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APRIL 1961

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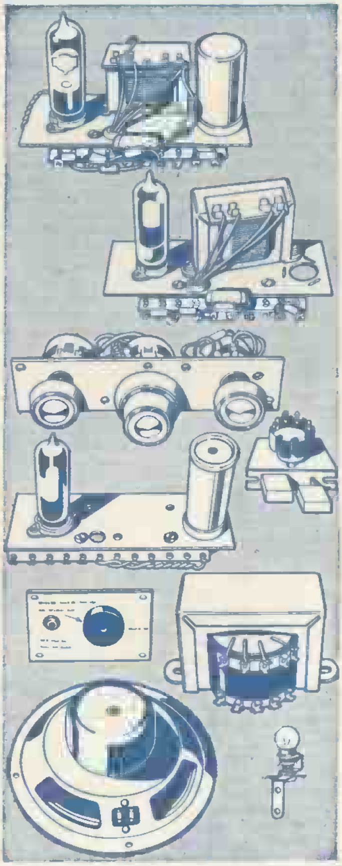

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59/6

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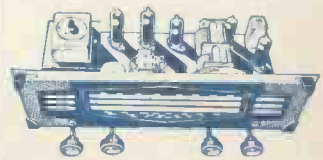

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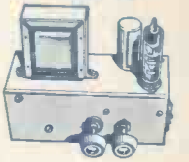

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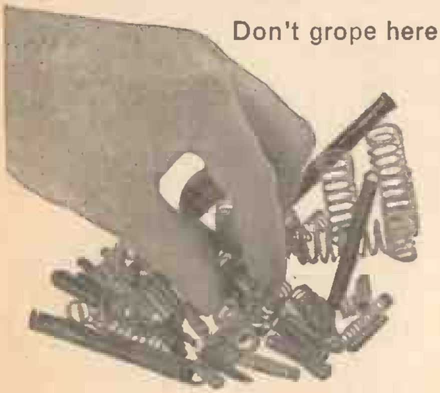

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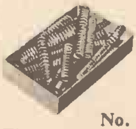

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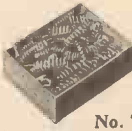

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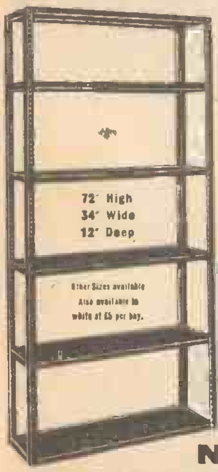

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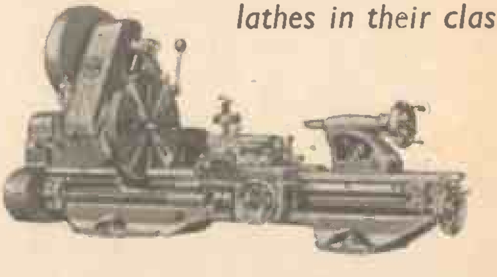

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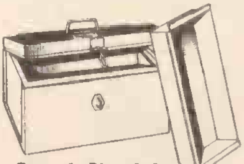

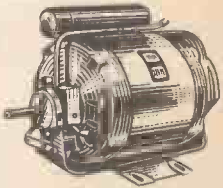

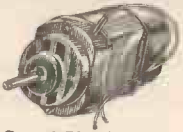


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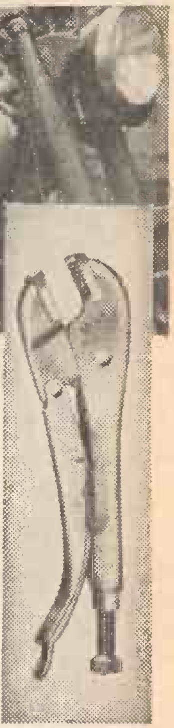

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Practical MECHANICS

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FAIR COMMENT

ELECTRIC POWER UNLIMITED

A conversation in the train was overheard recently, when the subject under discussion was electric power. "The nuclear power station is the thing," said one. "I just can't understand why they are still building hydro-electric stations." "There's no future in the nuclear power station—it's too expensive," said someone else. "What are we going to do when our coal stocks run out?" asked a third. The argument grew heated but all in all there seemed to be a lot of mixed thinking. Perhaps it would help if we had a look at a few facts.

Electricity is produced in three main ways. The first of these is by burning coal or oil to produce steam to power a turbine; this turns an alternator to produce electricity. The second method is to harness rivers, tides, etc., to turn a water turbine, connected to an alternator. The third method is the use of nuclear energy to create heat to produce steam which again powers a turbine and alternator. These three methods are being used side-by-side throughout the world.

In mountainous countries where there is heavy rainfall hydro-electricity is certain to retain its usefulness for obvious reasons. It is direct and it is cheap, once the initial power station and its associated water reservoir have been built. Advances are being made all the time in the efficiency of hydro-electric plant and more than one scheme is under way to extend the sphere of this kind of station to employ tidal power.

Continuous improvements are being made also in the design and efficiency of conventional coal and oil burning power stations and there is no sign that these may be superseded by nuclear power stations. The world's coal and oil reserves are still very large and in spite of the fact that the total consumption of electricity throughout the world is increasing rapidly, it is unlikely that any shortage of these fuels will trouble anyone living today.

Present nuclear power stations produce their energy from the fission process. From the reactor, in which this fission takes place, very hot carbon dioxide gas is drawn and passed into a heat exchanger. Water is passed through pipes inside the heat exchanger and converted into steam. Thus it can be seen that the nuclear power station merely provides a new way of producing heat and in other ways is identical with a conventional station.

Present-day nuclear power stations may in some ways be quite similar to conventional stations, but a possibility of the future—thermonuclear energy is likely to introduce a power station of a very different kind. Thermonuclear energy is produced from a process of *fusion* instead of fission. All ordinary water contains a minute proportion of "heavy water" which is an isotope of hydrogen with an extra particle in its nucleus. This heavy hydrogen is called deuterium. In a fusion reactor two atoms of deuterium would be combined to make one atom of helium, releasing in the process a colossal amount of energy. There is a strong possibility that a plant of this type could produce electricity direct, instead of creating heat for the production of steam. At this time, however, even though scientists of many countries are working on the project and many millions have already been spent, there is no sign of a breakthrough. Zeta was only one of many disappointments which have so far been faced by the scientists engaged in trying to produce power from water but if they can eventually overcome the fantastic difficulties involved, the world's power problems will be solved for all time.

The May, 1961, issue will be published on April 28th, 1961. Order it now!

Fig. 1. (Left)—The drill ready for action.

LIST OF MATERIALS REQUIRED

The Main Assembly

Pillar, 24in. × 1in. × 1in. mild steel (25in. if sunk into base).
Base, 10in. × 6in. × ¼in. mild steel; 10in. × 6in. × ¾in. plywood.
Brackets (4), 2in./2in. × 1in. × ¼in. bright steel angle.
Thumb bolts (2), ¼in. Whit. × ⅝in. long (steel).
Guide pulley post, 4½in. × ½in. round silver steel.
Front main bearing, 8¾in. × 1in. × 1in. mild steel.
Rear main bearing, 8¾in. × 1in. × ½in. mild steel.
Front table-arm bearing, 1¾in. × 1in. × 1in. mild steel.
Rear table-arm bearing, 2in. × 1in. × ½in. mild steel.
Top bearing block, 1½in. × 1in. × 1in. mild steel.
Bottom bearing block, 2in. × 1in. × 1in. mild steel.
Table bearing block, 1in. × 1in. × 1in. mild steel.
Top bearing arms (2), 6½in. × 1½in. × ¼in. mild steel.
Bottom bearing arms (2), 6½in. × 2in. × ¼in. mild steel.
Table bearing arms (2), 6½in. × 2in. × ¼in. mild steel.
Whitworth bolts (32), $\frac{5}{16}$in. × ⅝in. long, c'sk., steel.
Whitworth bolts (2), ¼in. × ⅝in. long, c'sk., steel.
4 B.A. bolts (20), ⅜in. long, c'sk., steel.
Wood screws (12), 1in. long, No. 8, c'sk.

The Table

Top, 7in. to 8in. dia. × ⅜in. thick steel plate.
Base, 7in. to 8in. dia. × ¾in. thick plywood.
Pivot, 2in. length of ⅜in. dia. silver steel rod.
Wood screws—4 No. 8, c'sk., ¾in. long.

The Pulleys

A three or four-step pulley (see text).
Two grooved wheels about 2½in. dia. × ½in. section with ½in. bore.
Two split pins, ¾in. long × $\frac{3}{32}$in. dia.
One steam pipe T-piece, ½in. I.D.
One locking bolt, 1in. long (including head) with ¼in. Whit. thread.
One bar silver steel rod, 1⅜in. long × $\frac{3}{32}$in. dia.

Raising and Lowering Mechanism

Spindle, 14in. length of ½in. round steel rod.
Handle, 9in. length of 1in. × ⅜in. flat steel; 3in. length of ¾in. hardwood dowel.
Filler block, 1½in. × 1in. × ⅜in. mild steel.
Filler block bolts. Two 6 B.A. × ⅜in. long.
Feed block, 1½in. × 1in. × 1in. mild steel.
Collars (2), ½in. bore with Allen grub-screws.
Ball races (2), open type with ½in. inside clearance.
Compression spring, 3½in. length × ½in. full I.D. Fairly light compression.
Chuck (see text.)
Pivot bolt, $\frac{5}{16}$in. Whit. R/H, 1in. long.
Riding bolt, ¼in. Whit. R/H, ⅝in. long.

A POWER BENCH DRILL

Jameson Erroll describes

THIS machine is sturdy, reliable and can be made without a lathe.

Fig. 1 shows that the design follows normal practice but has perhaps a simpler than usual feed principle. The machine's capacity is limited to ⅜in. for metal drilling and ½in. for wood.

The Main Assembly

Construction should commence with the base, the ¼in. mild steel plate being mounted on the plywood with No. 8 wood screws at each corner. The pillar is not sunk into the base because of the difficulty of cutting a 1in. sq. hole in the steel. There is no reason why it should not be if the reader fancies the job, but the steel brackets really furnish ample support. These are fastened to the pillar with $\frac{5}{16}$in. Whit. bolts and to the base with No. 8 wood screws. Bore $\frac{11}{64}$in. holes in the bottom flanges of the brackets and in the steel base (to clear the wood screws) but not into the plywood; countersink the holes in the brackets. Note how the bolts for fastening to the pillar are staggered; this ensures that no bolt will butt against its opposite neighbour, and also serves to distribute the resistance.

The front bearing blocks (three in number) should now be drilled with a ½in. central hole as shown in Fig. 2. Great care must be exercised to ensure that these holes are perfectly upright as, when assembled, two of them have to carry the revolving spindle and one the table—and all three must be in true alignment. These holes should also be slightly reamed as

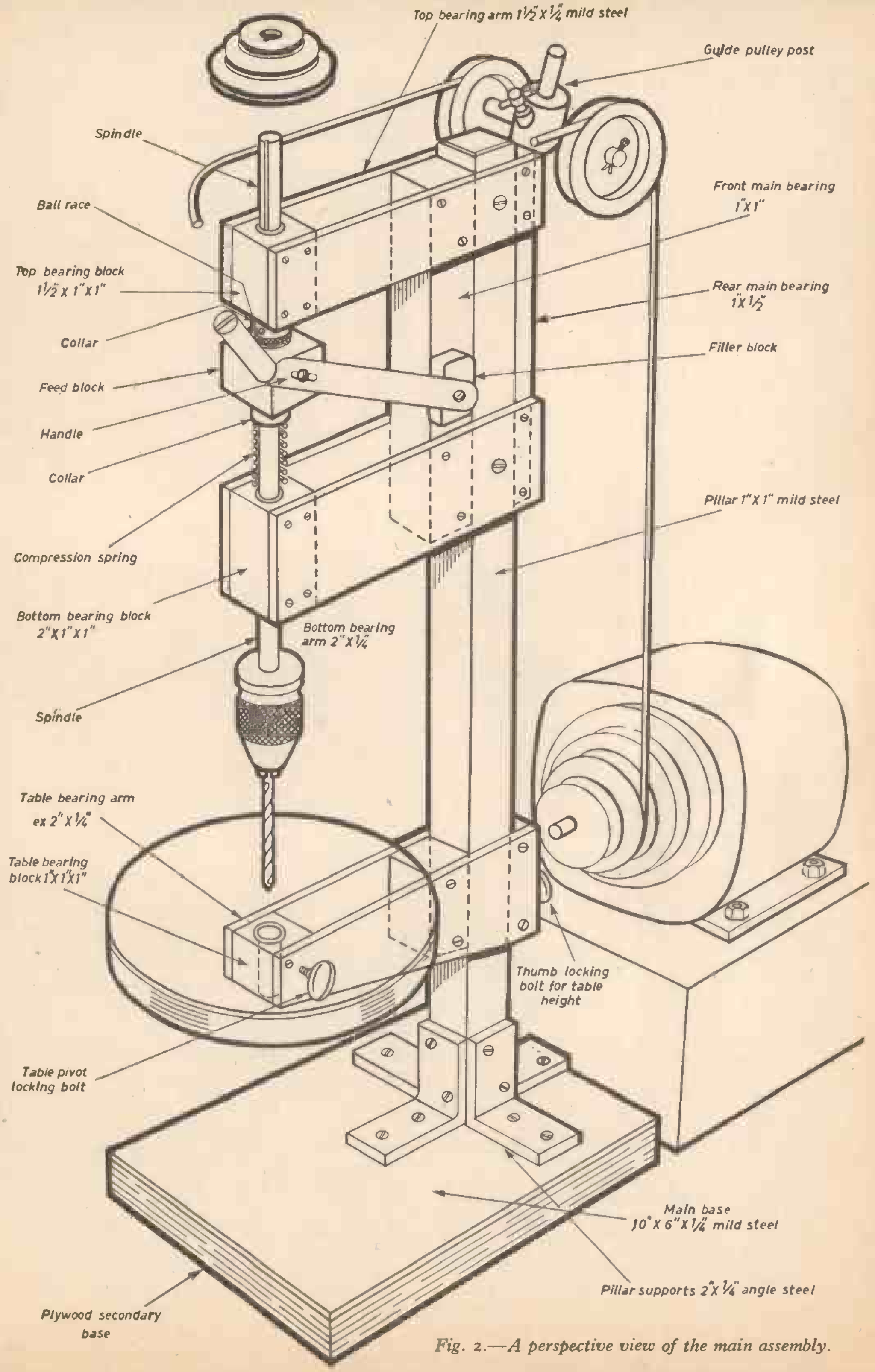

Fig. 2.—A perspective view of the main assembly.

both the spindle and the table pivot have to be easy but accurate fits. Alternatively, the two holes for the spindle may be bored ⅝in. and then have a ½in. bronze bush force-fitted into them. These bushes (which are frequently used for vee pulleys) can be purchased quite cheaply at any good ironmongers.

It will be seen that both table bearing arms are tapered, being 2in. wide in the rear and 1in. in front. These should be so cut, and the bottom of the 1¾in. × 1in. × 1in. bearing block cut to correspond with the under edge of the arms.

All the arms may now be drilled to take the bolts which will fasten them to the various blocks. Note that the front holes take 4 B.A. bolts, drilled well to the sides in order not to foul the main centre hole, whereas the rear ones take $\frac{3}{16}$in. Whit. bolts. Drill $\frac{9}{64}$in. for the former and $\frac{3}{16}$in. for the latter and countersink all of them. The holes in the various blocks are made with a No. 32 drill for the front ones and $\frac{9}{64}$in. for the rear ones, and tapped 4 B.A. and $\frac{3}{16}$in. Whit. respectively. It is advisable first to drill one hole in a block, temporarily insert a bolt, and then drill the other holes; this ensures that the tapped holes will align perfectly with the c'sk. holes and that the blocks will remain square with the arms. Fix the front blocks (those with the ½in. holes) and the intermediate bearings first, then slide the arms on to the pillar and fix the rear bearings. The table bearing arms require to be a sliding fit over the pillar and it may be necessary to insert a piece of thin steel shim between the arms and blocks to widen them slightly. The main bearing arms can be a tight fit since they do not need to move at all—in fact, they should not do so—and are therefore made rigid with ¼in. Whit. bolts, c'sk, ¾in. long, one in the centre of each arm, as Fig. 2 plainly shows.

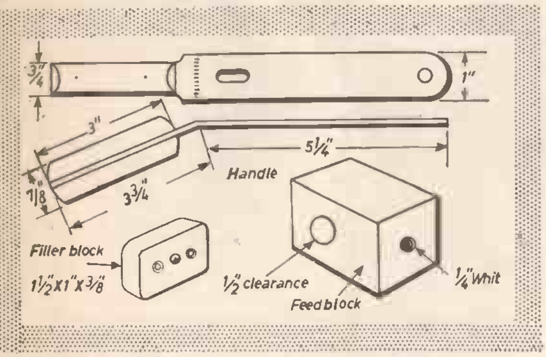

Fig. 3.—Some component parts of raising and lowering mechanism.

Two $\frac{13}{64}$in. holes now require to be drilled and tapped in the table bearing assembly to accommodate the two ¼in. Whit. thumb bolts which lock the table pivot in the front and the arm itself to the pillar at the back.

The guide pulley post is inserted near the top of the rear main bearing and is set upwards at an angle of 45 deg. Commence to bore the hole with a $\frac{3}{32}$in. drill, starting at right-angles and canting the work very, very slowly over to 45 deg. It is quite impossible to begin drilling at this angle as the tip of the drill will wander and, when pressure is applied, break. Now enlarge with a ⅛in. drill and continue to increase the size of the drills gradually until the ⅜in. hole has been bored. The post should be a press fit and be sawn off and filed level with the inside surface of the bearing. If it is at all a loose fit, pin it through the edge of the bearing to make it immovable.

The Table

The table (Fig. 5) should be from 7in. to 8in. in dia. and comprises a ⅛in. mild steel plate and a ¾in. plywood base fastened together with ¾in. No. 8 c'sk. wood screws. An old lathe face-plate of suitable size would save quite a lot of work since it would also have various holes through which work could be fastened by means of cramps. If the table has to be cut from a square plate, mark out the circle in Indian ink and gradually cut off the corners with a hacksaw and finish with a file. Do the same with the plywood base, fasten them together, and finish off both with a fine file and coarse emery cloth. The pivot presents no difficulty; it is a 2in. length of ⅜in. silver steel slightly rounded at the bottom, and is a wedge fit into the centre of the plywood base.

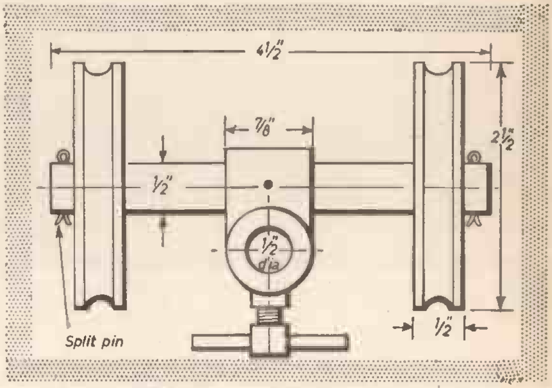

Fig. 4.—Front view of loose pulley assembly.

The Pulleys

The spindle should carry a three- or four-step pulley for the purpose of speed changing. It must, of course, be bought. If it is to run direct to the motor, i.e. no intervening loose pulleys to change belt direction, the pulleys should be of the same section as those on the motor—most likely "A" section (½in.) if of the vee variety. If, however, loose pulleys are incorporated—as they probably will be since otherwise the motor would have to be suspended on the main structure and the guide post removed—their section could well be ⅜in. to carry round leather belting. The author purchased second-hand a bank of three such pulleys, 1¾in., 2½in. and 3½in. with a ½in. bore and a ⅛in. × ⅛in. keyway, see Fig. 7. This keyway method of anchoring the pulleys to the spindle is in every way superior for the particular job in hand as it allows the pulleys to "ride" vertically and thus adjust themselves to the horizontal lay of the belt. If the step pulley available has no keyway, cut one; it is quite easy to do by threading a hacksaw blade through the bore. It need not be a full ⅛in. wide but must not be too slender or the steel key may be of insufficient thickness to stand the strain.

The loose pulley assembly, in Figs. 4 and 7, was made to accommodate two 2½in. dia. grooved pulleys with ½in. bore. They are carried on a 4½in. length of

½in. round steel rod and are a free fit; two split pins prevent them falling off the ends. Engagement with the guide pulley post was effected by means of an adapted steam pipe T-piece of ½in. i.d. To the short leg of the T was added a nipple and a short piece of piping, and through this was bored the ½in. hole to fit over the post. The pulley shaft is locked at its centre with a steel pin or rivet, and adjustment up and down the post is by means of a ¼in. Whit. bolt 1in. long (including large head) which is threaded into the lengthened T and furnished with a bar of $\frac{3}{32}$in. silver steel. This adjustment is necessary in order to apply tension to the leather belt as the sizes of the pulleys on the drill and on the motor are varied to suit required speeds.

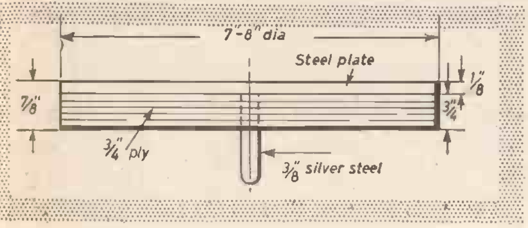

Fig. 5.—Edge view of the drill table.

Construction is made quite clear by reference to Figs. 4 and 7. It does not matter a great deal how this piece of apparatus is made provided it will carry the pulley shaft and slide along the guide post at right-angles to it.

Raising and Lowering Mechanism

Prepare the spindle by first cutting the keyway which should be approximately 4in. long × ⅛in. × ⅛in. This is a tedious job to do by hand, but is an easy and quick job on a milling machine. If cutting it by hand, hold three hacksaw blades side by side cramped between two pieces of wood with the blades running along on edge and protruding ⅛in. Fix the spindle firmly to the bench and fasten alongside two lengths of wood to act as guides. A stop at the end of the run should also be provided to ensure that each successive cut ends at the same place. Any irregularities may be trimmed up with a small file.

The other end of the spindle requires to be furnished with a thread corresponding to that on the chuck, which should he of the screw-on variety; *not* morse taper fitting.

The filler block is rounded at the corners as shown in Fig. 3 and drilled with two $\frac{7}{64}$in. c'sk. holes to pass the 6 B.A. bolts with which it is fastened to the front main bearing. In the centre is bored a clearance hole for the $\frac{3}{16}$in. pivot bolt. This block is centred at approximately 2½in. down the bearing block from the under edge of the top bearing arm. When this is fixed, and with the centre hole as a guide, use a $\frac{9}{64}$in. drill and bore into the side of the front main bearing to a depth of about ¾in., then tap $\frac{3}{16}$in. Whit. thread. The tapping should be a little on the tight side.

The feed block requires two holes, one of adequate ½in. clearance (or ⅝in. boring if a bronze bush is to be used) to enable the spindle to revolve within it, and one threaded ¼in. Whit. (at right-angles to it) to carry the riding bolt which runs through the slot in the handle. This thread should also be on the tight side.

The steel handle is nicely rounded at one end and the $\frac{3}{16}$in. hole bored as shown. At a point 4in. from the centre of this hole, drill a ¼in. hole and enlarge it each side by about $\frac{3}{16}$in. thus forming a slot ⅝in. long × ¼in. wide. This makes allowance for the slight arc which the handle makes when it is moved up and down. The 3in. length of dowel is now sawn in half lengthways and riveted to the other end of the steel handle to provide a comfortable grip. The surplus steel is cut away, as shown, and the shoulders rounded. The handle may now be bent, at 5¼in. from the rounded end, to an angle of approximately 20 deg.

The collars are normal ½in. bore and will be found to be about 1⅜in. dia. and ⅜in. thick. The ball races are, as already mentioned, of the open type, i.e. the balls are enclosed in partial cups held together with a thin steel band. Thus, when pressure is applied, the balls ride between the flat surfaces of the collars and the feed block.

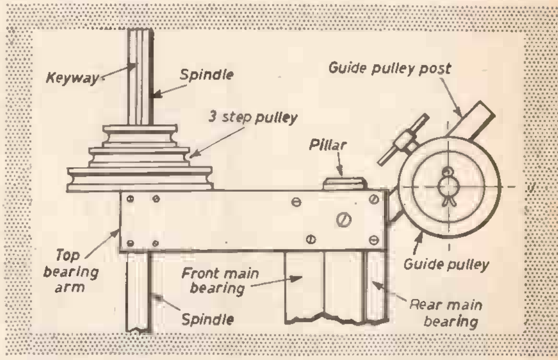

Fig. 7.—Side view of three-step pulley and guide pulleys

The kind of chuck bought must be left to the constructor since they vary considerably in design and price, but it should not exceed a capacity of ½in. It should definitely be furnished with key-tightening.

Assembly of Feed Mechanism

Between the top and bottom bearing blocks, the component parts of the raising and lowering gear appear in the following order:

1.—Collar, firmly grub-screwed to spindle. 2.—Ball race, merely dropped over the spindle and not fastened to it in any way. 3.—Feed block, again an entirely free fit but with no lateral movement. 4.—Ball race, as above. 5.—Collar, as above. 6.—Spring, a comparatively loose fit over the spindle.

There is no precisely fixed point at which the spindle should be suspended in relation to the bearing arms except that the top of the chuck should clear the bottom of the lower bearing block by about

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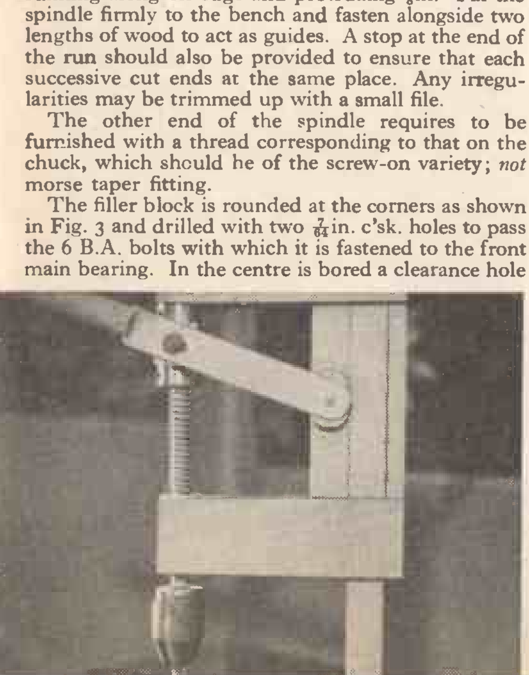


Fig. 6.—The feed assembly.

Britain Tracks Satellites

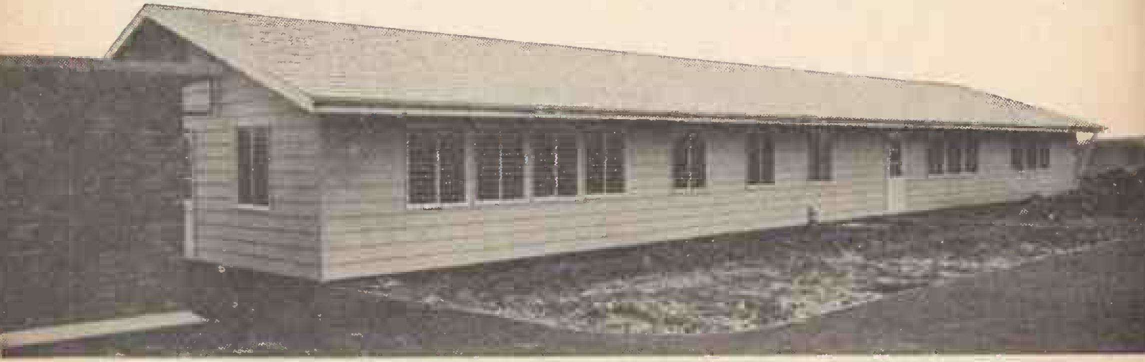
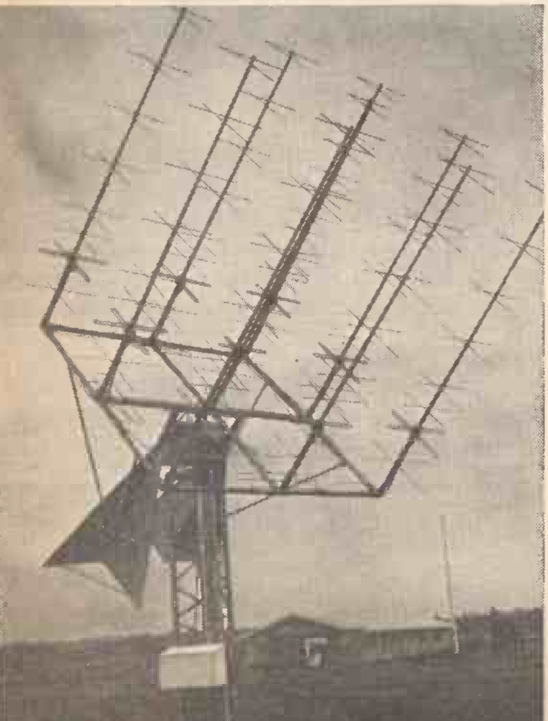


Fig. 1.—The main building at the Minitrack Station at Winkfield in which the electronic equipment is housed.

and it is at an unobtrusive field station at Winkfield, Berks, where the work is carried out

THE Minitrack station (Fig. 1) is an example of successful co-operation between Britain and America. All the equipment is supplied on loan by the National Aeronautics and Space Administration (N.A.S.A.), the U.S. Government department responsible for carrying out the non-military aspects of space research. The staff who operate the station are drawn from Britain's Department of Industrial and Scientific Research (D.S.I.R.)

Originally ten Minitrack Stations were built, most of which were in North and South America but including one in South Africa and another at Woomera in Australia. This network was sited in low latitudes and its purpose was to track satellites with orbits at comparatively small inclinations to the equator. Four new stations, one of which is Winkfield, have now been set up to deal with satellites having orbits with higher inclination angles.



The Winkfield installation and its communication network will be of considerable value to the research effort in the two countries, particularly when British experiments are flown in satellites launched from Scout vehicles. Another example of the use of the Minitrack Station will be the reception of the telemetered data from apparatus flown in satellites to investigate the upper portion of the ionosphere. The Radio Research Station is to collaborate with America and Canadian scientists in two "topside sounder" experiments of this kind by receiving the data at Winkfield and at its outstations at Singapore and in the Falkland Islands. The information obtained in this way about the upper side of the ionosphere will be complementary to that about the lower side which the Radio Research Station obtains from ground experiments.

The installation at Winkfield has two separate functions—the determination of the direction of satellites as a function of time and the recording of telemetry data from satellites. It is designed to operate in the frequency band 136-137 Mc/s. although additional facilities are provided for telemetry at frequencies around 108 Mc/s.

Fig. 2.—(Left) A steerable telemetry aerial, used for receiving the results of experiments in satellites.

Fig. 3.—(Below) Close-up of one of the "fine" aerials of the Minitrack interferometer system.

Satellite Tracking

The tracking at Winkfield is of high precision and uses the interferometer principle to determine the direction of the satellite. The phase difference between radio signals received on aerials spaced apart at accurately known positions is measured; the phase difference represents the difference in time taken by the waves to reach the two aerials, one of which is shown in Fig. 3. By making simultaneous measurements on aerials set up on a N.S. (North-South) line and others on an E.W. (East-West) line the phase differences can be converted to give the angle in space of the satellite. Highest accuracy of angular measurement is given for a satellite immediately above the system; in this situation a precision of a few seconds of arc might be expected ideally, but in practice this is likely to be degraded to the order of a minute of arc corresponding to a movement of only a few hundred yards for a satellite at a height of, say, 400 miles. Fig. 5 is a general view of the equipment.

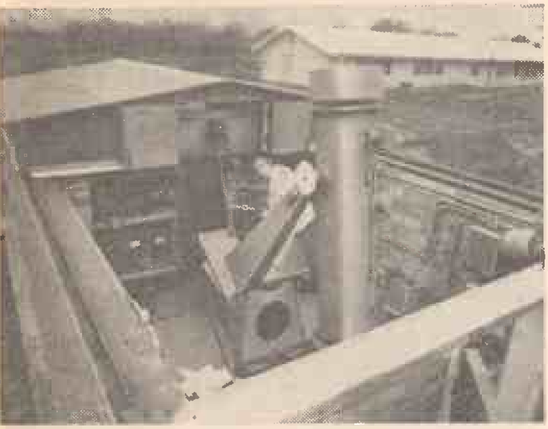


Fig. 4.—The camera and associated equipment used in calibrating the Minitrack interferometer system.

Photographic Check

From time to time it is necessary to check the accuracy of the system and for this purpose a specially designed camera is mounted at its centre (Fig. 4). An aircraft carrying a flashing light, controlled from Winkfield, and a transmitter is flown over the system on a clear night and photographed. The true direction of the aircraft at any given instant is found from the photograph, which shows the position of the aircraft against the star background, and serves as references against which to compare the simultaneous radio measurements of direction.

It is necessary to know the time as accurately as possible when each measurement of direction is made and this is achieved by means of a crystal clock.

Telemetry Equipment

The equipment used for receiving experimental data telemetered from the satellite comprises remotely controlled beamed aerials (Fig. 2)—one receiving on 108 Mc/s. and another on 136-137 Mc/s.—a receiver and a magnetic tape-recorder. The eight channels of the tape-recorder are used for various functions depending on the particular satellite under observation. Generally, however, they record the signal strength, timing pulses derived from the crystal clock and signals of accurately known frequency (used for monitoring the speed of the tape) together with the essential telemetry information. A transmitter is incorporated in the installation and serves to activate a receiver carried in the satellite; this facility can be used, for example, to cause experimental data recorded on a tape-recorder in the satellite to play back the information by radio to Winkfield where it can be re-recorded.

Teleprinter Network

A teleprinter circuit to the Goddard Space Flight Centre of N.A.S.A. is used to convey summarised results from each satellite transit observed at Winkfield. In the reverse direction up to date orbital information on all relevant satellites is provided, and the Winkfield station is alerted for new launches. Data are provided enabling the directional aerials used in receiving telemetry signals from the satellites to be correctly oriented. The teleprinter system also provides a link with other research centres in the United States and headquarters of the Radio Research Station.

Fig. 5.—General view of Minitrack equipment showing (left to right) the phase recorders, phase measuring gear, control console and standard frequency/timing rack. The telemetry receiving rack is on the extreme right.

L.B.S.C's 3½in. Gauge

EVENING STAR

2. Tackling the hornblocks, axleboxes, hornstays, spring pins, spring plates, bolster and stays.

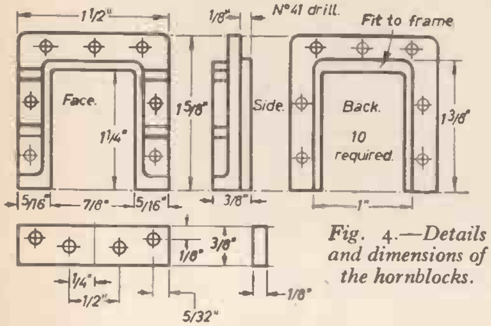


Fig. 4.—Details and dimensions of the hornblocks.

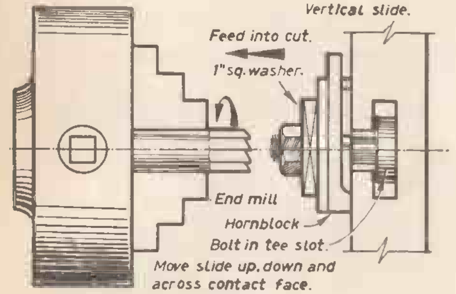


Fig. 5.—Machining cast hornblocks.

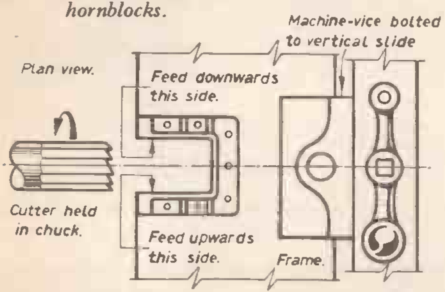


Fig. 6.—(Above, left) Machining out the jaws.

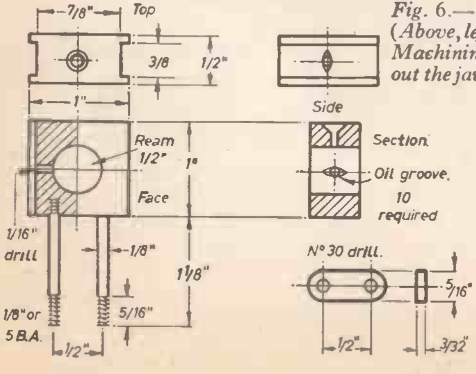


Fig. 7.—(Left) Details and dimensions of the axleboxes.

TEN hornblocks are required, and these may be either of the hot-pressed alloy kind, or ordinary bronze or iron castings. Although the former are slightly less resistant to wear than cast hornblocks, they save quite a lot of machining, as they usually fit the openings in the frame without any titivating at all. At most, a slight cleaning with a file on the contact side which goes next to the frame plate, will enable the flange to fit nicely in the opening. Drill seven No. 41 holes in each, as shown in Fig. 4; fit each to an opening, making sure that it beds tightly against the frame plate. Clamp temporarily in place, then run the No. 41 drill through the frame, using the holes in the hornblock as guides. Countersink these holes on the outside of the frame, and rivet up with 3/32in. charcoal-iron rivets. Hammer the shanks well down into the countersinks, and file off flush. There must be no projection outside the frame. Tip: to support the rivets while hammering, drill a countersink the size of the rivet head, in the end of a short piece of ½in. × ¼in. steel rod, close to the edge. Hold this vertically in the bench vice, and rest the rivet head in the countersink while wielding the hammer.

Cast Hornblocks

These, if reasonably clean, may only need a little filing on the backs, to enable them to fit the openings. I have here, at the present moment, a set of cast-iron hornblocks that are as clean as die-castings. Should the castings be rough, it is easy enough to machine them up accurately in the lathe, by aid of a vertical slide (see Fig. 5). First smooth off the flange on the ribbed side of the hornblock by rubbing it on a big flat file laid on the bench, or on a piece of coarse emery-cloth laid on the lathe bed, or something equally flat and true. Bolt it to the vertical slide, back outwards, by a bolt in one of the tee-slots, with a square washer about ⅛in. thick under the nut. The washer mustn't exceed the width over flange at each side. Set the hornblock vertically by aid of a try-square, then set the vertical slide at right angles to the lathe centres: easily done by putting the face-plate on the mandrel nose, and setting the face of the vertical slide parallel to it. Put an endmill, or home-made slot drill, in the three-jaw chuck, then manipulate the slide handles until the part of the back of the hornblock to be machined is opposite the cutter. Feed the hornblock on to the cutter by moving the saddle; then the two sides of the hornblock back can be faced off by moving the vertical slide up and down, and the top piece by moving the cross-slide. Fig. 5 shows the whole set-up. The cutter shouldn't be less than ⅜in. dia.

When all the hornblocks are riveted on, bolt the frames back to back with the hornblocks outwards—" inside out " as the kiddies would say. Be careful to line them up exactly. The jaws can then be machined out to take the axleboxes, by bolting a machine-vice to the vertical slide, holding the frames in it, with the jaws to be machined centrally with the vice jaws, and moving the hornblock up and down over the side of an endmill, about ⅜in. dia. held in the chuck (Fig. 6). The jaws can also be smoothed out by hand; grip the frames in the bench vice with one pair of hornblocks central with the vice jaws, and file out the hornblock jaws until a piece of bar ⅞in. wide, slides easily between them without shake. Finally, smooth off all the hornblock feet flush with the bottom edges of the frames, which may now be re-erected " for keeps."

Axleboxes

The axleboxes (Fig. 7) can be made from 1in. × ½in. hard drawn bronze or gunmetal bar, or from castings. Advertisers usually supply the lot cast in one stick. Saw or part off from the bar, five pieces each sufficient for two axleboxes. First job is to mill the grooves to fit the hornblock jaws. If a regular milling-machine is available, just grip each piece in a machine-vice on the table, setting it level by applying the needle of a scribing-block to each end. Traverse it under a ⅜in. side-and-face cutter on the arbor, taking a cut 1/16in. deep. Reverse, and ditto-repeato. For the second cut I always put a piece of bar between the vice runners and the groove, which ensures them being parallel, and carefully check the width of the box between bottoms of grooves, with a slide-gauge.

Grooving in the Lathe

To do the job in the lathe, refer to Fig. 8, grip the piece of bar under the slide-rest toolholder. Pack it up so that the centre of the bar is dead level with lathe centres. Set it at right angles to the bed, by putting on the faceplate and holding a steel rule, or a parallel piece of bar, between faceplate and axlebox blank. Put a ⅜in. endmill or slotdrill in the three-jaw, and feed the blank on to it by turning the handle of the top slide. Traverse the blank right across the cutter, and there is your groove. Turn the blank over, and repeat operation. Check width over grooves, either with a slide-gauge set to ⅞in. or by cutting an opening ⅞in. wide and 1¼in. deep (same as the hornblock jaws) in a piece of sheet metal about 3/32in. thick, and using it for a gauge. It should slide easily in the grooves.

Fitting Axleboxes and Hornblocks

Saw each of the pieces of grooved bar in half, then face off the ends in the four-jaw chuck until each is exactly 1in. long. Fit each to a hornblock, in which it should slide freely without shake. Mark the hornblocks and axleboxes 1 to 5 on one frame, and 6 to 10 on the other, so that once fitted, they can always be replaced in their proper order. Find the exact centre of axleboxes 1 to 5, centrepop them deeply, and drill a No. 30 hole in each. Either use a drilling machine, or drill them in the lathe, with the drill in the three-jaw, and the axlebox held up tightly against a drilling-pad in the tailstock barrel. Don't drill by hand on any account, as the holes *must* go through dead square. Next clamp box No. 1 to box No. 6 exactly in line; I always use a piece of grooved bar at each side, as shown in Fig. 9. Then drill No. 6, using the hole in No. 1 as guide, and repeat operation with Nos. 2 and 7, 3 and 8, 4 and 9, and 5 and 10. This little wheeze ensures that if any slight error is made in drilling the axleboxes on one side of the frame, and it is easily done, the box on the opposite side will have a similar error, and the axles will still all be at right angles to the frame, which is all that matters.

Put all the axleboxes back in the hornblocks, and check for truth by putting a piece of ⅛in. silver-steel through each pair. This should lie exactly at right angles to the frames. If it doesn't, correct the holes with a rat-tail file, clamp the boxes together again, and put a 3/16in. drill through them. Recheck with a piece of 3/16in. silver-steel. This kind is usually straight enough to use for checking. The boxes should now be O.K. and the holes may be opened out with 31/64in. drill, and reamed ½in. The oil holes may then be drilled. The top one is drilled 1/16in. and countersunk. The side holes are also drilled 1/16in. and a slight groove is made inside the axle hole, as shown in Fig. 7. This can be done with a little chisel made from 3/32in. silver-steel. File the end off on the slant, like the delicatessen merchant slices a German sausage. Heat the end to red, plunge into cold water, rub the filed part on an oilstone until it is bright and smooth, then lay the chisel on a piece of sheet iron about 1/16in. thick, and hold it over a gas or spirit flame. As soon as the bright part turns dark yellow, tip the chisel into the cold water. It is then ready for use. Make a similar nick at each side of the box, where the oil hole comes out into the groove, as shown.

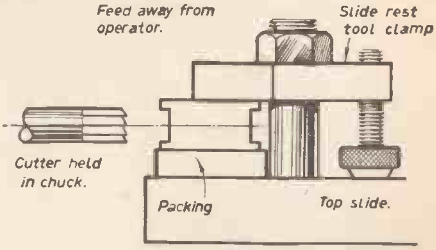


Fig. 8.—Milling grooves in the axleboxes, using the lathe and an endmill.

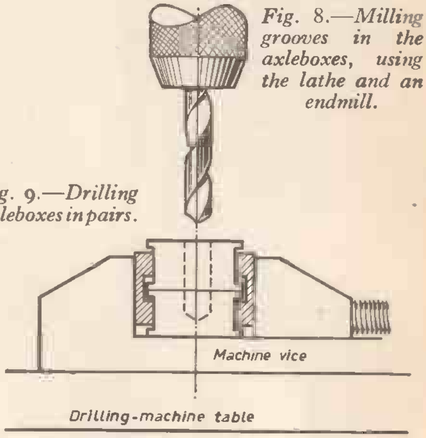


Fig. 9.—Drilling axleboxes in pairs.

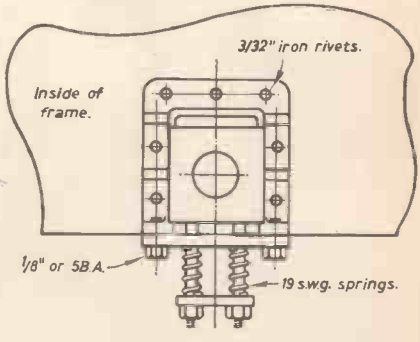


Fig. 10.—The hornblock/axlebox assembly.

If the axleboxes are made from cast bar, each sawn-off length should be chucked in the four-jaw and faced off front and back, to bring the thickness to ½in. before carrying out the above operations.

Hornstays and Spring Pins

The hornstays are made from ⅛in. × ⅜in. mild steel strip, ten pieces each 1½in. long being required. Mark one off as shown in the drawing, being careful to get the two middle holes on the centre-line. Centre-pop deeply, and drill No. 30. File off any burring, then use the drilled hornstay as a jig to drill the other nine. Be sure that the drilled one and the blank are clamped together in line, so that all holes are exactly the same. Next clamp each to the bottom of a hornblock, with the offset holes against the centres of the lugs or feet. Run the No. 30 drill through the holes, making countersinks on the lugs; follow through with No. 40 drill, and tap ⅛in. or 5 B.A. Remove hornstays, put the axleboxes in, and replace hornstays, fixing with screws as shown.

Jam each axlebox tightly against the hornstay by putting a wooden wedge between the box and the end of the hornblock jaws. Run the No. 30 drill through the middle holes in the stay, making contersinks on the bottom of the box. Drill the countersinks about ¼in. deep with No. 40 drill, and tap ⅛in. or 5 B.A. I usually jam up all the boxes, put the frame assembly upside down on the drilling-machine table, make the countersinks with a No. 30 drill in the chuck, then change the drill for a No. 40 and drill the boxes through the holes in the hornstays. Then I shift the assembly to the bench, and tap the holes through the hornstays, which ensures the tapped holes being accurate. It's quick, too! If a drilling machine isn't available, drill the holes in the lathe, with a No. 40 drill in the chuck, and the box held against the tailstock drilling-pad When tapping, be sure to put the tap in quite square with the end of the box.

For the spring pins you'll need twenty 1 5/16in. lengths of ⅛in. round silver-steel. One end of each is screwed for 5/16in. length, and the other for 3/16in. length, all ⅛in. or 5 B.A. Grip each tightly in the three-jaw, and use a die held in a tailstock die-holder. Pull the lathe belt by hand while feeding the die on to the pin, and use plenty of cutting oil, to make certain of clean threads.

Spring Plates

The spring plates are made from 5/16in. × 3/32in. mild steel strip, in exactly the same way as the hornstays, drilling one and using it as a jig to drill the others. The whole lot can then be assembled as shown in Fig. 10, using ordinary commercial steel nuts under the plates. To wind the springs, put a piece of ⅛in. round steel in the chuck, poke the end of the 19g. spring wire between two of the jaws, pull the lathe belt by hand, and guide the wire on to the rod with your thumb. It doesn't hurt! Wind on enough for about four springs at each go. Snip off the lengths with cutting pliers, then touch each end of the spring on a fast-running emery-wheel to square it off.

Bolster and Stays

The pony bolster and king-pin stay, pump and rear stays (Fig. 11) may be cast or built up. If cast, the ends may be milled, if a machine is available, by holding in a machine-vice on the table, and running under a cutter about 1in. wide on the arbor. They can be milled in the lathe by holding in a machine-vice bolted to the vertical slide, and traversing across an endmill held in the chuck. Failing that, they can be done by hand. Grip in a bench vice, with the end just showing above the tops of the jaws, and go to work with a big flat second-cut file. Take it steady, and be sure to hold the file level. Check with a try-square, and finish exactly to width shown, viz. 2⅞in.

To build up, either use pieces of ⅛in. steel plate (same as used for frames) with pieces of brass angle riveted along each side as shown, or cut the pieces of steel to 2⅞in. plus twice the depth of flange, and bend the ends over to form the flanges. This is easy if a bending machine is available, but I don't recommend it otherwise. Drill the holes as shown, then put each in place between the frames in the positions shown in the frame assembly drawing (Fig. 1, March issue). Put a big cramp over the frames to prevent shifting, run the No. 30 drill through the holes in frames, making countersinks on the flanges, follow through with No. 40, tap ⅛in. or 5 B.A. and fix with countersunk screws.

Next month we shall be making a start on the wheels and axles. I shall describe step-by-step the machining and drilling involved.

If any reader has run into difficulty with the work described so far, I should be pleased to advise.

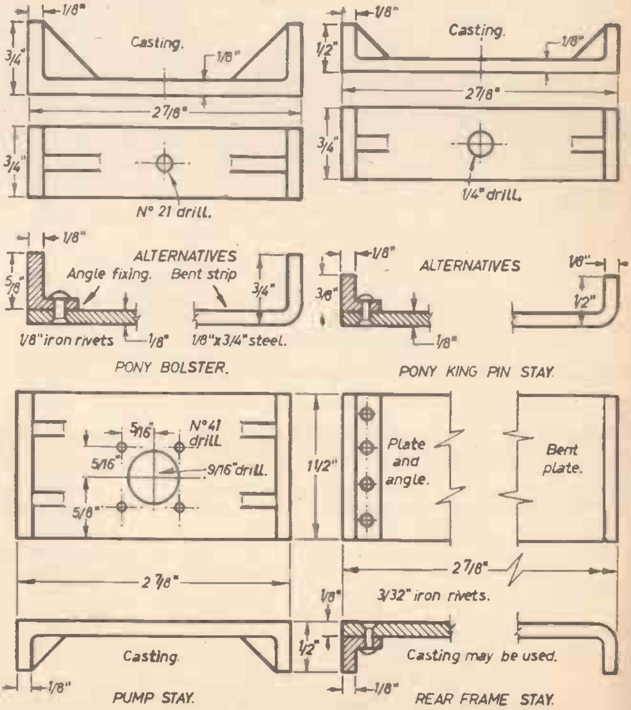


Fig. 11.—Details and dimensions of the pony bolster and king pin staypump stay and rear stay.

A PRINT TRIMMER
for the home photographer

THE photo-trimmer (see Fig. 1) can be used for enlargements up to a size of 10in. × 8in.

The baseboard is made up from ¾in. chipboard, blockboard or plywood. Cut this 12in. long and 9in. wide, making sure that the corners are square. The fixed cutter is made from a 10in. length of ¾in. × ⅛in. mild steel strip. Drill 9/64in. clearance holes for four ¾in. No. 6 screws, and countersink so that the screws finish just below the surface of the strip. File a curve on the rear end of this strip, and drill a 17/64in. hole for the pivot ⅜in from this end.

The Movable Cutter

This is 4½in. longer than the fixed one; drill and shape the rear end as before, and also drill 9/64in. holes at 1in. and 3in. from the front end for fixing the handle. Prepare two pieces of hardwood to a size of 4in. × ¾in. × ⅜in. to make the handle. Round off the outer edges, and drill and countersink one piece, the clearance holes being 9/64in. dia. These holes should be located accurately by using the movable cutter, which has already been drilled, as a guide. Fix the two pieces of wood for the handle with two ¾in. No. 6 screws.

Close contact between the two cutters along their full length is ensured if the pivoted end of the movable cutter is bent very slightly inwards (see Fig 3). To do this, put the cutter in the vice with ¼in. of the rear end showing, and hammer the projecting end to produce a bend of about 3 deg.

Sharpen the edges of the cutters by filing, as shown in Fig. 4, tilting the file to an angle of about 5 deg. to the horizontal. Finish off by draw-filing, making sure that no rounded edge remains. An oilstone can be used to remove the burr.

Secure the fixed cutter to a short side of the base, leaving the cutting edge projecting a maximum of 1/32in. above the level of the baseboard. This will allow for later re-sharpening.

The Pivot

This is made from a 1½in. length of ¼in. mild steel rod. Thread one end for a distance long enough to take a nut, allowing a little extra for riveting over. Screw on the nut, and rivet over the end of the rod to prevent it working loose. Also thread the other end, leaving a portion ⅜in. long unthreaded (see Fig. 2). This illustration also shows how the component parts are assembled to make the pivot. If equipment for threading the rod is not available, an ordinary 1¼in. × ¼in. bolt will serve.

A strip of plywood, ¾in. wide, is pinned along the rear edge of the base. This may be graduated with suitable divisions if required.

Plane up two 12½in. lengths of 2in. × 1in. hardwood, and screw these to the under surface of the base with three 1½in. No. 8 screws. These pieces project ⅜in. at the end of the base to which the fixed cutter is attached.

The sliding stop is made from a 9in. × 2½in. piece of plywood. It is slotted, as shown in Fig. 5, to within 1in. of the end, the slot being 3/16in. wide. Drill a hole 1in. from the edge of the base to take a 1¼in. × 3/16in. bolt. This, with a washer and wing-nut, locks the sliding stop in any required position.

Two or three coats of french polish applied with a brush, provide a durable finish.

Fig. 1.—A photograph of the completed trimmer.

by K. Blackman

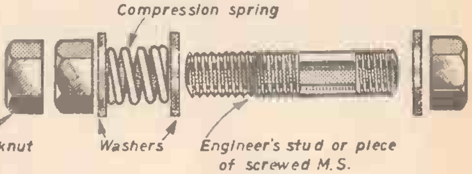
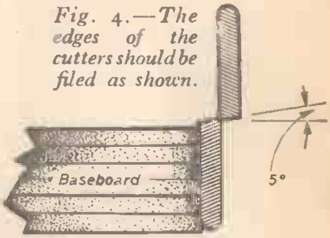


Fig. 2.—The pivot.

Fig. 3.—The two cutters.

Fig. 4.—The edges of the cutters should be filed as shown.



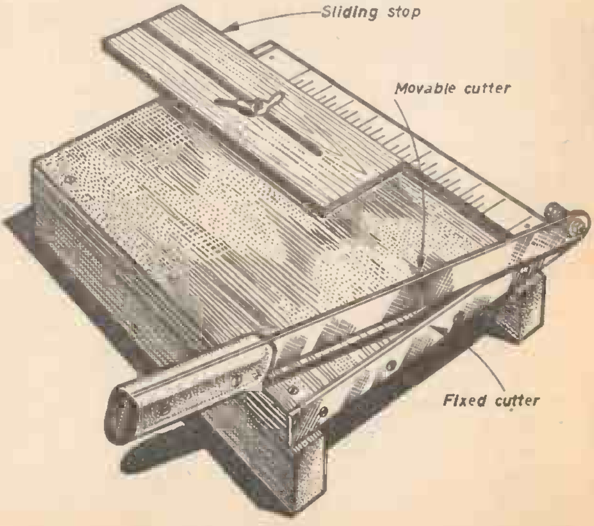


Fig. 5.—The sliding stop and other details of the trimmer.

The St. Bernard Tunnel

Switzerland to Italy Direct—Even in the Winter

THE name Grand St. Bernard has been famous as a pass over the Alps since the days of the Gauls. For the Romans it was of great commercial and military significance and they improved it from a mere track to a stone-surfaced road. There are now other passes through the Alps but the Grand St. Bernard still retains its importance, so much so that it has become intolerable during recent years that such an essential route should be open for only four months of the year. It is to allow all-round-the-year travel through the Alps that two tunnels are under simultaneous construction through this massive mountain barrier. One is being burrowed under Mont Blanc and the other through the St. Bernard. See Fig. 6.

When this latter tunnel is completed in the early part of 1962 it will be possible to drive direct from Martigny in Switzerland to Aoste in Italy at any time of the year. The route can be seen in Fig. 2. Travelling from Martigny, the old route is followed to Bourg St. Pierre where the new approach road skirts the town to the east and follows the side of the valley in practically a straight line to the tunnel entrance. The approach road is covered and a sectional view showing some details of construction is given in Fig. 2. As can be seen there is an unrestricted roadway of some 26ft. and in certain places special reinforcement has been introduced to withstand snow slides and rock falls. This northern approach road is $3\frac{1}{2}$ miles long and has a gradient of 1 in 16.

Northern Highway Station

Under this heading is included the whole entry zone area, comprising all the necessary Italo-Swiss frontier services on the one hand and maintenance services, accommodation for personnel and ancillary services on the other. It consists of a huge covered building, the centre part of which houses the customs and police offices and cable distribution centres. On the first floor are operations and control rooms for the working of the tunnel, the Company offices and ventilation plant for the station.

The Tunnel

The tunnel itself, when completed, will be some $3\frac{3}{8}$ miles long. It will slope up gently from the Swiss entrance to the centre with a gradient about 1 in 300 and down towards the Italian exit at a rate of about 1 in 60. This can be seen in Fig. 4 as also can the positions of the two ventilation shafts. Topographical conditions made only two chimneys

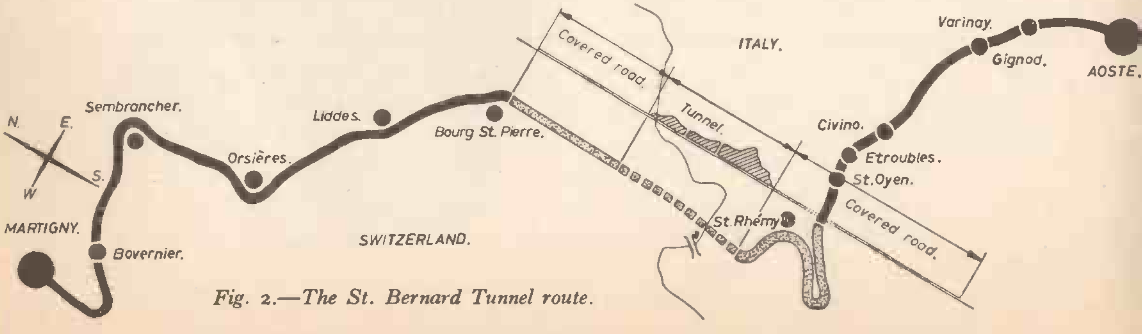


Fig. 2.—The St. Bernard Tunnel route.

Fig. 1. (Left)—The covered approach road (Italian side) under construction.

possible. Ventilation is of the traverse kind which affords the maximum safety. Fresh air is introduced via the southern (Italian) entrance and the ventilation chimney at the Swiss end. Foul air is expelled at the northern entrance and via the ventilation chimney at the tunnel centre. The fresh air is introduced through grilles at pavement level and expelled through grilles in the ceiling (Fig. 8). Of the most modern kind, the ventilation equipment automatically regulates the supply according to the requirements registered by air analysers. The system can cope with the exhaust fumes of some 500 or 600 vehicles per hour.

Main features of the tunnel are shown in Fig. 8.

Fluorescent lighting is to be installed and this will be gradually dimmed towards the exits.

Fig. 3.—Steel helmeted miners at work on the rock face.

Three power stations supply the tunnel, one at the northern entrance belonging to the Grand St. Bernard Company, the Italian power supply and the tunnel company's own hydro electric works operated by the waters of the rivers Drance and Drone.

The amount of traffic will be recorded by eight electro-magnetic recorders giving a statistical account of the vehicles using the whole of the tunnel.

The traffic control light system consists of the usual red and green lights at the two entrances, the sidings and at the two bends of the junctions in the middle of the tunnel.

Laybys 50yd. long, and wide enough to allow large trailers to turn round will be provided and, at intervals through the tunnel, there will be fire hydrants, repair and rescue equipment and telephones. Arrangements have also been made to deaden sound by the installation of a soundproof ceiling and the use of special paint on the walls.

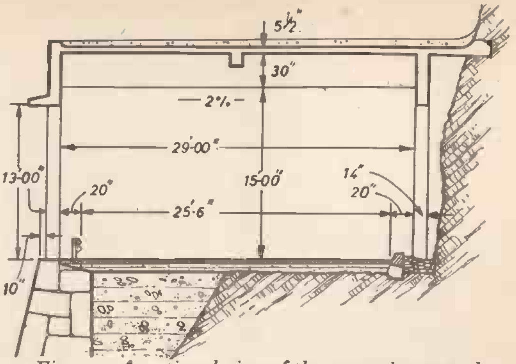


Fig. 5.—A sectional view of the covered approach road.

Southern Highway Station

On the southern (Italian) side this is not the same as to the north. The installations are separated into two groups divided by a reinforced concrete bridge across the valley. At the tunnel entrance are positioned the ventilators and equipment for the operation and control of the oleo (hydro) system. Across the bridge are the same installations as found on the Swiss side. A new covered approach road will link the tunnel with the future Aoste-Etroubles motorway (Fig. 7).

Construction Work

Work on the tunnel and the approach roads is proceeding from both ends. The Swiss Grand-Saint-Bernard Tunnel Company started work in the spring of 1959 and now the approach road is virtually

Fig. 4.—Showing the slope of the tunnel and the ventilation shafts.

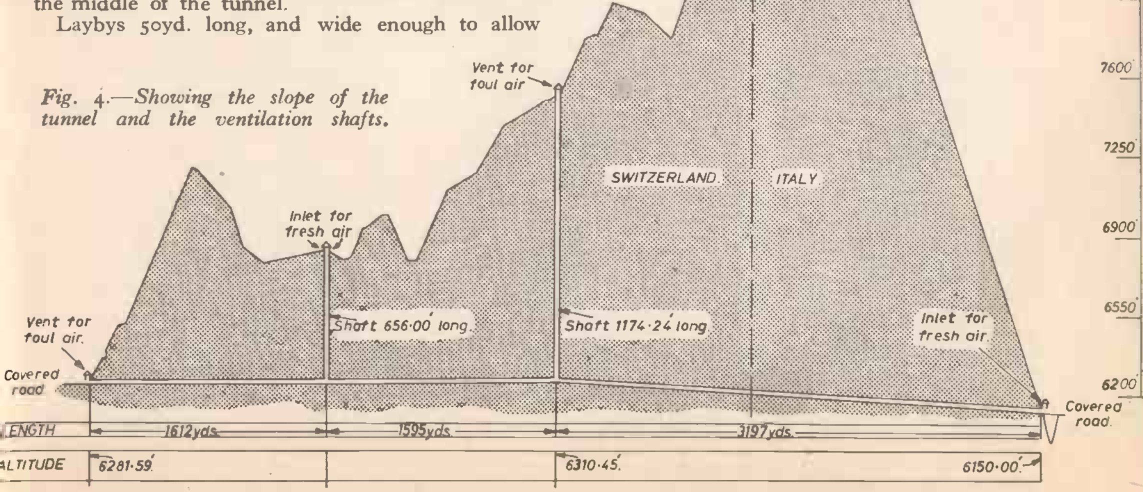


Fig. 6.—Work in progress deep inside the St. Bernard Massif.

complete (Fig. 1) and the actual tunnel well under way. The rock through which the tunnel is being dug is of mica slate and not favourable for mining. The layers are almost vertical and their strata almost parallel to the axis of the tunnel. There are extensive layers where the variable density of sand between the strata adds to the difficulty. The efficiency of explosives is so badly affected as to make spectacular progress out of the question. The normally maintained progress is between 5yd. and 8yd. (three blastings) daily, with an exceptional achievement of 10yd.

The system for discharging spoil comprises a mechanical shovel, crushers and belt conveyors. The conveyor is in five 270yd. sections and has a capacity of approximately 200 cu. yd. of rubble per hour. The debris disposal equipment is capable of advancing some 13yd. per day but the blasting rate stops it from working at full capacity.

On the southern side, Italian engineers encountered a 1,350yd. stretch of spongy waterlogged rock, their work being made troublesome and dangerous by the nature of the subsoil. When harder rock was reached a special drilling platform with three tiers was brought into use. On this a battery of 20 compressed air drills is mounted. When the rock has been drilled, the holes are plugged with explosives and the platform moved back. A 1-metre gauge electric railway is used to remove the debris after the explosion. The viaduct outside the Italian entrance to the tunnel is complete.

Fig. 7.—The scene on the slopes at the Italian end of the tunnel.

It is at present estimated that when the tunnel is completed some 290,000 vehicles will pass through it in the first year.

Motorists will have to stop for customs and tolls, etc. only at the entrance of the tunnel and will be able to leave at the other end without stopping. The following are the total charges envisaged:

	Swiss Francs
Motor cycles	1.50 to 1.70
Cars up to 10 h.p.	5.00 to 5.75
Cars up to 15 h.p.	8.00 to 9.20
Cars over 15 h.p.	12.00 to 13.80
Coaches up to 40 seats ..	13.00 to 15.00
Coaches over 40 seats ..	14.00 to 16.00

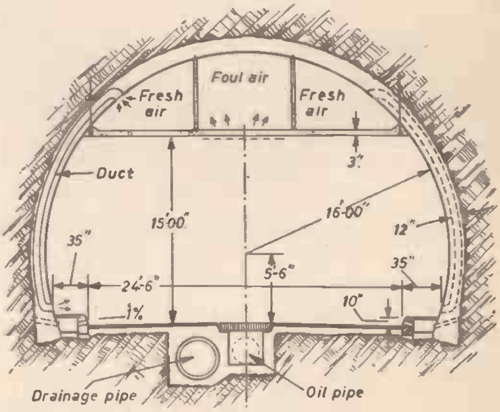


Fig. 8.—Main details and dimensions on the tunnel.

SCIENCE NOTES

Measuring Sound

HERE is a new weapon in the war against noise in the modern world. Noise, before it can be reduced, must accurately be assessed and this is the purpose of the unique transistor sound level meter shown below. It is a portable, battery-operated, direct reading instrument which can easily be held in the hand. Developed by Dawe Instruments Ltd., of Brentford, it will measure sound over the whole of the audible range.

Dawe portable sound meter.

Hospital Reading Device

THE patient shown in the photo below cannot move his arms but by puffing his cheek against a tiny button near his mouth, he activates an electronic device which turns the pages of his book. He reads the words in the mirror shown top left in the photograph.

Heart of a Planetarium

THE photo above right shows one of the most complicated pieces of optical equipment ever devised. It is a planetarium projector, often termed a "dumbbell" projector, and made by the optical firm of Zeiss. Most of the world's major planetariums, including London, have instruments based on this prototype. To gain some idea of the instrument's capabilities, the London projector can present all stars of the 1st and 2nd magnitude and 8,900 stars from the 3rd to the 6th magnitude; also the sun, moon, the naked eye planets, meteors, nebulae, star clusters and aurorae.

Planetaruim projector by Zeiss

A New Weapon Against Oil Pollution

THIS neoprene inflatable oil boom encloses a cut-out berth at Ellesmere Port on the Manchester Ship Canal. The floating boom is approximately 650 feet long and can be temporarily sunk by releasing the air within it to allow vessels to enter and leave the berth. The picture shows the air pressure installation in the foreground. The floating boom ensures that no accidentally-spilled oil from a discharging tanker will pollute the water outside the confines of the boom.

(Left) Hospital reading device.

(Below) inflatable oil boom.

home-made CHEMICAL LABORATORY APPARATUS

Part 8 describes making test tubes, Liebig's condenser and measuring cylinders

IT is hardly worth while buying tubing to make test tubes, but tubes up to about ½in. dia. are easily made. Larger ones may be made from old fluorescent tubes; the author found he could make serviceable tubes, but not flawless ones.

The tube is cut to twice the length required. It is heated in the centre, yellow flame first and then full on roaring, rotating all the time. When soft it is *removed* from the flame and then pulled out strongly and quickly. The two parts are severed in the middle and each worked on separately.

The pointed end is heated, turning all the time, until it assumes the shape of Fig. 47c. The glass blob is removed (or partially removed) by bringing up to the tube a small piece of glass. This will adhere to the blob and draw it off. Repeat as often as necessary. If the shape of the end of the test tube is not satisfactory it may be flattened on an asbestos mat, reheated and when quite soft blown out to a curve by blowing into the open end of the tube.

The finished tube is annealed in a yellow flame. The completed product, often termed a boiling tube, may be completed by making a slight lip all round using the technique shown in Fig. 38c, Feb. issue. Hard glass tubes cannot be made at home. Fig 50 shows some home made test tubes.

A Liebig's Condenser

This can be made from an old fluorescent tube (Fig. 48). If there is any trouble over cleaning out the tube, concentrated Nitric Acid gently run down the tube while turning will remove the fluorescent powder.

Examine the ends for longitudinal cracks and if present cut off an inch or so in the usual way. Two well soaked corks, or rubber bungs are used in the manner shown. The diameter of the inner and cooling inlet and outlet tubes will depend on the volume of vapour expected to be cooled. ¼in. will be found adequate for normal needs, larger sizes mean more area of cold contact and better condensation.

Distilling

Distilled water may be made very cheaply using a Primus stove and a large flask (the author uses an old 12in. television tube). Glass tubes and containers must of course be used for the condensed liquid.

It is illegal to distil alcohol without a licence but no one is likely to object to a few trial drops being tested. Dissolve about 10 grams of sugar in 100cc. of warm water and add a little baker's yeast made into a paste with 10cc. of water. Leave in a warm place for a few days. Distil cautiously. Test the first few drops of distillate by tasting on the tip of the tongue, and see if it will burn when a light is applied. NOTE:—do not apply a light near the distillation apparatus or you might start an explosion.

Making Common Salt

An exciting experiment is making a sample of common salt using two very dangerous chemicals, one highly acidic and one strongly alkaline. The apparatus required is one which will accurately give readings of volumes of liquids.

Using a measuring cylinder, about 25cc. of a weak caustic soda solution is placed in a beaker or dish. A measuring cylinder is then filled to a certain mark with a dilute (about 50/50 acid and water) solution of Hydrochloric Acid. This is slowly tipped into the Caustic Soda solution, a few Mls. at a time until the soda is just neutralised (blue litmus paper just *begins* to turn red). The solution is then brine, it may be tasted or evaporated in an evaporating dish (Feb. issue) on a Sand Bath (Jan. issue).

Measuring Cylinders

Good measuring cylinders may be made from old fluorescent tubes. See Fig. 49 for details. The tube is cut off as detailed in the Sept. 1960 issue and may be up to 12in. long; longer ones become unstable on the bench without unduly large bases.

The electrode/filament assembly is now broken off using a long screwdriver to work it backwards and forwards a few times. The result is shown in Fig. 49B.

A lip is now made by heating the rim carefully in a yellow flame at first and then a roaring one. With an old file or round piece of dowel a lip is formed on the hot glass. It is cooled slowly in a yellow flame.

The base, which may be either of the bayonet or plug type, is now pushed into a tin lid full of freshly mixed plaster of Paris and water. Plaster is obtainable from the builder's merchant. Make sure it is upright and leave 24 hours. Paint the plaster with cellulose paint. The cylinder now has the appearance of Fig. 49C.

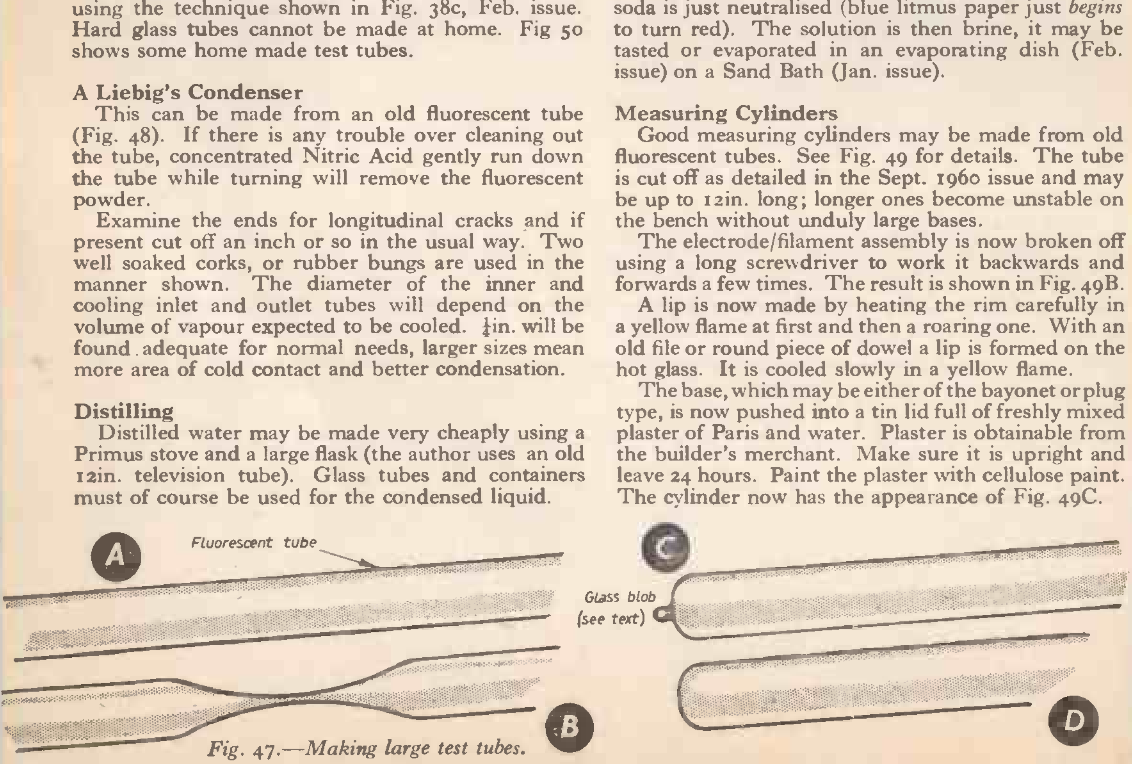


Fig. 47.—Making large test tubes.

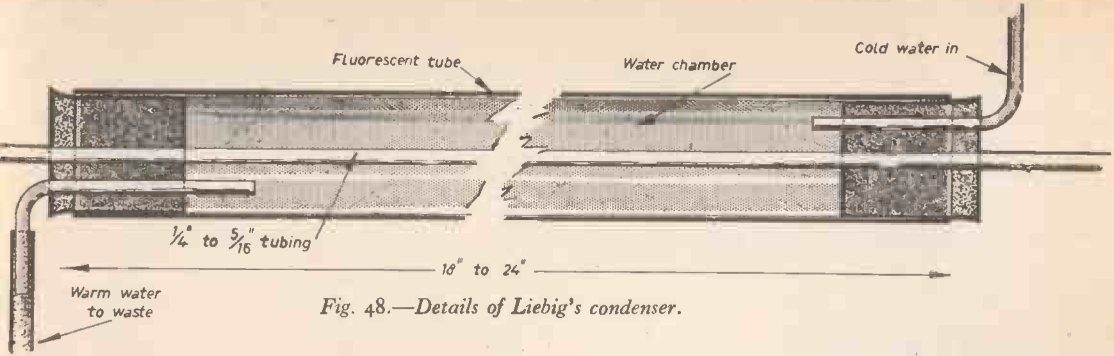


Fig. 48.—Details of Liebig's condenser.

Calibration

A thin strip of paper is now gummed down the outside of the cylinder and allowed to dry well. If another cylinder or burette is available then 5cc. at a time of water is added and the level to the bottom of the meniscus (Fig. 49D) is marked on the paper. To avoid progressive errors it is best to empty out every time and add 5cc. more from the burettes, etc., i.e. 5cc., 10cc., 15cc. up to 100 or more as required.

If a balance is available drops may be added one at a time until 5 grams is shown. Provided the room is cool (the nearer to 4 deg. C. the better) this method gives very great accuracy.

Refer to Fig. 49C and you will note that the glass support to what was an electrode assembly makes the calibrations slightly non linear at the bottom end. Readers should note that they cannot add 100cc. of water and then divide the height by 10 (using the parallel lines method, for instance). The result would be inaccurate.

Marking the Scale

The paper strip may be marked with Indian ink and be given a coat or " Aircraft Dope " celluloid solution in amyl acetate, or clear spirit varnish. The author, however, found that after a few months use these methods were not entirely satisfactory. If used, a scratch should be made at the 100cc. mark on the glass and a spare scale made for use if the old one comes off. Recalibration is thus avoided.

Special paint (red and black) for use on glass is obtainable from laboratory suppliers. Cylinders so marked have been used for 12 months so far.

The writing diamond was used in a similar way. Great care is required as a wrong mark cannot be obliterated and no mark should be re-cut with the diamond or the latter will be rapidly damaged. White chalk may be rubbed into the scratches to make them more visible or cellulose paint may be used.

(*To be continued*)

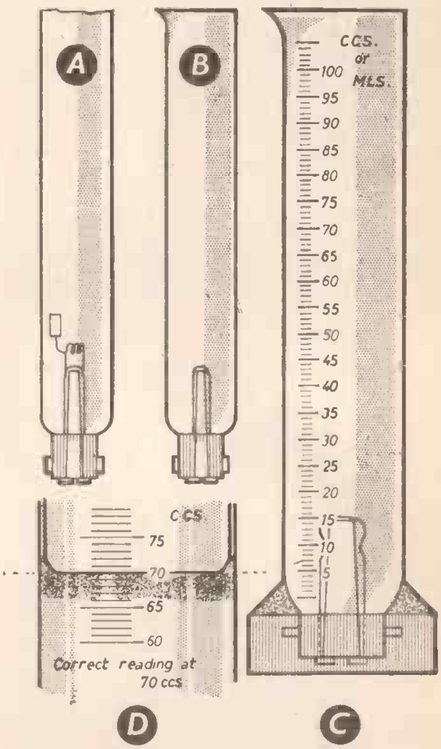
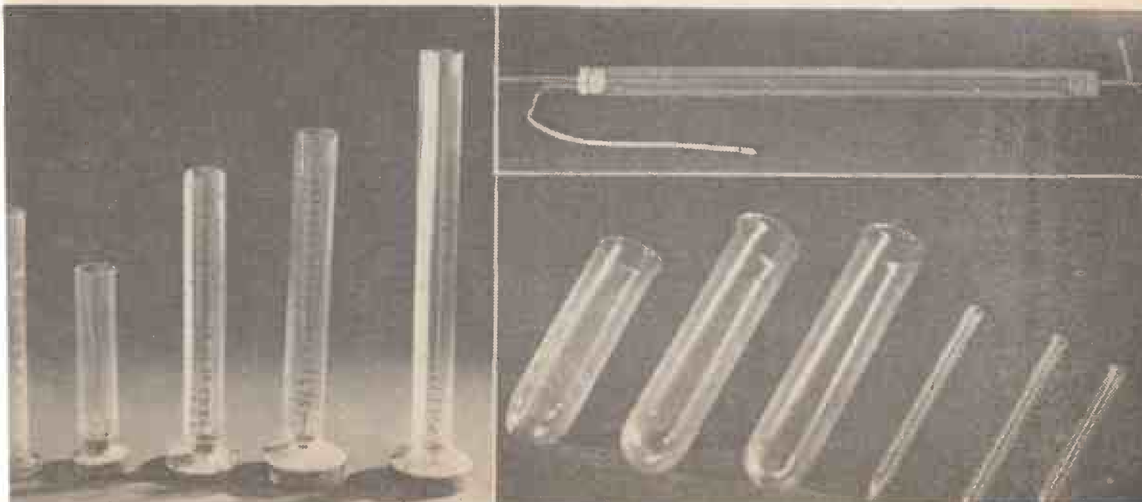


Fig. 49.—The measuring cylinder.

Fig. 50.—Photographs of home-made measuring flasks, Liebig's condenser and test tubes.



The author's gauge " O " loco.

MORE ABOUT OUR GAUGE

THE details published in our January issue assumed some prior knowledge of model loco construction, but we have received a few queries from beginners who are constructing the engine for whom a little more explanation is required.

The Check Valve

A few people are unaware of the function of the check valve on the L.H.S. of the boiler. On a full-size engine this valve admits feed water into the boiler, the water being forced in by a feed pump or injector.

When the pump or injector stops, the check valve prevents the water flowing out again. The valve is in various positions on different locos, i.e. on G.W.R. and L.M.S. engines it is on top of the boiler; on Southern Railway engines it is in the position as shown on this model. On a full-size engine there would be another check valve on the opposite side of the boiler, since every full-size boiler has two independent feeds (Board of Trade Rule). A drawing of a check valve is shown in Fig. 11. On the model there is no room for a working check valve, so a dummy valve is fitted. This is simply an elbow screwed into the boiler. A cycle tyre valve does the duty of the actual check valve. The valve is of the " Dunlop Easipump " type and can be used as a test cock by depressing the plunger. If steam comes out, the water is low. If water comes out, the water level is high enough for safety.

Water is pumped into the boiler by a small track-side hand pump; an ex-Government KI-GASS pump is ideal for this purpose. (This pump was once used for priming aircraft engines and is obtainable from Whistons at about 5s.) The arrangement is clear from the photographs and the drawing, Fig. 7 (January issue).

Displacement Lubricator

This item seems to have caused some confusion, but there is no mystery about it really, in fact, it was used on some of the very early locomotives and is still used to-day in an advanced form on the surviving steam locomotives.

It consists of a vessel containing oil, and connected at the top to small bore pipes which lead into the steam pipes close to the cylinders. When the regulator valve is opened, steam is fed via a small bore pipe to the bottom of the lubricator (some makers prefer to feed it in at the top). On its way from the boiler the steam condenses and the small drops of water being heavier than oil stay at the bottom of the vessel and force the oil up and out to the cylinder.

This action is assisted by the pulsation of the steam pressure and sometimes has to be restricted by a fine needle valve in the steam line. This has not been found necessary in this model, but it is mentioned just to show that one can overdo things.

The working pressure (Lubricator shown in Fig. 9) is unlikely to exceed 30 lb., although the boiler would stand much more. A high pressure, however, would lift the cylinders away from the port blocks and the regulator disc away from its face; if the springs were strong enough to hold these items together there would be too much friction for comfort.

The safety valve spring is a few turns of cigarette lighter spring and holds a ⅛in. dia. phosphor-bronze ball on to its seat, the seating is prepared by hammering a steel ball bearing ⅛in. dia. into it, and is quite steam tight.

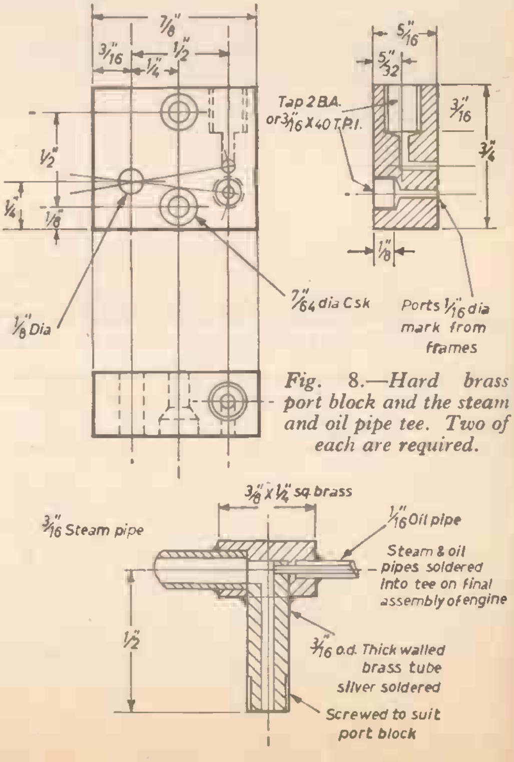


Fig. 8.—Hard brass port block and the steam and oil pipe tee. Two of each are required.

"O" LIVE STEAMER

SOME READERS' QUERIES ANSWERED BY N. DEANE

The Port Block

A sketch of this is given in Fig. 8, but do not mark off the holes directly. First mark out and drill the frame and frame template as in Fig. 12. Bolt the blocks to each respective frame and drill from the frames into the blocks. The blocks are bolted to the *inside* face of the frames for this purpose. The spirit tank is on the small side as the engine is very compact, and if the engine is to have a longer running range, a spirit tank can be fitted into a model coal wagon i.e. a camouflaged tender. The drip feed valve as originally specified can be temperamental. A more reliable method is to use a wick syphon as in Fig. 10. The drawing is self-explanatory.

The holes in the top flange of the frame are used to attach the cab, and tank ends. These items are set up on the frames before brazing together and the holes in them are marked from the frames. The parts are then bolted down on to a piece of plate and the joints brazed. The fixing holes in the piece of plate are of course marked from the frame.

This engine was built almost entirely from scrap material and cost very little. Readers will, of course, use whatever material is available and can take a lot of liberties with the details. A water gauge can be fitted if desired, the glass should be not less than $\frac{3}{16}$ in. dia. but in the smaller models they are not very reliable and test cocks are to be preferred.

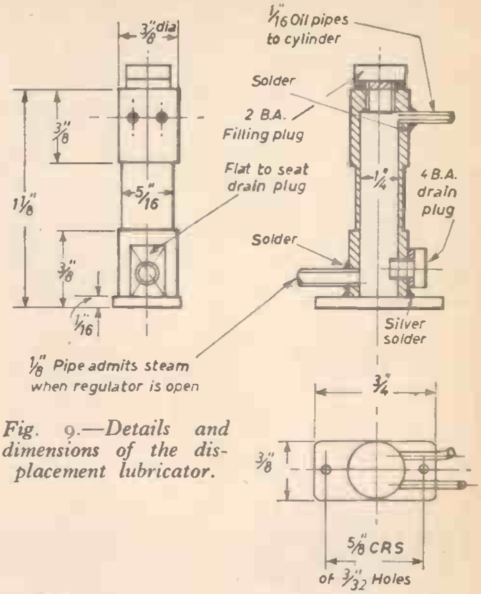


Fig. 9.—Details and dimensions of the displacement lubricator.

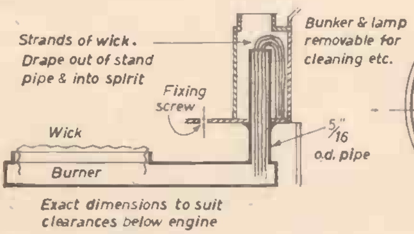


Fig. 10.—Siphon wick feed for spirit lamp.

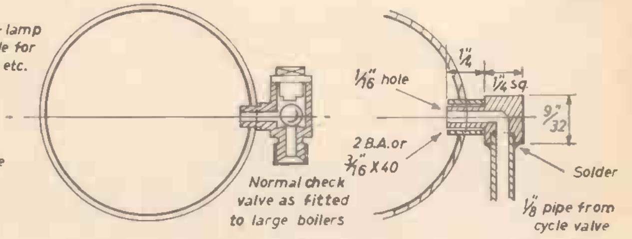


Fig. 11.—Normal full-size check valve and dummy check valve.

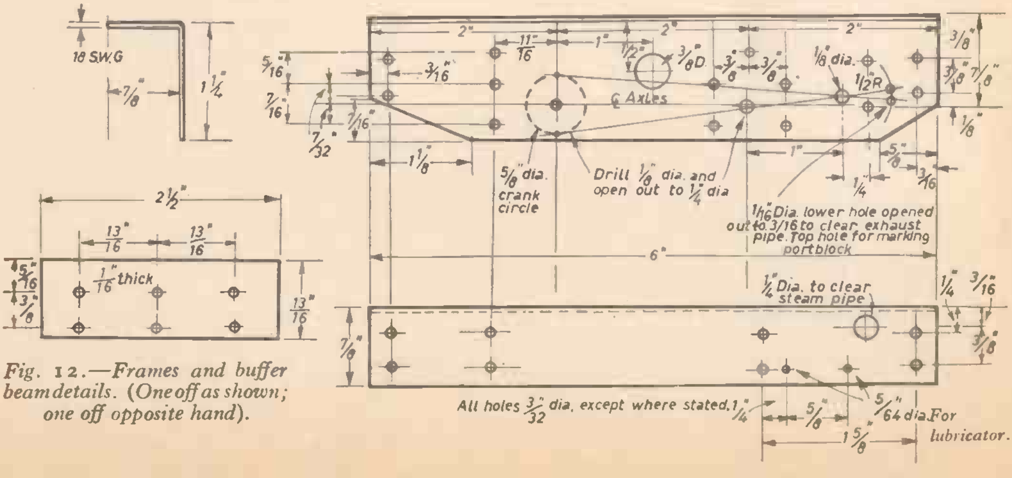
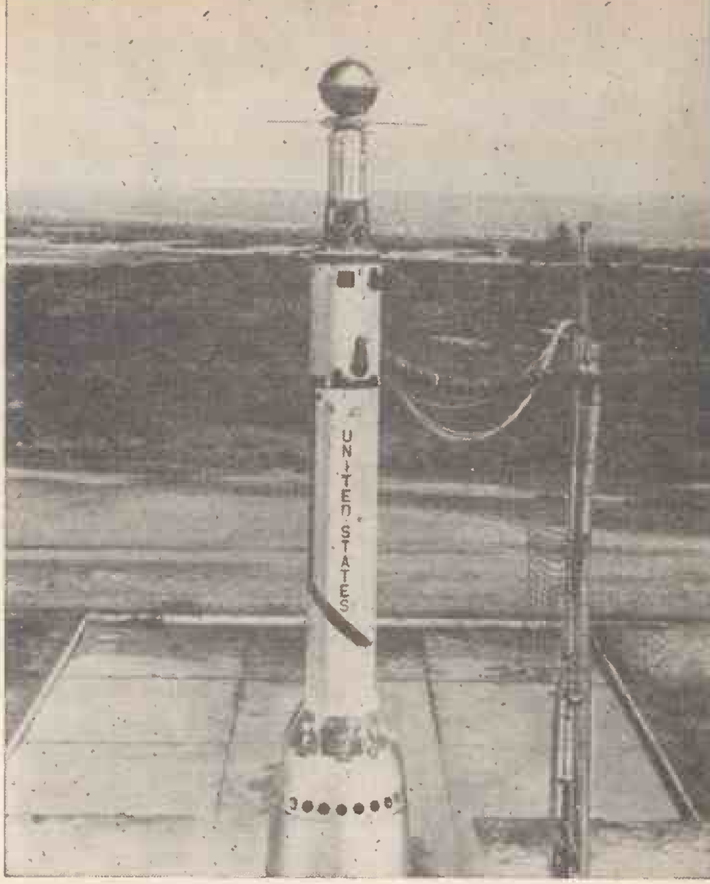


Fig. 12.—Frames and buffer beam details. (One off as shown; one off opposite hand).

S. C. Fraser gives details of the VISIBLE SATELLITE



The second and third stages of the Delta launch vehicle to be used to place the Echo 1,100ft. sphere in orbit, are shown partially uncovered. Resting on the solid propellent third stage is the 28in. canister which contains the folded sphere. The first stage is a modified Thor vehicle; the second is the liquid fuel Able rocket. The Thor also employs liquid fuel.

LATE last summer millions of people, in all parts of the world, looked up to the night sky to see a man-made satellite, shining as bright as the biggest stars.

The satellite was Echo 1, a gas-filled balloon, 100ft. in diameter, which was launched from Cape Canaveral on August 12th in a canister, and inflated high in the sky. (Originally described in July issue of PRACTICAL MECHANICS.)

Because it was so clearly visible at night, Echo 1 captured the public imagination, and quickly became one of the best-known satellites ever launched. Its aims, too, were widely approved. For Echo 1 was an important, experimental step towards the establishment of a communication system that ultimately could provide world-wide television and radio transmissions, as well as global telephone links.

When communication satellites are perfected, the means will be available to flash television pictures of important events and spectacles instantly from one continent to another. In the same way, transoceanic telegrams could be delivered in a few minutes. Phone calls could be sent cheaply by means of satellites to any part of the world.

To bring these exciting prospects nearer to reality, the United States is experimenting with two kinds of communication satellites, " passive " and " active."

Echo 1 is a passive satellite, so called because its main function is to bounce radio signals back to earth. In transmitting messages by this type of satellite, radio signals are beamed towards it from a sending station which can be thousands of miles away. The active satellites carry electronic equipment that enables them to send, receive or store messages. Score, launched in 1958, was the first of this type. Courier, the delayed-repeater satellite launched on October 4th last year, was another.

Within hours of launching, Echo 1 enabled men to speak to each other for the first time by means of artificial satellite. " Live " telephone conversation took place between a scientist in Holmdel, New Jersey, at the Bell Telephone Laboratories where the Echo satellite was designed and the Jet Propulsion Laboratories in Goldstone, California. The distance between these laboratories is 2,400 miles.

Plugged into Telephone

During Echo's 31st orbit, the satellite was successfully plugged into the United States land telephone system. It showed that satellite communications could be applied to a conventional telephone network.

This is what happened. An official of the Bell Telephone Laboratories picked up his phone at Holmdel and called the Jet Propulsion Laboratories at Goldstone. There his call was " patched in " to a radio beam, which bounced off the satellite. It was picked up by the Bell Laboratories, plugged into the Bell Telephone system through a conventional exchange at Middletown, New Jersey and back to Holmdel, where the project manager answered the phone. The two officials talked for more than five minutes. One of them said that the conversation sounded "just as if we were 40 miles apart." Later a call was made from an ordinary telephone in California and was connected to a number in the town of Kapple, New York State.

Echo 1 weighs only 150lb. Its aluminium covered plastic skin is very thin—about half the thickness of ordinary Cellophane—and the only instruments it carried are two tiny transmitters, weighing 11oz. each, which were used for tracking.

For the launching, the deflated satellite was folded into a small airtight magnesium cocoon. Explosive charges split open the cocoon after it had attained orbit. Exposed to hot sunlight in the near-vacuum of space, the ballon was then inflated by special rapidly-vaporising powders.

The initial inflation was provided by benzoic acid, while the second powder, anthraquinone, which evaporates more gradually, filled out the balloon to its ultimate spherical shape.

The orbit was calculated to keep the satellite in continuous sunlight during the first two weeks in order to retain its fully inflated state. Only in this form is it capable of reflecting radio signals within the necessary limits of precision.

Clearly Visible

While it remained in its sunlight orbit, the satellite was visible at many points around the world, especially in the periods just after sunset and just before dawn. Near the horizon, it was in sight for about 5 minutes, and when passing overhead it could be followed for about 10 minutes.

After about two weeks, Echo 1 was due to disappear from view as it passed into the shadow of the earth. Then the satellite started to go into eclipse—for a few minutes during each orbit As the eclipse time gets longer, it's temperature drops far below zero. The vapours will condense and the balloon is expected to collapse. It will then be useless for radio experiments.

But its life may still not be over. Scientists are wondering if Echo will reinflate as it comes back into the sunshine, or will too much powder have seeped out through micrometeorite punctures. Unless the satellite returns to its spherical shape it will not be useful for further communication experiments, because reflected signals from a misshapen surface would not be uniform. But in any case, scientists will have learned more about the density of micrometeorites in space.

New Booster

To launch the Echo into space a new booster was used. This was the Delta launch vehicle, and it was ready just 16 months after the National Aeronautics and Space Administration had signed a contract with the Douglas Aircraft Company for its development. It is to be used for a number of satellite and deep space missions this year.

The Delta stands 92ft. high and has a maximum diameter of 8ft. Its fuelled weight on the pad is a little less than 112,000lb. Its Rocketdyne first-stage engine develops 150,000lb. thrust.

In configuration, Delta is similar to Thor-Able. New features in Delta are an improved auto-pilot and radio guidance system for first and second stage powered flight and precise altitude control for the longer coast period between second stage burnout and third stage ignition.

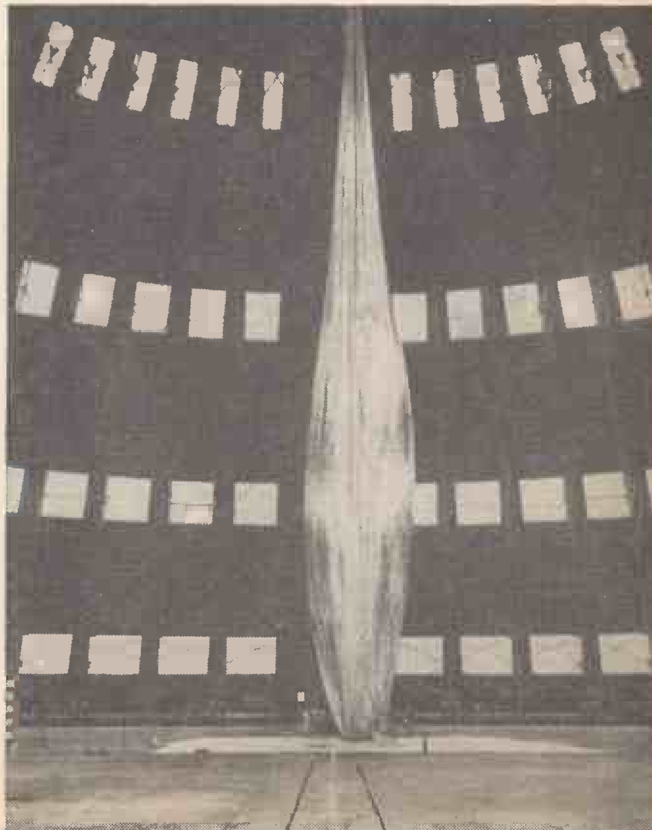
The first stage of Delta is a Douglas SM-75 Thor rocket without the Thor guidance system and with an adaptor to receive the second stage. The second stage is an Aerojet-General AJ10-118 liquid engine which is modified from the second stage of Vanguard and Thor-Able vehicles. The third stage is an Allegany Ballistics Laboratory ABL-248 solid propellent rocket also originated for the Vanguard and Thor-Able.

Metal Antennae

Another method of relaying radio messages from devices in orbit is likely to be tested during the next few months. The U.S. Air Force thinks it may be possible to relay messages with a reflecting belt made up of tiny wires swarming in orbit round the earth. The tiny metal antennae are said to be half as thick as human hair, and the length—a matter of inches—will depend on the frequency to be used.

A relatively small number of these devices will probably be sent into orbit by a launching vehicle with a separate mission, and an effort will be made to bounce messages from them in much the same manner as was done with Echo satellite.

Shown here partially inflated, this plastic sphere became a 100ft. earth satellite when it was launched. Although 40,000lb of gas were required to inflate the sphere for ground tests, only a few pounds are required when it is in orbit.



HOVERCRAFT

THE TRANSPORT OF THE FUTURE

Have you ever wondered just what the basic principle of the hovercraft is? Have you ever speculated with your friends as to what lies in the future for this type of transport? This article will provide some of the answers and perhaps some further talking points . . . .

ANOTHER large aircraft firm is entering the hovercraft field and the Saunders Roe SRN-1 now has a baby cousin. This is the GERM (Ground Effect Research Machine) produced by Folland Aircraft Ltd., one of the companies of the Hawker Siddeley Group (see Fig. 1). The vehicle is part of the substantial background of experience on which designs for commercial hovercraft, including the recently announced " Hovertruck " are being based.

Compared to the established systems of surface transport, all forms of hovercraft share the advantage of requiring considerably less power for forward movement, because their surface friction losses are negligible. Their applications fall into two distinct categories; those requiring comparatively smooth, prepared surfaces on which to run, and those that can operate over rough, unprepared surfaces. It is the second group of vehicles that has attracted the more attention on account of its greater mobility and amphibious capability, and it is on this group that the Folland designers are at present concentrating their main effort.

Fig. 1 (Right)—The Folland Aircraft Ltd., GERM (Ground Effect Research Machine.)

Basic Hovercraft Principles

Essentially, there are two ways of forming the all-important cushion. It may either be produced by pumping air into a self-contained space or plenum chamber under the vehicle and allowing it to leak out near the ground around the periphery (Fig. 2), or alternatively, an annular jet of air may be ejected downwards and inwards at relatively high speed all around the edge of the vehicle so as to form an invisible curtain (Fig 3). This traps the cushion which is itself formed by the momentum change in the curtain air as it is forced to turn and move outwards after leaving the periphery nozzles. In practice this has been found much the more efficient method of attaining realistic hover heights and it has been adopted in all the Folland designs.

A serious handicap suffered by most hovercraft in the past has been that their general configuration has been dictated by their power plant installation. They have virtually been built around the engine, fan and air ducting, and this produces an inefficient layout in the case of a commercial vehicle. Here it is essential to provide a fairly large uninterrupted space in order to accommodate widely varying loads, and one obvious way of doing this is to locate the entire curtain-producing system outside the loading area, around the periphery of the vehicle.

Using this approach, Folland has been testing a number of different air compressing systems, all of which lend themselves to the recirculation of the curtain air as a vital means of reducing the pressure rise needed through the compressor—and hence of operating at greatly reduced power and correspondingly improved economy. The first system (Fig 4) consists of a flexible train of blades, carried on a series of rollers or sprockets around the outer edge of the vehicle in the form of a moving cascade, which pumps the air through continuous ducts. This scheme is equally well suited to rectangular or to oval-shaped hulls and has the attraction of being

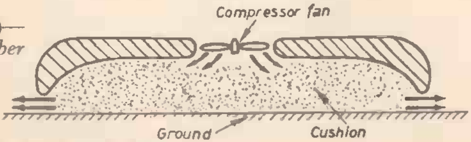


Fig. 2 (Right)—Plenum chamber hovercraft.

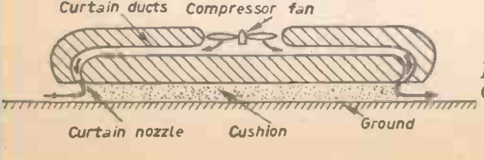


Fig. 3 (Left)—Curtain type hovercraft.

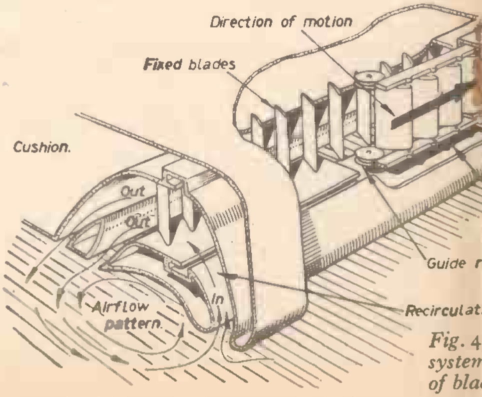


*Fig. 4
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better able to withstand impact damage than is the rigid large-diameter fan.

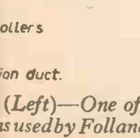
The next method (Fig. 5) makes use of a peripheral injector, which operates on the principle of injecting small quantities of high velocity air through narrow slots, thus entraining a larger volume of air to produce the necessary curtain flow. Attractively simple in theory, this system poses a number of problems in design and manufacture on a large scale.

The third (Fig. 6) consists of a series of small high-speed fans, disposed around the outer edge of the vehicle and linked by flexible drives to the main power plant. A major advantage of this arrangement is the ease with which the fans may be serviced, or replaced in the event of damage. Such a scheme would appear to require less development than the other two and also represents a means of employing the same lifting system for various sizes of vehicle.

Using any of these systems, adequate hover heights can be attained on thrusts amounting to as little as one-tenth the weight of the vehicle.

Propelling a Hovercraft

The major problem facing the designer is that ground effect, which so greatly augments the vehicle's hovering capabilities, is only available to a limited extent for propulsion and manoeuvring by tilting the vehicle. It is therefore necessary in most cases to provide an independent system for propulsion and for the more critical case of manoeuvring. For operation over the widest variety of surfaces—land, water, marsh and broken ice, for example—propulsion and manoeuvring forces must be provided without actual contact with the surface. This can be



(Left)—One of the recirculation
s used by Folland. A flexible train
des is carried on a series of rollers
d the outer edge of the vehicle.

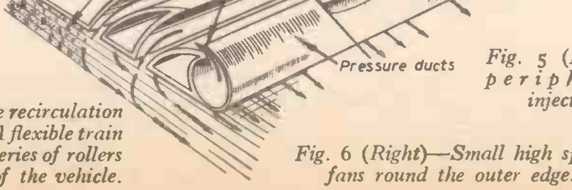


Fig. 5 (Left).—peripheral injector.

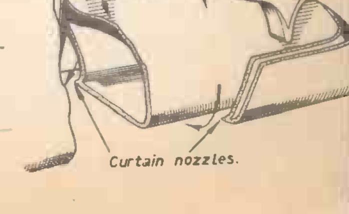


Fig. 6 (Right)—Small high speed fans round the outer edge.

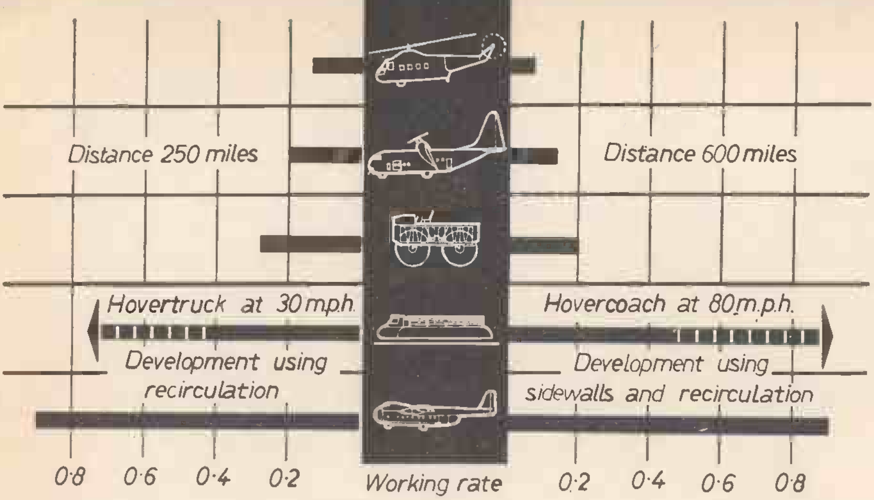


Fig. 7.—Summary of working rates for various types of transport. Working rate $= \frac{\text{tons payload}}{\text{horsepower}} \times \frac{\text{miles}}{\text{hour}}$ *can be considered as the load moved for a given cost per hour over a stipulated distance.*

achieved by the use of jets, propellers or ducted fans, but gives rise to power requirements quite as large as those for lifting the vehicle. For more limited types of operation, however, considerable economies in power can be effected by using surface contact—in the form of a keel or twin immersed sidewalls for operating across water, combined with a marine propeller or water jet, and engine-driven low pressure tyres or tracks on land. This is not such a curious combination as it might at first appear because, of course, most of the weight is still supported by the cushion, so that the wheels are in consequence lightly loaded.

Various types of power plant have been considered in conjunction with the various methods of producing the cushion. Multiple fans can conveniently be driven either by a reciprocating engine or by a gas turbine, the case for the latter being mainly for larger vehicles of above about 20 tons, where high power outputs are required at weights far below the best that can at present be achieved by even the lightest piston engine. For the ejector system, a large supply of pressure air is required and this appears to combine very well with the idea of using a turbine-powered gas producer, such as the Bristol Siddeley BS53—again for the larger sizes of vehicle.

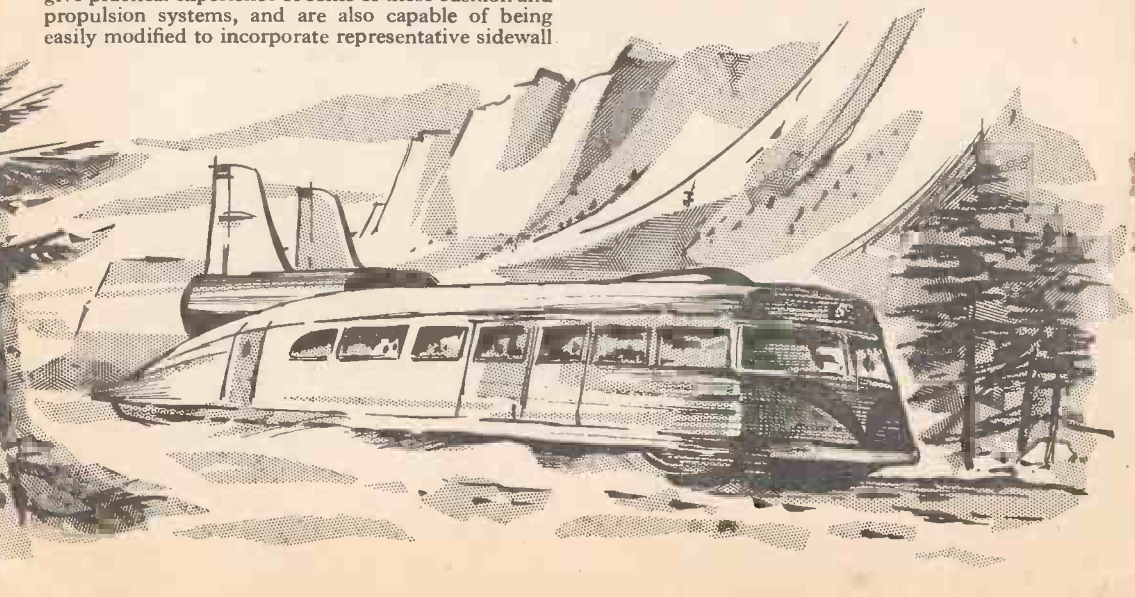
The GERMS now being built by Follands will give practical experience of some of these cushion and propulsion systems, and are also capable of being easily modified to incorporate representative sidewall designs, recirculation systems and more advanced methods of control. They may also be used for on-the-spot investigations into operating problems in various parts of the world.

The Hovertruck itself is intended as a utility vehicle, capable of carrying mixed loads of up to five tons over unprepared roads, rough ground and across water at speeds of up to 30 m.p.h. It can carry fuel sufficient for one day's work.

This form of transport will be of advantage in isolated areas in surveying and oil prospecting and in the production, for example, of banana and other crops at considerable distances from the nearest roadway. In many instances the direct route from the site to the railhead or loading deck is over rough ground, swamp and sometimes across rivers, involving several different forms of transport, with loading and unloading from one to the next.

While it has been calculated that the use of hovercraft will lead to slightly higher direct operating costs, in terms of pence per ton mile, than with any single conventional method of surface transport, it should show a very large saving on cross-country journeys of this nature.

Fig. 9 shows an artist's impression of the Folland 5-ton Hovertruck and how it is ideally suited to work in a remote desert oilfield, with a combination of land



and off-shore drillings. Here the transport of personnel and equipment has in the past necessitated the use of both trucks and marine craft in preference to costly helicopter operations. The Hovertruck can travel directly from the base to the drilling site, entering the water by running down the beach, or via a simple ramp if the coastline is sheer.

A Bigger Hovercraft

In many areas of the world, coastal passenger and freight traffic is made difficult and uneconomic by local geographical conditions. There are, for example, many cases where towns and villages situated on coastal inlets or inland waterways could conveniently be served by high speed amphibious craft. Fig. 8 shows a large coastal vehicle, capable of carrying 150 passengers or 20 tons of freight. Its internal accommodation would be similar to that provided in existing long-distance trains and road vehicles, with an alternative application as a car ferry. A cruising speed of 80 knots (150 km. hr.) would be possible with an operating range of 600 nautical miles (1,100 km.), allowing a full day's operation without refuelling.

Once again, direct operating costs would undeniably be higher than those generally associated with conventional vehicles (not including specialised off-the-road vehicles, such as marsh buggies, which are more costly still). But as in the case of the Hovertruck, the greatly reduced journey times of a large coastal vehicle, and the reduction in its requirements for handling facilities, would show a substantial overall economy over most existing methods of travel and open up enormous possibilities for undeveloped countries.

Probably the best way to compare these vehicles with other forms of transport is in terms of their rates of working. These can be expressed as tons-per-horsepower multiplied by miles-per-hour, i.e. the product of load-carrying capacity and speed—or the amount of load that can be moved in a given time for a given amount of power. A comparision on this basis is made in Fig. 7, which shows the working rates for hovercraft, specialised cross-country wheeled vehicles, helicopters and transport aircraft, for various ranges of operation without refuelling. From this it can be seen that, depending on the conditions selected for the hovercraft, it can be made to achieve working rates which compare favourably with those of all existing forms of transport.

These figures have been calculated for the comparatively simple vehicles on which Folland is at present working in the belief that the building of hovercraft on the scale of the transatlantic and even the cross-channel ferries of which we read so much these days, will demand some years of previous practical experience with smaller vehicles. A craft such as is shown on our cover is still very much in the future.

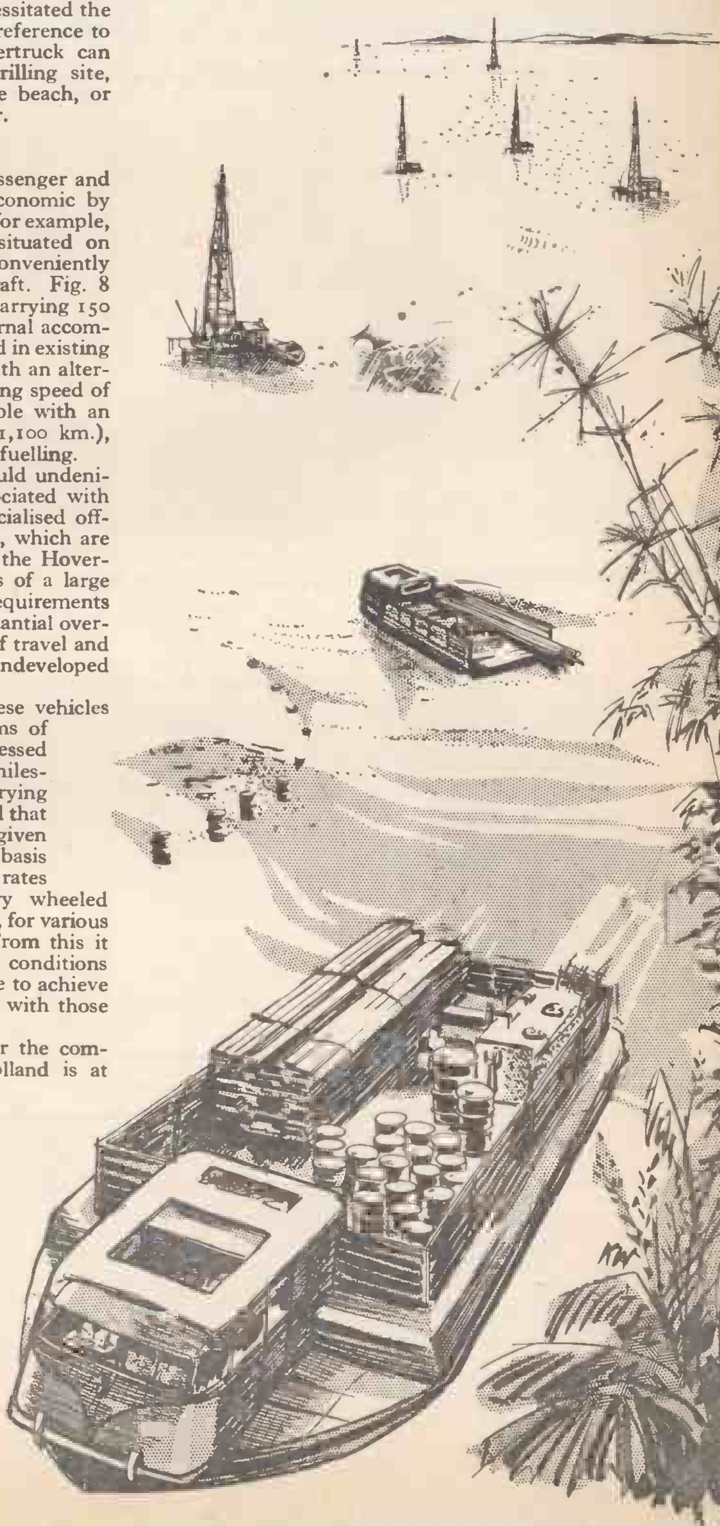
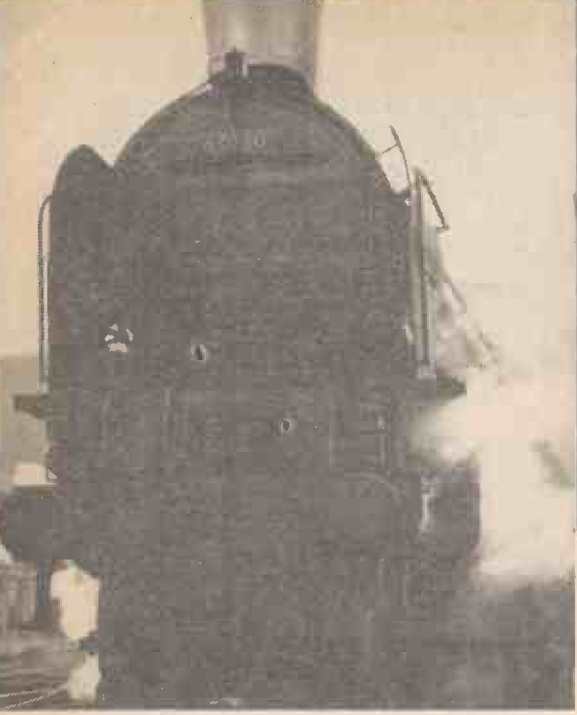


Fig. 8 (Left)—A large coastal vehicle capable of carrying 150 passengers or 20 tons of freight.

Fig. 9 (Right)— An artist's impression of the Folland 5-ton Hovertruck.

Steam is Best *or is it?*

L. Lawrence discusses the relative merits and disadvantages of the various types of railway locomotive traction and reaches some startling conclusions.



The locomotive is the " Kestrel " and the train it is hauling the 3.10 p.m. King's Cross to Newcastle.

THE fact that the steam locomotive has been doing its job satisfactorily for nearly a century and a half, shows that there is nothing radically wrong with it. Consider its construction; a frame with wheels, and the simplest of spring suspension. Two, three, or four cylinders driving the wheels direct through pistons and connecting-rods. One valve per cylinder, directly driven through a simple valve gear, operated by two eccentrics or a return crank, and readily and instantly reversible. Cylinders are operated by steam from a compact boiler carried on the frame, and the boiler can be fired by coal or oil. Once steam is raised, the locomotive can start itself and its load, merely by opening the regulator or throttle. It is simple to handle, and can be serviced by any mechanic of average intelligence. Its first cost is comparatively low, and it has a long working life; many engines pulling useful loads at this moment, are over 60 years old. The centre of gravity being high, and the motion balanced, there is little lateral oscillation, and the minimum of wear on the rails. When used on local services, or main line work where the distance between stops doesn't exceed 50 miles or so, water tanks and coal bunker can be carried on the engine frames instead of a separate tender, making for compact and handy units capable of running equally well in either direction.

"Milly Amp"

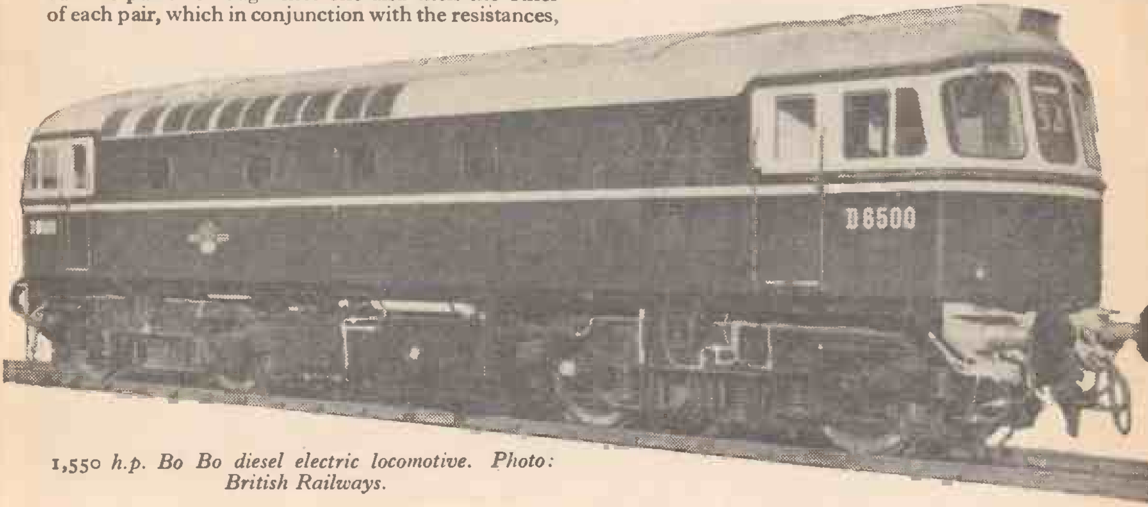
The "straight" electric locomotive has much in common with its steam sister, but with one outstanding disadvantage, viz. it doesn't generate its own power, but has to pick up its source of energy either from a third rail, or overhead wire. Consequently its scope is limited to lines so equipped, and it is only an economic proposition where the traffic is dense. Some of the earlier locomotives were built with frames and wheels similar to steam practice, two or more big motors being mounted above frame level, driving a set of coupled wheels either by outside inclined connecting-rods, or through a jack-shaft, or by gearing incorporating a spring drive. This arrangement was common in the U.S.A. and Europe.

2,500 h.p. Bo Bo electric locomotive for use on the third rail D.C. electrification system of the Kent coast lines. Photo: British Railways.

The most common type of electric locomotive has two bogies, either four- or six-wheeled, with the motors mounted on the bogies, driving the axles through gear-wheels. This arrangement, while simple, brings the centre of gravity very low, and causes much more wear on the rails than the type mentioned above. The control gear on the direct current locomotives, which work at from 500 to 750 volts, is fairly simple. The main current would be too heavy to pass direct through the driver's controller, so a small current passes through it and operates a set of magnetic contactors which carries the main current. A bank of resistances is carried, to tone down the " juice " when starting, and " circuit breakers " (automatic overload switches) are provided in the main circuit to prevent an excessive rush of current from burning out the motors.

The motors are usually wired in pairs, on the "series-parallel" system, so that when starting, current passes through first one and then the other of each pair, which in conjunction with the resistances, gives a smooth start. When under way, each motor receives current direct. Compressed air for operating air-brakes and whistle, is supplied by a motor-driven compressor governed by a pressure-controlled switch. For working trains fitted with the vacuum brake, a motor-driven exhauster is provided. The motor-coaches of multiple-unit trains are fitted up in similar manner; in fact, they actually *are* electric locomotives furnished with a passenger-carrying body, with a separate compartment for the driver, or motorman as he is usually known.

204 *h.p. diesel mechanical shunting locomotive. Photo: British Railways.*



1,550 *h.p. Bo Bo diesel electric locomotive. Photo: British Railways.*

The high-voltage alternating-current locomotive is a rather more complicated box of tricks, as transformers have to be carried to step down the high voltage to working level, and where D.C. motors are used, rectifiers have to be provided to change the current from A.C. to D.C. The slightest leak in the insulation is liable to cattle up the whole works. However, taking it by and large, the electric locomotive compares very favourably with the steam locomotive in regard to cost and maintenance. It has a long working life; once in contact with the third rail or overhead wire, it is self-starting, is instantly available, and will keep on working day and night, all around the clock, with the minimum of attention. But if for any reason, the "juice" goes off, it is absolutely and completely finished. One current failure can put a whole section of railway out of action.

Diesels

There are two kinds of diesel locomotives; diesel-electric, and diesel-mechanical. The first-mentioned

350 *h.p. diesel electric shunting locomotive. Photo: British Railways.*

is, in effect, an electric locomotive carrying its own power station. In addition to the equipment already mentioned for the "straight" electric engine, it has to be provided with a diesel engine of adequate power to drive a generator capable of supplying the traction motors with sufficient current to operate them to full capacity. The diesel-mechanical requires some form of transmission between the engine and the driving wheels, which may be hydraulic, or some form of gearing. Electric or mechanical transmission is essential, because a diesel engine, unlike a steam engine, is unable to start itself, and cannot be directly connected to the wheels. Even when running, it has nowhere near the flexibility of a steam engine.

A diesel engine, just the same as a petrol engine, to obtain the requisite power, must be of multi-cylinder design with its added complication. The diesel locomotives on the Western Region, for example, have two twelve-cylinder engines, each cylinder having six valves. Just fancy—two dozen cylinders and a gross of valves, against two cylinders and two valves of a *Hall* class steam locomotive, or four cylinders and four valves of a *King*! The diesel engine is a complicated box of tricks with plenty to go wrong at the least provocation. To describe all the blobs and gadgets which go to make up a diesel locomotive would take up far more space than is available here The craze for "something new and modern", coupled with high-pressure salesmanship plus misleading statistics about operating costs, availability and what-have-you, resulted in the adoption of diesel traction for the railways in place of steam.

The Great Awakening

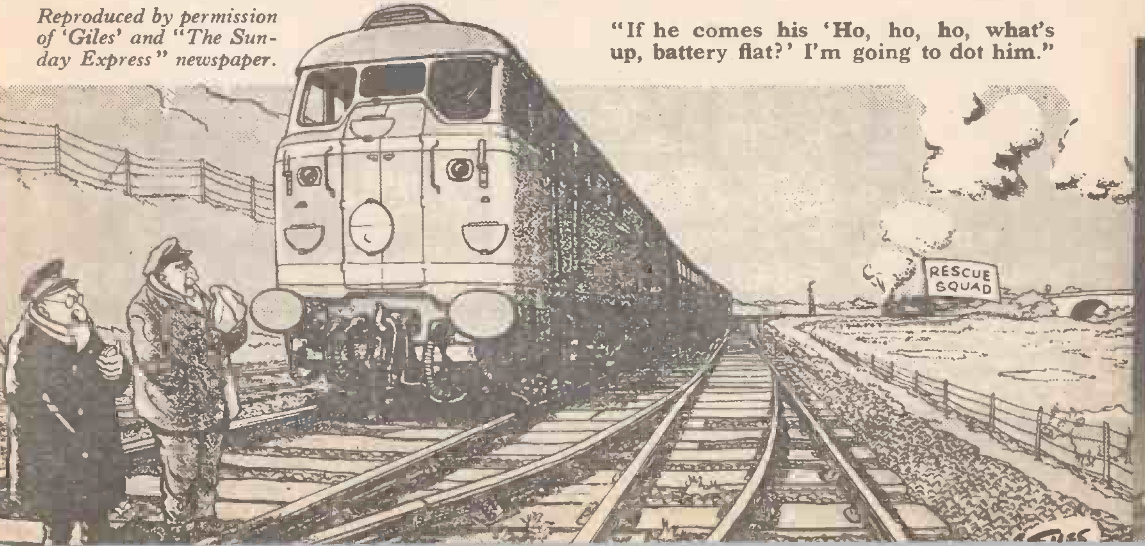
The initial cost of a diesel locomotive is from four to six times as much as for a steam locomotive of equivalent power. Now that those in service have begun to wear, it has been found that the cost of maintenance is about four times that of a steam engine. Breakdowns occur daily; the *Daily Express* columnist, Nancy Spain, wrote that when accompanying Mrs. Bessie Braddock on a trip to Liverpool, the diesel locomotive broke down, and after an hour's delay, a "dear old-fashioned puff-puff" took the train on. To my own knowledge, on two occasions when a diesel failed, another diesel sent to the rescue also packed up; in both cases a steam locomotive finished the trip. That was on the Southern Region. Not long ago, on the Eastern Region, in one depot there were several brand-new diesels going rusty while awaiting repairs, while the old steam locomotives that they were supposed to replace, were still doing the job in fine style. It is the same all over the country.

The biggest diesel showdown of all, was contained in a paper presented to the Institution of Mechanical Engineers on November 30th last, by Mr. H. F. Brown, an eminent American consulting engineer; and a more damning indictment it is hard to imagine. Mr. Brown completely exposed all the misleading statistics that are consistently put forward by the biased advocates of diesel traction, and produced facts, figures, and a number of graphs to substantiate his statements. One point was that comparisons were made with new diesels against small and worn steam locomotives over 30 years old; had the comparisons been made with new steam engines, which could be built up to 7,000 h.p., the results would have been reversed. He also showed that two diesels were needed to haul a train which could easily be handled by one steam engine.

In comparing the tractive effort of a diesel with a steam locomotive of equivalent power, he showed that the diesel had a higher starting force up to about 6 m.p.h. but above 20 m.p.h. the steam engine had double the tractive force. Incidentally, that was amply demonstrated on the Great Eastern line when a diesel and a *Britannia* were tried on a Norwich-Liverpool St. express. The diesel got off the mark slightly quicker, but once the *Britannia* got into her stride, she licked the diesel hands down for speed, both on the level and up the grades.

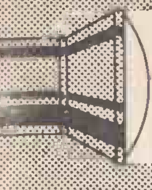
Mr. Brown also showed that the diesel locomotive wears out the track quicker than a steam locomotive, and finished by stating that the all-embracing economies claimed for diesel motive power do not appear in the records, and that diesels have added to the financial burden of the railways instead of showing a saving.

(*Concluded on page* 366)

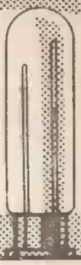


Reproduced by permission of 'Giles' and "The Sunday Express" newspaper.

"If he comes his 'Ho, ho, ho, what's up, battery flat?' I'm going to dot him."



SWITCHING WITH LIGHT BEAMS



Part 14 in our Automatic House Series by E. V. King

Unit No. 2

BASICALLY this is the same circuit as was given last month and only brief details will be necessary. It is a combined photo switch using a cheap and novel form of transformer.

Parts Required

These are exactly as for Unit No. 1 except the following: two exactly similar standard output transformers. Available surplus from Messrs. Duke & Co., 621 Romford Road, E.12, or two 6V. filament transformers. A rectifier valve 6X5 with Int. Octal base in lieu of MR. P.E.C. R.C.A.'s 930 or use 868 as in unit No. 1.

Layout

This is in no way critical. The prototype is shown in Figs. 120 and 121. Before fitting the two transformers make sure which two connections on each are of high and low resistance. Number them (Fig. 122) 1 and 2 for low and 3 and 4 for high. VR (H.T.) is made a screwdriver trimmer type potentiometer at the back of the unit.

Wiring

This is quite straightforward. Wire up the rectifier valve and C18/C19/R19 before fixing the transformers in position. Leave out R (optional) for the time being and find the correct value later; wire VR (H.T.) direct to R19.

Wire as in Figs. 120 and 122 (the positions of the components have been modified slightly to allow readers to follow all the wires).

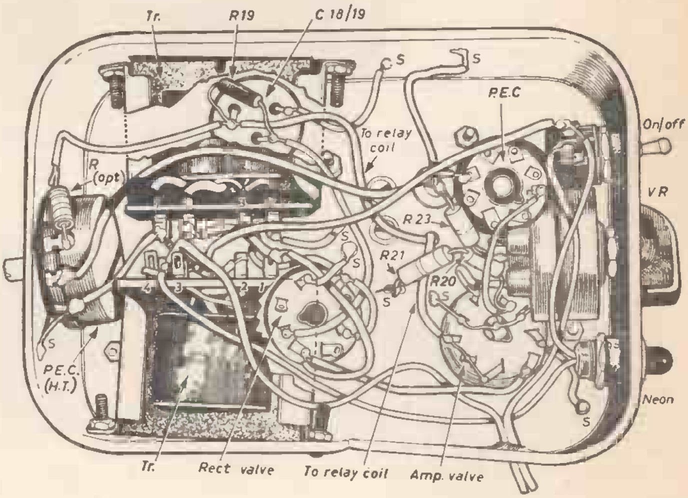
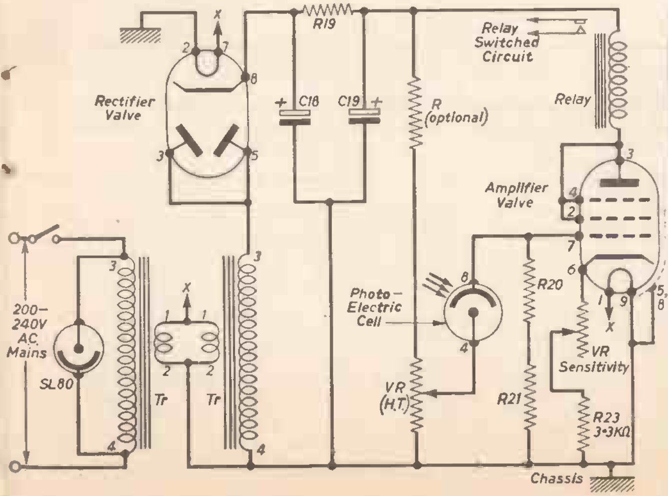


Fig. 120 (*Right*)—*Wiring of photo-switch unit No.* 2.

Fig. 121 (*Right*).—*Top view of photo-switch unit No.* 2

Fig. 122 (*Below*)—*The theoretical circuit.*



Testing

Plug in as for Unit No. 1 and carry out the same tests. If a meter is fitted unsolder one lead to the relay coil and insert the meter in circuit. Do not worry if the valve filaments are slightly underrun. The results to be expected will be about 60 per cent. of current ratings for Unit No. 1. This slight loss in sensitivity may be compensated by very careful relay adjustment and remember this unit is smaller, and cheaper to build. It may be used for any purpose concerned with light beam operation or " ambient " light or darkness such as a fog warning indicator, secret door locks, and other uses as already mentioned.

Unit No. 3

This is a much cheaper and smaller unit which will operate without a D.C. H.T. supply. It is ideal for operation where a good beam is available such as for automatic doors, counting cars coming in a drive, and some types of burglar alarm. Since the chassis is live to mains it should be enclosed in a wooden container, should not be used outdoors and care taken to make sure that external switched equipment is *only connected to the relay contacts.* No danger is then involved in the switched circuit. Correct mains connection MUST BE OBSERVED. (See Fig. 123.)

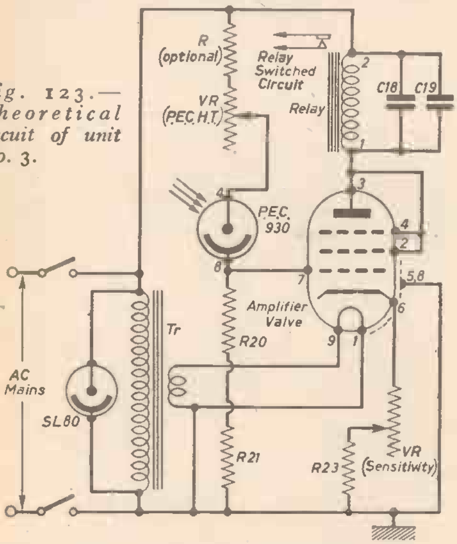


Fig. 123.—Theoretical circuit of unit No. 3.

Parts Required

These are as in the other units. The transformer may be an ordinary 6V. filament or bell transformer. An old output transformer (pentode type) will also suit.

The toggle switch MUST be a double pole switch so that the neon is a true indicator that the chassis is live when switched on. Arcolectric Toggle T956 and F610 is suitable, and is best bushed to isolate it from chassis (or use an insulated type).

The Layout

Any convenient layout will suit. P.E.C. must not be too far away from the amplifier valve (say up to 3in.). The condenser C18/19 MUST be wrapped in transparent tape or good insulating tape before being clamped in position, and must be of the type which has a soldered earth connecting tag or negative lead. Readers are reminded again that the can of the condenser must NOT be connected to the chassis via the clamp (see Figs. 124 and 125).

Wiring

Provided C18/19 is isolated from chassis as mentioned and the leads from relay tags numbers 3 and 4 are well insulated so that they cannot touch the chassis no snags will occur. Be careful about the wiring to the double pole switch or you will blow the house fuses by short circuiting the mains when you switch on. This may also damage the switch.

Testing

This is carried out as with the other units. It is best to leave out R (optional) and replace it with a length of wire. A D.C. milliameter may be inserted in lead No. 2 to the relay. The lead, seen clearly in Fig. 123 is unsoldered from its tag on the relay coil and the meter inserted in circuit. The readings to be expected will be about half those for Unit No. 1.

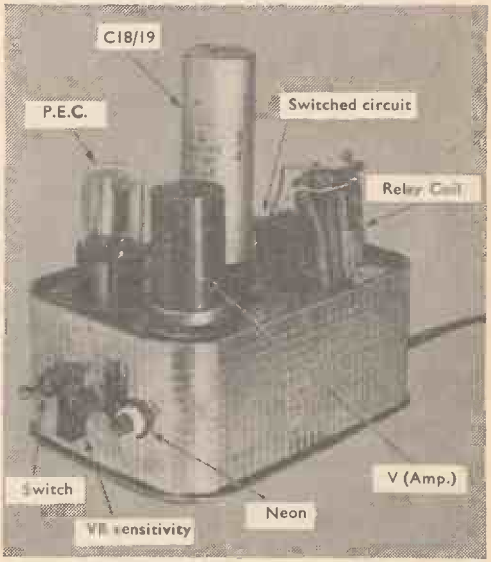


Fig. 124.—Top view of unit No. 3.

Since the standing current in the amplifier valve is now only about 1 mA. the relay may be more finely adjusted so the final sensitivity is somewhat more than half that for Unit No. 1.

External Wiring of a Switched Circuit

So that readers may be able to use the units for any purpose they desire it is now proposed to deal with two sample cases:

1. Switching porch and outside lights on and off with sun rise and sun set automatically without a time clock or solar dial.
2. A warning indicator to show if baby has got out of the cot and is wandering.

Case one uses ambient light; case two focused filament light.

Automatic Switching at Sunrise and Sunset

The units described will do this easily and the idea is economically sound. Chicken houses may be closed or opened using a two-way relay, and in a similar way curtains may be automatically pulled. For porch lighting a P.E.C. switch unit (No. 3) is placed on a shelf across a window (garage, cupboard, or spare room) with the cell window adjacent to the house window. The switched circuit is wired as in Fig. 126. Care is required when working in damp locations. Do not try to earth the chassis of the No. 3 Unit. Use a wooden case or No. 1 or No. 2 units, which can be earthed.

Adjustment is best made as dusk approaches as overlap at dawn will not matter.

The units described all have got n/o relays incorporated; this use requires a n/c one and No. 229 from Messrs. A. T. Sallis is a two-way type which will suit.

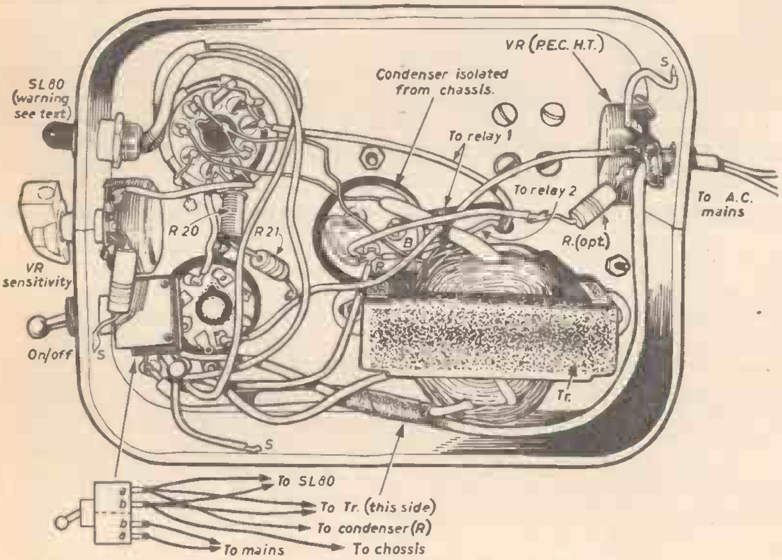


Fig. 125.—*Underside views of Unit No. 3, showing wiring.*

Switching Heavier Loads

Where a number of lamps are to be switched at one time the small contacts of the relay incorporated would not last long and a power relay is required to do the main switching. The basic circuit is shown in Fig. 127. The D.C. supply will have to suit the relay used. A.C. may be used with special relays, but it may give rise to "humming" under some conditions. The H.T. supply of the P.E.C. unit (Nos. 1 or 2) may be used to operate the power relay in some cases.

Baby's Wandering Alarm System

Any of the units may be used. Arrange as in Fig. 128.

The unit must be totally enclosed so that the child will not tamper with it, or it may be placed in a cupboard or another room with only the light window projecting.

Light Baffles

Where a beam of light is to work in the daytime or in the presence of other artificial light a baffle is often required. It consists of a round or square section tube about 4in. long which is attached to the unit in front of the cell as in Fig 130. Where it is required that an intruder shall not see a light beam a similar baffle is fitted on the lamp house as well.

Construction

Always try the apparatus without a baffle first. Correct sensitivity and H.T. settings may obviate its use.

Make the inside window as big as the anode of the P.E.C. and be sure the baffles fit well, or if of metal, that they are soldered in all the way round.

Many small cocoa type tins will make excellent baffles if some spare lids are cut down and soldered inside. Square section mustard tins, too, will do very well if fitted with hardboard sections.

The Light Beam

A beam of about 12W. intensity and the size of the anode of the P.E.C. will work the unit. However, a 24W. low voltage lamp is best used as in Fig. 129. A low voltage is used as the filament is then of the more compact type used in automobile headlamps. Either 6, 12 or 24V. types may be used.

Unit "A"

This is made from a coffee powder tin fitted with a small double pole bayonet holder and a headlamp bulb.

The lid has a tube of cocoa tin metal soldered in place as in Fig. 129A. The tube is serrated at the end and the serrations turned over for ⅛in. to act as an end stop for the lens. A few tinplate

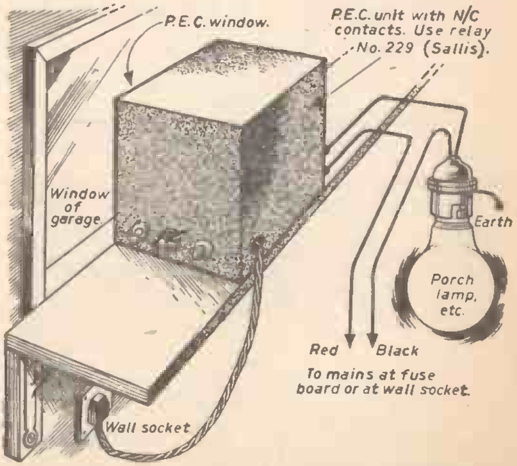


Fig. 126.—*Using a photo-switch to control a porch lamp.*

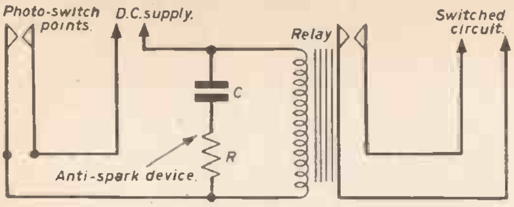


Fig. 127.—*Circuit for switching heavy loads with P.E.C. units.*

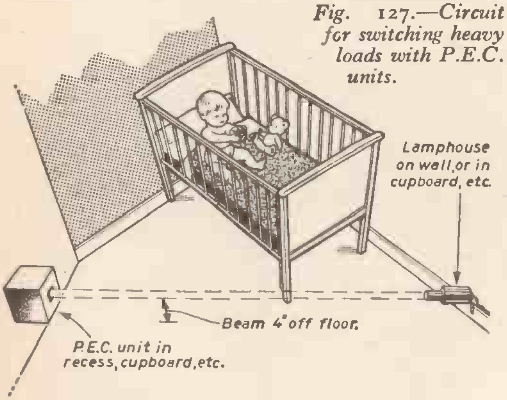


Fig. 128.—*'Wandering baby' alarm.*

clips are soldered inside to hold the lens.

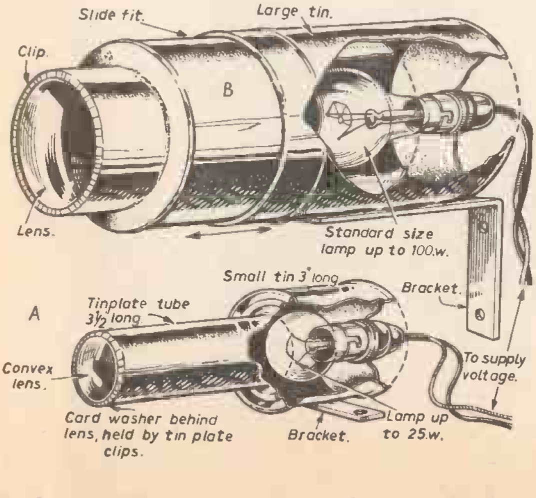
This must be of the "magnifying" type; that used in the prototype was No. 5, 38mm. dia. and 3¾in. focal length available from Messrs. H. W. English, Rayleigh Road, Hutton, Brentwood, Essex. No. 24 lens is somewhat cheaper and has a focal length of 2¼in. which might prove suitable. In any event do not cut the tube to length until the correct focus has been found by trial and error.

Focusing the Lens

Connect up the lamp and place a piece of paper the size of the P.E.C. anode at about the distance required in operation. Now move the lens backwards and forwards until the filament (upright) fills the oblong piece of paper as fully as possible. Note the distance from lens to lamp and build the unit to this dimension.

Fig. 129 (*Below*)—*Two light beam units.*

Fig. 131 (*Right*)—*Wiring diagram and theoretical circuit of counting device.*



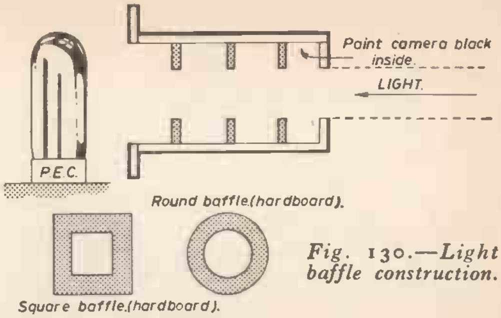


Fig. 130.—*Light baffle construction.*

Unit "B"

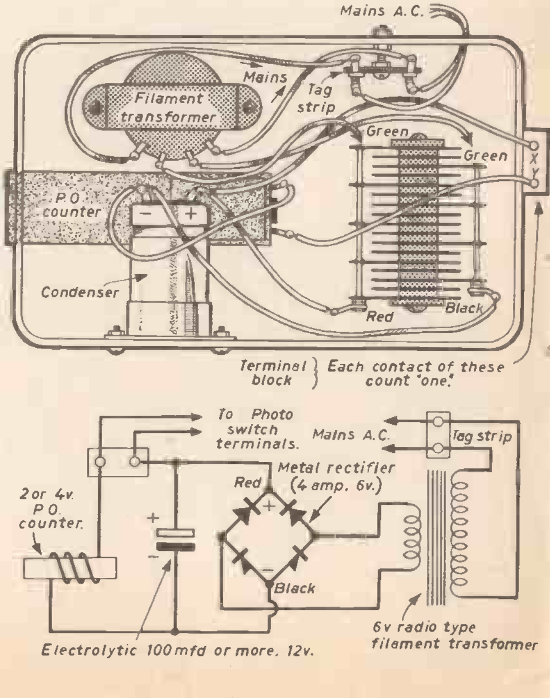
A more powerful, but rather large beam source may be used if the apparatus of Fig. 129B is used. A large type lamp is fitted, one can slides in the other. In the prototype the lens used was No. 28 from Messrs. H. W. English but possibly the imperfect, cheaper No. 1232 will also suit. The prototype lens has a diameter of 92mm. and a focal length of 3¼in. Since the unit can be focused most lenses may be used and lamps changed at random. If the lamp's case is painted black on the outside it will not overheat; 24V. lamps are obtainable in most wattages and give the best results.

Counting Devices

The counting device shown in Fig. 131 is made up on a baking tin and if the two terminals fitted are shorted, the dial mechanism clicks over one number. If a bell-push is fitted to the terminals, each time it is pressed the dial moves once. If the device is wired to the terminals of any of the photo-switches so far described, interruption of the light beam will cause the counter to move "one."

Most of the parts are standard. The filament transformer should be 2A at 6V or any standard pentode output type. The metal rectifier is bridge type, full wave, 6V or 12V at 4A. Also required are a P.O. counter for 4 or 6V and an electrolytic condenser 6 or 12V, 100μ F. approx. For safety, earth chassis and one photoswitch terminal.

(*To be continued*)



your own PROJECTION SCREEN

described by "Helios"

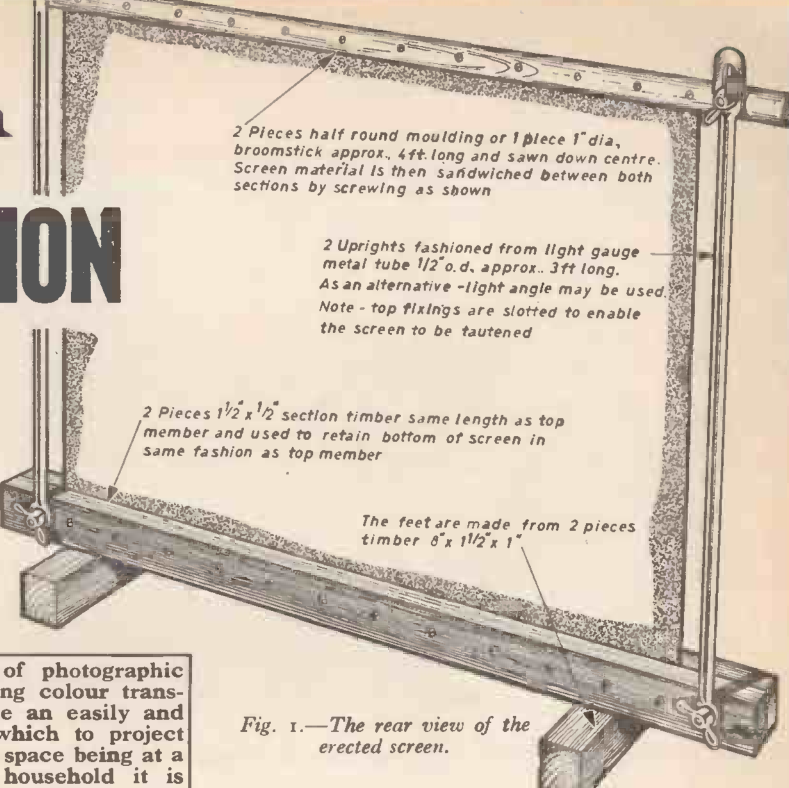


Fig. 1.—The rear view of the erected screen.

A GROWING number of photographic enthusiasts are making colour transparencies and require an easily and cheaply made screen on which to project their masterpieces. Storage space being at a premium in the average household it is essential that the screen be capable of being folded away when not in use and also capable of quick and easy erection.

Tools required to make the screen are: Saw, screwdriver, brace and bits (¼in. and ⅛in.), flat file, cold chisel and hammer. If the timber is not purchased ready cut to size and planed, then a hand plane will be required too.

The screen should be made to a size to suit the user's requirements. The dimensions given here are merely for guidance.

The component parts can be seen in Fig. 1. The top is an ordinary 1in. dia. broomstick sawn down its entire length. The base comprises two pieces of wood—any wood will do—about 1½in. wide × ½in. thick.

Light gauge tubing ½in. dia. is specified for the sides although an alternative such as slotted angle metal would be quite suitable. The ends of the tubes are hammered flat for 2in. at one end and about 3½in. at the other. Slots and holes ¼in. wide are cut in the flattened ends as shown. To cut the slots drill ¼in. holes at the two ends of each slot, chisel the metal out between the holes and finish off with the flat file. You'll have to lay the flat end on something similar to a blacksmith's anvil when doing the chiselling operation.

In addition to these items the following sundries are required: small tin of matt white paint (photo shops sell a special white paint for the job); 4 bolts 1½in. long × ¼in. dia., with wing nuts; 2 No. 10 woodscrews, 2¼in. long; 24 No. 8 woodscrews, 1in. long; 8 flat washers with ¼in. holes.

To assemble the components, the linen material (which should be somewhat shorter on its longest dimensions than the wood base pieces) has one edge clamped between them. The two pieces are held together with 12 screws. The opposite side of the screen is similarly screwed between the two halves of the broomstick which forms the top.

Drill ¼in. holes through the ends of the top and the base to take the bolts, as shown in Fig. 1. The two tubular sidepieces are attached, using wing nuts and flat washers. The object of the slotted holes is to enable the linen screen to be stretched tight when erected.

The two feet are attached to the base by the long woodscrews. Drill ¼in. holes for the screws in the feet so that they will twist around when the screen has to be folded away.

The screen itself should be given a coat of matt white. A ½in. wide black border enhances the appearance. The frame may be left plain or painted.

To fold up when not in use see Fig. 2. Remove the top two wing nuts, take the broomstick away from the uprights, and replace the wing nuts. (Replace the nuts immediately—if they are laid down somewhere they will mysteriously disappear for ever!) Fold the uprights down behind the base. Roll up the linen screen on the top, painted side inwards. Turn the two feet parallel to the base and tie the lot up with two pieces of tape or string.

Fig. 2.—The screen folded.

more power for your Viewer

By W. A. Agnew

THE designers of illuminated transparency viewers have to provide a light compact piece of equipment whose functional efficiency has to be combined with styling and appearance; consequently the size and weight of the battery is of paramount importance and has to be limited to achieve portability. The use of an external battery of larger dimensions would allow longer viewing and by judicious modification, the advantages of the original portable design for short-term viewing can be retained. The larger battery is of particular value when mounting transparencies

Fig. 1. shows the two miniature sockets mounted at the rear of the viewer into which an external 3V. cycle lamp type battery is connected by means of two plugs mounted on a Bakelite strip and a short length of lightweight flexible wire.

The details given can be modified to suit almost any type of viewer. The interior should be examined first of all to decide the position of the holes for the sockets so that when mounted, they do not foul any of the interior contacts or the push-button switch arrangements. Having decided on the position mark a centre " pop " with a scriber and drill a pilot hole with a $\frac{1}{8}$in. metal drill followed by a $\frac{3}{16}$in. size. The sockets are mounted in position with the lock nuts provided.

A 2in. length of plastic flexible wire is soldered to the socket tag and to the flat switch contact piece which lies flush with the bottom of the case. A $1\frac{1}{2}$in. piece of similar wire is soldered to the raised brass contact which forms the remaining part of the switch the opposite end terminating in a miniature clip-on grip which is attached to the brass strip connected to the bulb holder. Fig. 2 shows additional wiring.

A terminal tag is fixed under the assembly nut on the centre contact of the bulb holder and is connected to the remaining socket. The plugs supplied with the sockets are then mounted on a small piece of Paxolin to line up with the socket entries and a length of flexible wire soldered to them. The two ends of this flex are soldered to a cycle battery. The internal cells normally employed in the viewer are removed when the external battery is used. The illumination is controlled in the usual way by operation of the push-button switch. To use the viewer in the normal way the clip on the flexible wire is removed from the contact strip and folded down out of the way after which the small cells are clipped into place.

A container can be made up from light wood covered with Fablon or painted to match the viewer case. All the materials required were obtained from a radio dealer specialising in ex-W.D. surplus material for 3s. excluding the battery, which costs 1s. 6d.

Fig. 1.—Showing the viewer with cover removed.

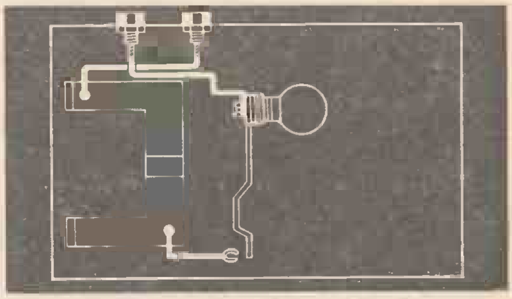


Fig. 2.—The additional wiring.

PUZZLE CORNER

1. Turnabout

HERE is a perfectly straightforward addition sum:—

```
 7213
 3465
 2354
 5893
-----
18925
```

Can you re-arrange the figures in each line across, but not changing any figure from one line to another, so that the total remains the same?

2. As the Crow Flies

LET us assume that Cambridge and Nantwich are exactly 128 miles apart as the crow flies and that Leicester is precisely half that distance from either. I am at Barton-on-Humber which is 104 miles from Cambridge and 88 miles from Nantwich. If I proceed by air in a straight line to Leicester, how far will I have to travel?

Answers

```
 2371
 4653
 3542
 8359
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18925
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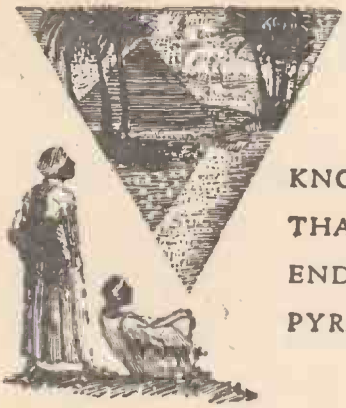
The square of the distance in miles =

$$\frac{104^2 + 88^2}{2} - 64^2 = \frac{(13^2 + 11^2 - 128)8^2}{2} = 81 \times 64$$

= 5184 therefore my distance from Leicester is the square root of 5184 = 72 miles.



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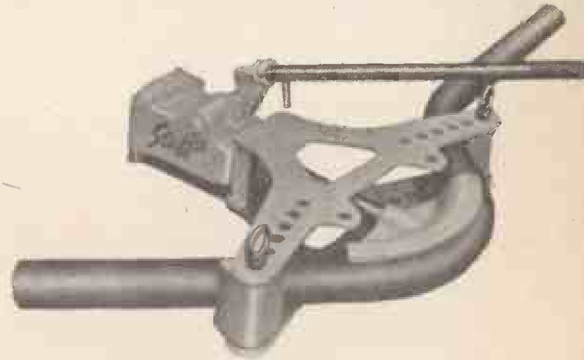
TRADE NOTES

A REVIEW OF NEW TOOLS, EQUIPMENT, ETC.

New Pipe Bender

A new British made, 1½in. capacity, hydraulic three-point bending machine is now being manufactured by Chamberlain Industries Ltd., of Staffa Works, Argall Avenue, Leyton, London, E.10. The bender consists of a powerful hydraulic pump ram unit, a forming head assembly and centre formers for ½in. to 1½in. nominal bore pipes to B.S.S. 1387. A particular feature of the machine is the angle of bend indication marks cast in one end of the formers which provide a useful guide during the bending operation. The price of the complete machine, including formers and the wooden case, is £35.



The Staffa pipe bender.

Sifbronze Price List and Welding Chart No. 2

THE Suffolk Iron Foundry (1920) Ltd. of Stowmarket, supply free copies of their illustrated price list on application. Also available from the same firm is a quick reference welding chart. This chart gives at a glance conversion factors and tables, temperature scales, flame temperatures, gas values, melting points and welding data for Sifbronze welding on mild steel and mild steel fusion welding, and other information. Chart No. 2 in this new series is printed in two colours and costs 2s. to cover the cost of packing and postage.

Wolf's hedge trimmer attachment.

Improved Hedge Trimmer

WOLF Electric Tools Ltd. now supply an improved version of their hedge trimmer attachment. It has an increased cutting capacity and is ideal for trimming or hard cutting back on hedges and small shrubs. The cutting blades are now 2in. longer giving a blade length of 12in. In addition the gears have been modified to give a slower cutting speed. The trimmer can be used with any of the Wolf power tools. The retail price is £5 19s. 6d. with a patent clippings bag as an optional extra at 19s. 6d.

Reddi Soldering Gun

THIS attractively designed soldering gun is ready for use with a capacity of 60W. in a few seconds. It has a built-in twin focused spot lamp and a special tip which heats only at the point of soldering. It is well balanced and has a sensitive trigger action. The gun uses very little current due to short heating time. It is suitable for 110/115V. A.C. or 220/250V. A.C. and carries a twelve month guarantee. The price is £3 12s. 6d. and it is manufactured by Red Handle Products Ltd., of 26 Henrietta Street, Coventry.

The soldering gun ready for action.

Adjustable Square

THE Moore and Wright adjustable square is an entirely new tool, it will not only show if there is an error in squareness but the fitted micrometer unit enables the exact amount of inaccuracy to be measured. The manufacturers are Moore and Wright (Sheffield) Limited, of Handsworth Road, Sheffield, 13. The retail price is £15.

New Record Player

MAGNAVOX are producing a new monaural record player, called the " Manhattan." The Magnavox M.602 measures 19in. × 15in. × 8½in. and is finished in blue and tan. This record player uses a 7in. × 4in. elliptical wide-range speaker and the Magnavox Standard auto-changer operates at 16⅔, 33⅓, 45 and 78 r.p.m. There is a crystal turnover cartridge with a 1 mm. sapphire stylus for L.P. discs and a 3 mm. sapphire for 78 r.p.m. The address of Magnavox is 129, Mount Street, London, W.1.

Magnavox " Manhattan " record player.

A New Drawing Material

ALMOST every man who makes things, and this includes most of our readers, requires to work from a drawing. Drawings in the workshop are likely to damage easily and it is for this reason that a stable and almost indestructable drawing material has been introduced by the NIG Manufacturing Co., Ltd. This material is almost impossible to tear or " dog ear " and should be of interest to the owner of any workshop from the smallest to the largest. The address of the manufacturers is 3-9 Dane Street, High Holborn, London, W.C.1.

The Carver Rack Clamp

THE Carver Rack Clamp is claimed to have many more advantages over the more conventional clamp. It has a short shielded screw, which will outlast ordinary clamp screws and give a powerful grip without distorting the clamp. The shield protects the screw from weld spatter damage. The clamp's fine pitch screw, with its hardened end, gives over 1,000lb. grip. There is no long screw to bend or allow side play. It can be operated in reverse as a jack and can be used as a wrench, for, with its tilting pad, the rack clamp engages slotted ring nuts perfectly. There is a choice of Model T.186, with 6in. capacity, at £1 12s. 6d. or 12in. capacity Model T.205, at £2 2s. 6d. Also available is a heavy duty model. Enquiries should be made to Carver & Co. (Engineers) Ltd., Eldon Street, Walsall, Staffs.

The new rack clamp.

Stanley Sabre Saw and New Side-cutting Blade

THE Stanley Sabre saw, which can also do the work of a rip or crosscut saw, band saw, keyhole saw, hack saw, jig saw and (inverted in the vice) fret saw, can be used with a special new blade which cuts sideways. It can cut parallel to and only ⅝in. from the base of a wall and by adjusting the base of the saw and fitting a special flush cutting blade it will cut right up to a wall.

Other features of the sabre saw are the built-in-blower to keep the working area clear of debris and the wide variety of easily changed blades available for cutting a wide range of materials. Saw prices are £25 (heavy duty) and £29 (extra heavy duty). The new side-cutting blade and flush-cutting blade cost 9s. 8d. each.

(Below) The Stanley Sabre saw.

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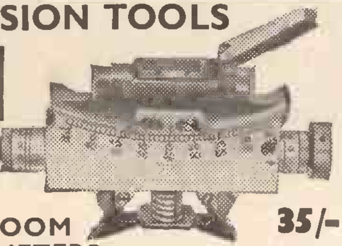

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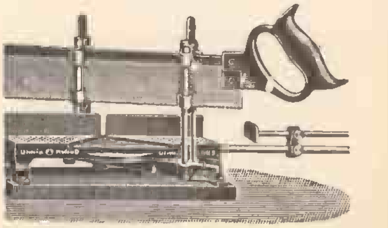

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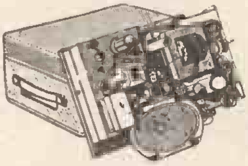

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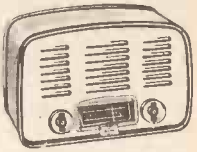

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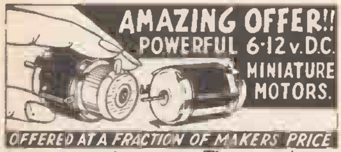

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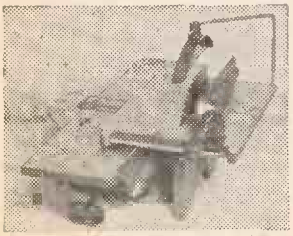

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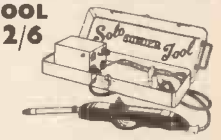

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LETTERS TO *The Editor*

The Editor does not necessarily agree with the opinions expressed by correspondents

Dining Table Work Bench

SIR,—I live in a rather cramped flat where there is insufficient room space indoors for a permanent workshop. I have a workbench installed out of doors on a veranda attached to the flat but owing to the cold weather we have recently found it impossible to work out there. I had to think up some other form of bench which could be used indoors without taking up any extra space. The photographs on the right show the solution I found.

I have in my dining room one of the old fashioned oak dining tables with a removable centre section. When taken out it leaves a table 3ft. 6in. × 3ft. 6in. As can be seen from the photographs, I have converted this into a power bench, which can be turned back to a dining table in a matter of minutes. The motor is permanently fixed and is wired to a switch occupying the place of the old screw mechanism. A plywood base was screwed to the main frame of the table; this holds all the tools and any small parts being worked on. Photo No. 3 shows the motor connected up to a small lathe and No. 4 connected to a drill.

Perhaps this idea would interest other flat dwellers. —F. W. Hudlass (Richmond).

Water-Suction Device

SIR,—In the article "A Useful Water-Suction Device" in your January issue, a nozzle is used. Why not make use of a T-pipe joint as shown in my diagram? Did the author intend his gadget to act as a pump which would suck out the tank water on switching on the tap, without the aid of a cork? In fact the device does not "suck" water. With the T-pipe the tap should be switched off as soon as the water has reached the tank.—W. David (Glasgow).

Author's Comments

I do not agree that a tee-piece in place of the tapered nozzle would be effective. The fact that the nozzle emits only a small quantity of water, but that at great force, is the reason for the flood water being ejected at a very much faster rate than the small quantity being introduced from the tap.

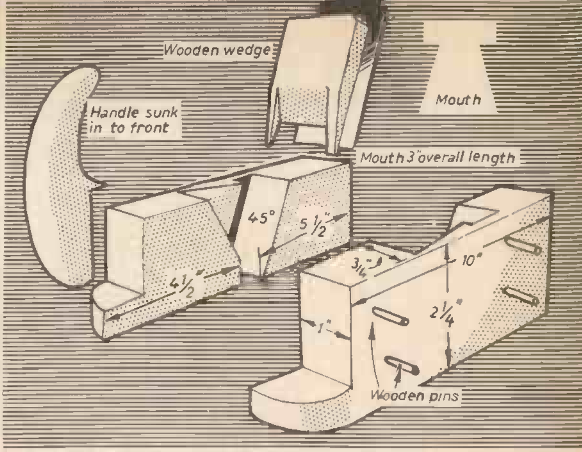
Further, I cannot agree that, with a T-pipejoint and the switching off of the tap as soon as the water reached the tank, the latter would eventually be emptied. Why should it? The result of the above procedure is that one has merely inserted a pipe full of water into a tank containing liquid at a certain level; there is no movement at all taking place, and nothing to encourage any.

An ordinary dining table . . .

with an electric motor underneath . . .

can provide a home for a lathe and a drill.

Mr. W. G. Gooch's home-made plane.



Dimensions and details.

A Home-made Plane

SIR,—Over 35 years ago, when I was an apprentice, I made a wooden plane. I have used it constantly for removing the rough surface of sawn timber, prior to planing smooth and, in fact, it is still in use. The plane can be re-mouthed any number of times.

The tool is shown above in the photograph and the main details of the plane can be seen in the diagram on the right. It was decided to make the plane in two halves and this is the best scheme as one can fit in and wedge at the correct angle before assembling. Beech was the wood used and the two halves were finally glued together, with the use also of wooden pins.—W. G. Gooch (Lowestoft).

A Power Bench Drill

(*concluded from page* 329)

½in. This will be found to leave roughly 4in. of spindle above the top of the upper arm, which will accommodate the three-step pulley and allow plenty of play for automatic adjustment as the round leather belt rides over it and the guide pulleys and then the motor. Fig. 1 shows this. With the spindle thus positioned, a clearance of about 7in. to the table is made available (ample for most jobs) and this distance may be further increased in exceptional cases by removing the table and its support, and using the base as a table.

See that both collars are fixed so that the ball races engage the top and bottom of the feed block firmly to prevent any vertical play, and that the two bolts passing through the handle are screwed home with only sufficient clearance to permit the necessary up-and-down movement minus any side play.

Power and Speeds

A ¼ h.p. motor provides sufficient power and should be furnished with a four-step pulley—say: 2in., 3in., 4in. and 5in. If it has a speed of 1,425 r.p.m.—as most do—the following drill speeds will be available:

Motor pulley	*Drill pulley*	*Speed of drill*
2in.	3½in.	814
2in.	2½in.	1,140
3in.	3½in.	1,221
2in.	1¾in.	1,628
4in.	3½in.	1,628
3in.	2½in.	1,710
5in.	3½in.	2,035
4in.	2½in.	2,280
3in.	1¾in.	2,443
5in.	2½in.	2,850
4in.	1¾in.	3,257
5in.	1¾in.	4,071

It is not necessary constantly to change speeds unless long periods of drilling with particularly small or large drills have to be undertaken. The author normally works at 1,221 r.p.m., i.e. the 3in. motor pulley in gear with the 3½in. drill pulley. Option should be exercised in favour of using a larger motor pulley than that used on the drill for the reason that the round leather belt grips better on the grooved drill pulleys than on the vee motor pulleys. At the same time, a certain amount of " slip " is sometimes an advantage, e.g. when the drill jams; the motor can be switched off quickly before damage is done to the drill or the work.

Steam is Best, or is it?

(*concluded from page* 352)

What Might Have Been

If the money spent on diesel locomotives had been spent on improving the steam locomotive, and building new super-efficient types, the position to-day would be far different. The introduction of modern boiler-washing and lubrication techniques, electric lighting for destination, classification, and inspection lamps, ball and roller bearings wherever possible, and boilers to burn the surplus coal that the National Coal Board cannot sell are a few of the improvements possible. On top of that, you get four more steamers for the price of one diesel!

Money spent on rebuilding and improving steam locomotive depots would make grime and dirt things of the past. As to availability, a " dead " steam locomotive can be got ready in an incredibly short space of time by blowing steam into its boiler from either a stationary boiler, or from another engine already in steam. She would be ready as soon as the fire had burnt through. Finally, there is nothing that a diesel locomotive can do, that a steam engine cannot do better and at less cost!

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2-10-0 by L.B.S.C.

(Extract from recent letter)

Dear Wilwau,

"—a 5in. Gauge Evening Star would pull your foundry up by the roots, etc., etc."

Dear Curly frae Purley,

You were never one to make rash statements or phoney claims about your engines but I think I ought to tell you the roots at Hardgate are now firmly established, and they maun be gie hefty roots for they cover a few thousand sq. ft. I believe the roots extend right doon tae Milngavie where ye helped me plant Wilwau Castings 15 years ago. That makes the roots four miles long if they're an inch. I'll tell ye what if you would like to build Evening Star in 5in. G. yersel I'll supply a' the castings right down to the C. Iron brake shoes. When ye get it feenished bring it up tae Hardgate and fetch the biggest hook ye can lay hands on. No need for ye tae bring a chain, I'll borrow the longest drag chain in John Brown's Shipyard which is just doon the road a wee bit. We'll dump the chain doon at one end o' the building and we'll tak' an end apeice. You'll tak' the high road an' I'll tak' the low road an' I'll be at the other end afore ye. While I'm waiting on you coming (or going) roond the bend I'll tak' a walk doon tae the Information Bureau tae find oot how tae tie a granny knot in a chain. Come tae think o' it we might make an awful mess o' the golf course which lies between Hardgate and Milngavie. Just imagine what the members would say when they discovered a couple o' hundred new bunkers had sprung up (or doon) overnight. Tell ye something Curly, some o' these guys wi' the fancy sweaters couldnae hit a golf ball wi' a Myford lathe.

Wilwau

P.S. I hope to advertise some castings for Evening Star soon.

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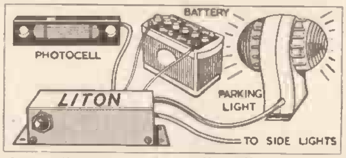

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YOUR Queries ANSWERED

Underwater Photography from the Surface

I WISH to take underwater photographs but because I cannot swim, I will have to take them from the surface. Can you please give me any advice on this subject?—B. Morman (London, S.E.3).

IT will be necessary to have a watertight box of metal or plastic, say 6in. deep and of a cross-section sufficient to hold the camera. The bottom of the box must be of glass, either plate or really good quality window glass, and the joint between this and the box must be waterproofed with one of the proprietary joining compounds. There should be no possibility of the glass being pushed out of its housing. The box needs no top, but it should have a handle fixed to one side to prevent it slipping out of your grasp.

In use, the camera is laid, lens down, on the glass so that the only light reaching the lens is through the glass. You should be able to get your eye near enough to the viewfinder to cover the entire scene but, if not, the box will have to be made rather wider to accommodate your face. Try a cardboard model first and see how it works out.

The amount of light reaching the sea bed in British coastal waters is very small, even in shallow water, and you would be well advised to load with a super-speed film such as Agfa Record, unless you are working in really brilliant sunshine when a slower film such as Agfa Isopan ISS, Ilford H.P.3 or Kodak Super XX could be used.

As in all other branches of photography, the choice of shutter speed and aperture will depend upon the prevailing light conditions. Only a reliable exposure meter will give you the right settings.

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This coupon is available until April 30th, 1961, and must be attached to all letters containing queries, together with 6d. Postal Order. *A stamped addressed envelope must also be enclosed.*
Practical Mechanics. April, 1961

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Our Panel of Experts will answer your Query only if you comply with the rules given below

A stamped addressed envelope, a sixpenny crossed postal order, and the query coupon from the current issue which appears at the foot of this page, must be enclosed with every letter containing a query. Every query and drawing which is sent must bear the name and address of the reader. Send your queries to the Editor, PRACTICAL MECHANICS, Geo. Newnes, Ltd., Tower House, Southampton Street, Strand, London W.C.2.

Polythene Solvent

COULD you please tell me the solvent and adhesive for Polythene plastic.—J. J. Campbell (Eire).

POLYTHENE is soluble particularly above 68 deg. in trichlorethylene. This chemical can also be used as an adhesive for Polythene if the seams are moistened with it and pressed together with a warm iron. The chemical can be purchased from most wholesale chemical merchants such as: British Drughouses Ltd., Graham Street, City Road, London, N.1.

Cutting Hard Stone

I HAVE a number of large colourful pebbles and I would like to split and polish some of them to make into book-ends, what is the procedure? J. Robinson (Bath).

THE process can be achieved by grinding with the flat of a sandstone, water lubricated and fed with sharp-cutting sand. The wheel would have to be revolved at reasonable speed. It would be a tedious process but would achieve the object. As for the polishing of the surface of cut stone and pebbles; this again is a slow and arduous abrasive operation and jewellers' rouge is probably the best abrasive for this work.

Condensation on Car Hood

I AM experiencing condensation on the inside of a plastic coated canvas hood fitted to my car. I would like to know if there is any coating which could be applied on the inside to lessen this effect.—A. J. Starkey (Stoke).

THIS is a difficult condition to obviate completely, but the trouble can be lessened by spraying cork dust on to the undersurface, after coating the surface with an adhesive. One of the Bostiks would probably prove satisfactory. Cork, being a poor conductor of heat, will not act as such a good condensing surface as does the untreated plastic material.

Painting Sign Boards

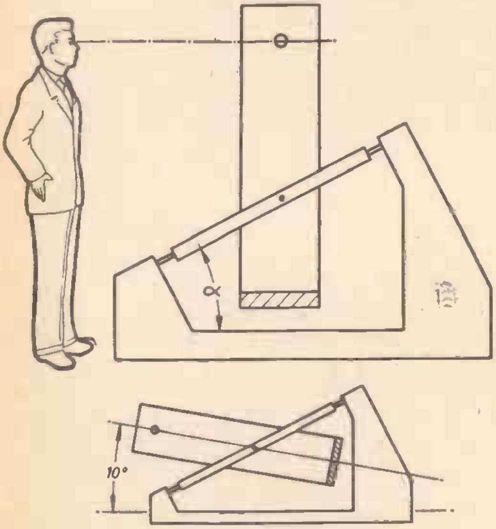
I WISH to use the silk screen printing process in connection with the manufacture of sign boards. Would you please advise me as to the paint used in the process for work on metal, wood and paper.—S. C. Creed (Folkestone).

THE normal type of silk screen paint will be suitable for your requirements and for exterior signs. A further screening with clear lacquer would be advisable.

Cradle and Stand for P.M. 6in. Reflecting Telescope

I HAVE now completed the 6in. reflecting telescope described in the May and June, 1960 issues of "Practical Mechanics." I would be much obliged if you could give me some idea of how to obtain measurements of the cradle and stand.—E. R. Frarey, B.A.A., A.M.Inst.E., M.R.S.G.B. (Yorks).

THE mounting size is best decided so that the eyepiece is level with your eye when the tube points to the zenith (see sketch below). The angle is the angle of your latitude which you can obtain from the ordinance survey map of your position. Once these two factors are known a simple scale drawing should show the best design. The telescope must not foul the pillars and does not need to point to an angle less than 10 deg. above the horizon Be sure to make the mounting very rigid.



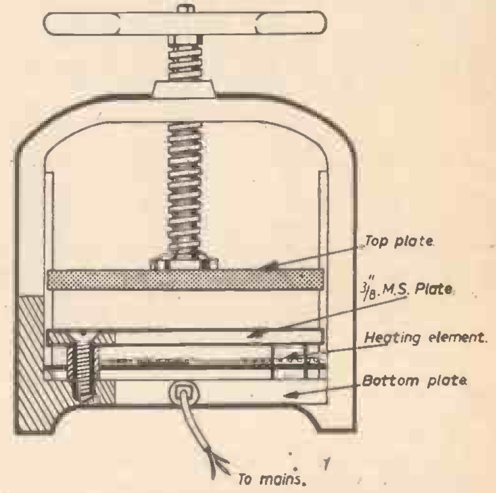
How to obtain the mounting size.

Dry Mounting Press

I HAVE a letter press which I intend to convert into a photographic dry mounting press. I wish to put a heating element of some sort between the bottom plate and a ⅜in. thick M.S. plate, to bring the temperature to 175 deg. F. approximately, which I believe is the correct temperature. I also intend to put in a thermostat. Would you please advise me on what sort of heating element and thermostat I should use. Also is my idea practical?—J. Courtney (Musselburgh).

THE proposed scheme would probably be quite satisfactory if used with a flat strip or plate heater, between thin mica sheets, which is firmly clamped to the bottom plate. The rating of heater required depends to a large extent on the time which can be allowed for the plate to reach working temperature. Quite a large heater could be used with thermostatic control, say about 2,000W. The thermostat should be of a type which can be mounted on the side of the bottom plate.

You may be able to obtain a suitable thermostat from one of the following firms:



The converted press.

Otter Controls Ltd., Queens Building, St. Peter's Square, Stockport. Micalex Co. Ltd., Ashcroft Road, Cirencester, Glos.

A suitable heating element could probably be obtained from: General Eelectric Co. Ltd., Magnet House, Kingsway, London, W.C.2. Geo. Bray and Co. Ltd., Leeds, 2.

INFORMATION SOUGHT

Readers are invited to supply the required information to answer the following queries.

Ciné Camera

HAS anybody any information on the G42 ex-Government ciné camera?—D. Agnew (Co. Antrim).

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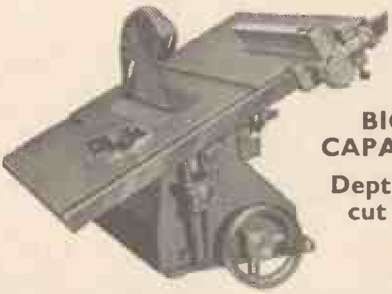

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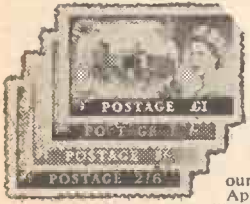

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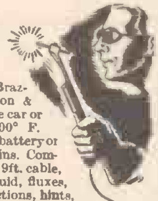

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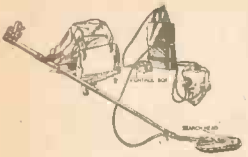

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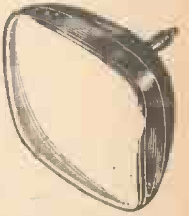

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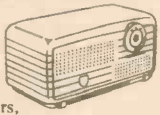

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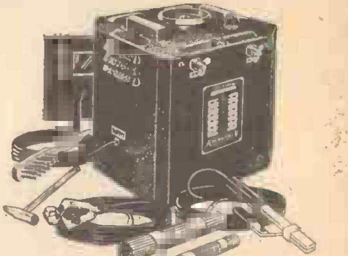

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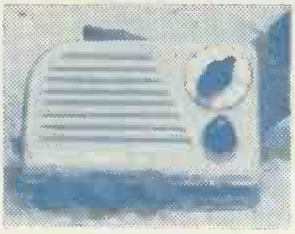

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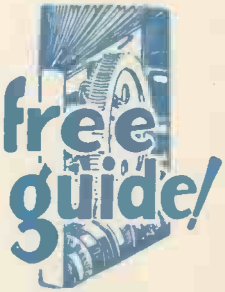
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