the point is perfectly central. Place this, point protruding and without the ball in position, in the hole in the top bush. Position the wheel in the bowl very gently but do not, at this stage, exert any pressure whatever—let the wheel rest on the bowl base as lightly as possible. Now cut some strips of thin cardboard ¾in. wide and press them edgewise between the outer perimeter of the wheel and the inner perimeter of the rim of the bowl. Experiment as to the thickness of the card will have to be made, as it is intended that

(Continued on page 334)

Chemical Magic
(Concluded)

nearly 800 times their own volume, thus creating a vacuum in the flask which will draw up the remainder of the liquid. Ammonia is alkaline and changes the weak acid solution to an alkaline solution. The litmus responds to this change by turning blue.

Suggestion

The upper flask must be well filled with ammonia gas.

These experiments are just a few of many intriguing experiments which can be very mystifying to the uninitiated.

A chemical magic show is unusual and has a high entertainment value but the presentation is extremely important. It is necessary to make up a story or " patter " for each demonstration which will tend to misdirect the audience. In this way the result will cause surprise, amusement and, perhaps, amazement.

Here is a suggested way of presenting experiment (5). " Here I have a newly discovered method of making coffee. It is, in fact so recent that it has not yet reached the public. I simply take this special glass rod and stir this glass of water." The demonstrator stirs in a clockwise direction and the liquid turns wine coloured. With a look of despair he puts the rod down, lifts the glass to smell the liquid and says, " That's peculiar —I have made wine! Ah! I know, I must have stirred it the wrong way." He again picks up the rod (by the opposite end) and, stirring anticlockwise, proceeds to produce coffee.

It would be wise to have an excuse ready in case someone in the audience asks you to drink it!

The sequence of the experiments can have a bearing on the success of the show and the patter should be aimed to follow naturally from one demonstration into the next. It is suggested that experiment (1) is a good one to open with.

It is also very important that the demonstrator is proficient and should practise each experiment until he is sure it will work every time.

The right " atmosphere " will add greatly to the attraction and here are some suggestions as to how to achieve this.

On either side of the table have a tall glass cylinder containing a coloured liquid (dilute hydrochloric acid and food colouring) and about 10 gms. of marble chips. Put a few moth balls into the liquid and add salt until they float. Add the minimum of water to cause the moth balls to sink. Small bubbles of carbon dioxide will be generated which will accumulate on the moth balls causing them to rise. On reaching the surface the bubbles will burst and the balls will sink. This will continue for a long time and will puzzle most of the audience.

Another way to decorate the table is to have several large crystals or a " crystal garden " on display.

To add mystery to the atmosphere a stream of water from a medicine dropper sprayed on to a mixture of one part powdered zinc to four parts powdered iodine placed in an evaporating dish will release violet coloured vapours. These will show up well against a white background.

PUZZLE CORNER

1.—How Many Books?

A MAN has a number of books to pack into parcels. If he puts 3, 4, 5, or 6 into each parcel, there is one book left over each time. But if he puts 7 into each parcel there is none left over. How many books are there?

2.—Paint the Cube

A FOUR-INCH wooden cube is painted on all sides; it is then cut into 64 one-inch cubes. How many of these smaller cubes will have only one painted surface?

3.—Cheque Please

A MAN without any money in his pocket cashed a cheque at his bank, spent 2s. 6d. and then found he had twice as much as the amount of the cheque he had cashed. He worked on this problem for a little while and found, as he suspected, that the cashier had given him pounds instead of shillings and shillings instead of pounds. What was the amount of the cheque?

4.—Letter Mix-up

AN office boy has four letters and four envelopes in which to put them. Not having his mind on his work, he contrives to put them all into wrong envelopes. In how many ways could he do this?

Answers

1.—There are 301 books.

2.—The four inside cubes on each surface of the large cube will be the only ones to have one side along painted, so the total number is 24.

3.—The amount of the cheque was £5 11s. 6d.

4.—This mix-up is possible in no less than nine different ways.

TRADE NOTES

A REVIEW OF NEW TOOLS, EQUIPMENT, ETC.

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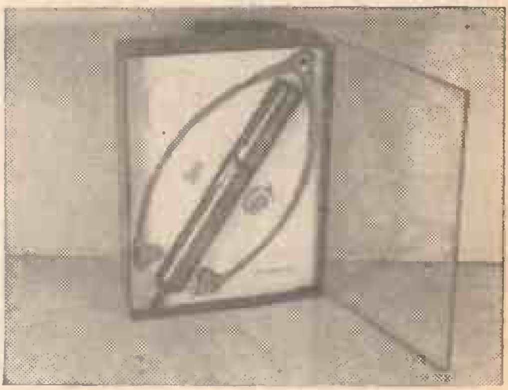
A stethoscope twin headset, such as used by doctors, is also included for use with the instrument. It is not essential for normal use but, by being applied to both ears, gives increased volume and cuts out the sound of background noises. It will detect wear and noises in machinery and engines and trace them to their source. The type of sounds heard are quickly identifiable—such as the sound made by broken, faulty or worn gear teeth.

Other applications include the sounds or vibrations of liquids flowing in pipelines or checkvalves opening, refrigerator testing, electric motor bearings etc.

The instrument, complete with twin headset and accessories, costs £6 6s. 0d. retail.



Trimark Pocket Stethoscope.

New Lawn Mower Sharpening Attachment for Wolf Power Tools

WOLF have introduced a lawn mower sharpening attachment for use with any of their Home Power Tools (Cub, Quartermaster, Cubmaster and Safetymaster).

The complete attachment, when fitted to the power tool, is run along the fixed blade of the mower—a guide locates on the cutting edge of this blade.

Two forked supports, adjustable to the spiral angle of the rotary blades, guide and special grinding wheel along the blade edge being sharpened. The unit is fully adjustable to ensure accurate sharpening.

Retail price is 39s. 6d.

Tudor Windscreen Washer

MOTORISTS who have been unable to fit a windscreen washer due to lack of underbonnet space are now catered for by the Tudor 353 Washer Kit which is now in full production. The prime feature of this new kit is the specially designed two pint "hot water bag" flat plastic container which can be easily installed where space is insufficient for the conventional round or "D" bottle.

Virtually foolproof and completely guaranteed, the kit is supplied with full easy-to-follow instructions and retails at 30/-.

your Queries answered

Colouring Copper

I WISH to oxidize copper to a blue-black bright finish, could you please tell me how this can be achieved?—C. White (Liverpool).

THE following electrolyte is used for colouring copper through a range of colours, yellow, orange, red, purple, blue, green, silver, rose and violet green.

Copper sulphate 75 gm.
Sodium hydroxide 75 gm.
d.l. lactic acid 126 cc.
Water to 1 litre.

Temp. 20°C. current density 0·25 Amps/sq. ft. anodes copper.

A Tellurion

COULD you give me any practical advice on the making of a Tellurion? The model I should like to make is for demonstrations before geography students.—A Bevan (Hants).

A TELLURION is an instrument for illustrating the day and night effects on the earth. It may also demonstrate the seasons. Obviously the most simple way in which this can be done is either to obtain a globe, complete with continents and oceans, or to make one with a ball turned in hardwood. In either case it must be mounted on pivots in a half circular brass frame, the pivots making an angle of 23 deg. 27 min. with the vertical, so that it shall be capable of revolving at that angle. The best plan will be to buy a finished globe already mounted and on a stand 10in. or 12in. diameter.

In addition you will require a short standard lamp holder of about the same height as the globe. The lamp will require to be powerful so that it can be placed some distance away and perhaps screened to avoid glare in the eyes of the students. The lamp will represent the sun.

Chlorophyll from Grass

I AM at present producing dried grass in commercial quantities and wonder whether you could tell me of a method for producing chlorophyll from same?—R. Perks (Glasgow).

THE best method would be to "kill" the grass, prior to drying, by immersion in a vat of boiling water. Drain superfluous liquor by spreading on racks, and then extract by means of industrial spirit (ethyl alcohol). The alcohol extract of chlorophyll is then distilled from a steam-jacketed still, the alcohol being thus recovered, while the chlorophyll remains behind.

We would suggest experimenting on the laboratory scale first, for you may find it unnecessary first to partially dry the boiling water extract—possibly pressing would suffice.

Facing Mixture for Brass

I AM using a small steel mould for the casting of brass and would like to know of a dressing that would stand up to twenty or more castings. I know that graphite is used but has to be renewed for each casting, I also know that whitening in some form is used on moulds for aluminium, but burn off when used for brass.—F. W. Chambers (London, N.W.2).

THERE are no washes of the type you suggest because the intense heat from the molten metal would instantly remove it from whatever surface it was applied. We suggest the following is a good facing mixture for brass:—

Best fine plumbago ...... 2lb.
China Clay .... 1lb.
Molasses .... $\frac{3}{4}$lb.

This is mixed with about $\frac{1}{2}$ gallon of hot water and is further diluted if spraying is to be attempted. However brass castings are generally cast green unless the work is important. Whether the above mixture will have any improvement on the quality of your work is problematical, but the most obvious course is to run off a few castings and see the result.

Wallpaper Hanging

I WISH to hang plastic faced wallpaper in a kitchen, the walls of which have been painted with emulsion paint. I have been told that it is unwise to do so as the emulsion stops the paste from drying into the wall and the plastic face of the paper prevents it drying into the room. How can I overcome this?—J. Rice (Liverpool).

PROVIDING the emulsion paint film on your wall is sound there should be no difficulty in hanging the paper you intend over the painted surface. Emulsion paint is a porous film and we do not foresee any drying difficulties though it may take an hour or so longer, dependent upon the humidity of the room concerned.

Renovating a Shed

I HAVE a shed made of asbestos and wood, the roof is corrugated asbestos and I have noticed that there is a greenish growth on it. I would like to clear this and also coat it with a waterproofing solution.—A. Simpson (Kent).

THE green surface which is occurring on your asbestos roof is in all probability a mould or lichen growth. This can be controlled by treating the surface with a sterilising solution such as Santobrite. Care should be taken in respect of its use and the water should not be allowed to drip on to the garden where there are growing plants. Santobrite is a water soluble salt, and in order to control the growth, periodical applications of say twice a year may be necessary.

With regard to waterproofing, the asbestos could be treated with silicones after the sterilising solution has dried.

Electrical Polarity of Atmosphere

I BELIEVE that the electrical polarity of the atmosphere changes from positive in strong sunlight, to negative during rain; and fluctuates during snow and thunderstorms. What is the potential value of this polarity and what instrument is used to measure it? Has it any bearing upon the plug point of an internal combustion engine or the growth of plants.—R. Fox (London, S.W.11).

THE upper layers of the earth's atmosphere are always in a state of electrification. Their potential varies from day to day, but exactly how they attain their electrical conditions is not yet known with any certainty. In fine weather, the potential becomes higher, the higher we ascend from the earth's surface, increasing at the rate of about 20 to 40V for each foot increase in height. The increase continues up to a height of about four miles, after which, so far as can be ascertained, it remains more or less constant.

The atmosphere's potential at any point is measured by placing an insulated conductor in that area and by allowing it to discharge its current into an electrometer or some similar electrical measuring device. In thundery weather the potential of the atmosphere increases to the order of several millions of volts. So far as can be ascertained, the normal atmospheric potential has no practical influence upon plant growth, nor upon the size and character of a spark at the plug points of an internal combustion engine.

Roulette Wheel

(Continued from page 328)

one thickness all round should cause the wheel to be a wedge fit inside the bowl. When satisfied that the wheel is a wedge fit, press firmly so that the pointed piece of silver steel marks the inside of the base of the bowl; this will give a perfect centre for boring the necessary holes to take the flange of the bush (1¼in. dia) and the body (¾in. dia.). Remove the wheel and fit the bottom bush; take out the pointed piece of silver steel and substitute the ball bearing; give a touch of very fine oil, and the wheel should revolve freely without any side play whatever and be at all times equi-distant from the rim of the bowl.

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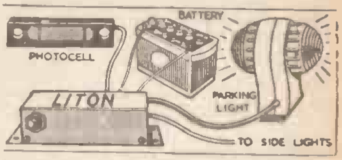

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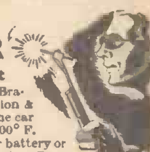

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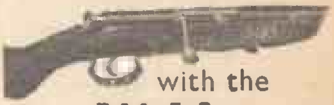

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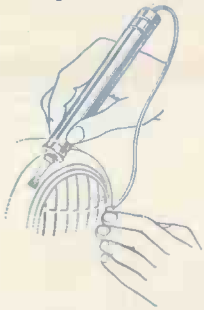

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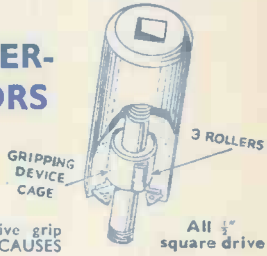

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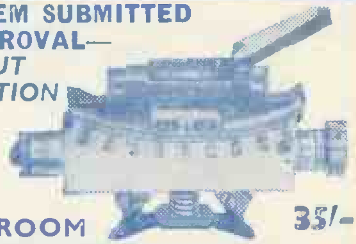

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