Practical MECHANICS

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SEPT 1961

A SPACE OBSERVATORY

BUILDING A TAPE DECK

MAKING ELECTRIC BLANKETS

Radio Controlled Model Shooting Brake

Practical
MECHANICS

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CONTENTS

CONTRIBUTIONS

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

FAIR COMMENT

THE ROBOT TEACHER

THE teaching profession has been in the news time and time again during the past few years and most of the publicity has been concerned with the grave shortage of teachers, particularly in technical and scientific subjects. The concern felt in Britain about this problem is not unique; it is felt in many other countries in the western world. One of the main reasons that there is a shortage of teachers is that only recently has the Government become alive to the fact that we are lagging far behind modern requirements for technicians and scientists. Now that the need has been recognised, it has become all too obvious that neither the teachers nor the teaching facilities are available. Recent events stemming from the teachers application for salary increases will be no help at all in a recruiting drive to interest more of the right people in taking up teaching posts—quite the contrary in fact. There is a programme in hand to expand the country's technical colleges, though it is difficult to understand what use this will serve without the trained personnel to teach in them.

We have watched these recent events with some disquiet and it was the thought that there may soon be a serious shortage in the most important profession that prompted us to wonder whether there might not be some alternative. We came to the conclusion that there can be no alternative to the teacher, but we did discover that there is a modern aid which could perhaps, if properly developed and used, relieve teaching staffs of some of the more routine instruction work.

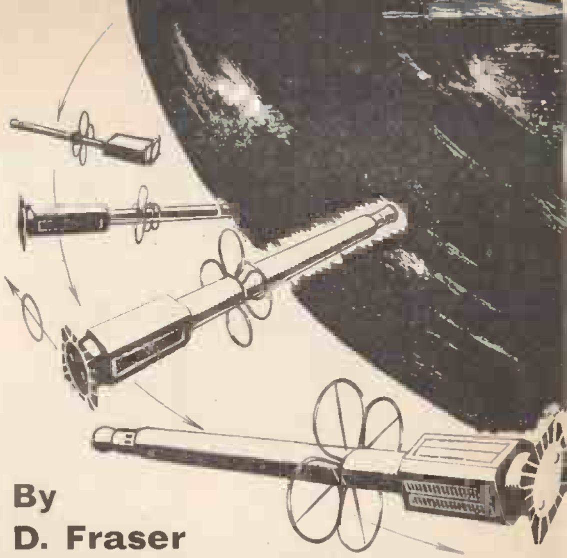
The aid is known as a teaching machine and preliminary tests in America have produced some surprising results. The new teaching method was developed by Dr. B. Frederick Skinner of Harvard University and first introduced in 1954. The machines vary somewhat in appearance but basically there is a window in which frames containing questions appear. There is a space for the answer to be written by the student and a lever to pull to find out if the answer given was correct. When the lever is pulled the answer is moved under a glass plate so that it cannot be changed.

The system is worked by breaking down a course in any subject into the smallest possible individual items. Each item is printed on a frame and phrased so that it ends with a question or an incomplete sentence. The student reads each item in turn, answers the question and then checks to see if his answer is correct. One of the most important aspects of this method obviously lies in the preparation of the machine's programme and here, not only an expert knowledge of the subject being taught is necessary but also a sound knowledge of the teaching machine programme technique.

There seems to be little information available on the success of this method of teaching but one test on an algebra class produced surprising results. Using the machines, a course usually taking a year was covered by a junior high school class in one term. The subject was dropped completely for several months and then a test carried out. The students on an average retained about 90 per cent. of what they had learned from the machines.

It is emphasised that it should be possible to "programme" almost any subject on to a machine and scope could be further extended by combining the machine with film or closed circuit television so that the whole class could participate. The teacher would be released to take classes where discussion and experiment are essential.

A SPACE OBSERVATORY



By
D. Fraser

THE world's first space observatory went into orbit during the last week of April, to open an entirely new branch of radio astronomy. It is a 95lb. astronomy satellite—Explorer XI—which carried into orbit a 7½ft. radio telescope to track gamma radiation from the stars.

The radio telescope is designed to pick up gamma rays from the stars of the Milky Way, hundreds of millions of miles away, and from even deeper cosmic sources. These gamma rays—invisible electromagnetic waves of energy like radio waves—never reach the earth, as they are screened out by the atmosphere. But they are of intense interest to astronomers.

They are believed to radiate from radioactive substances hurled into space by "dying" stars, and are thus a clue to the composition and age of the stars. Since gamma rays travel in straight lines, undeflected by spatial magnetic fields, their source may readily be determined.

Description

Resembling an old-time street lamp, the Explorer XI looks unlike any satellite orbited to date. It combines, structurally, a 12in. dia. 23½in. long octagonal aluminium box mounted on a 6in. dia., 20½in. long aluminium instrument column. The box provides both a housing for the gamma-ray telescope and four of the external surfaces for the satellite's solar cells. The 44in. long fourth-stage rocket remained with the satellite. This extension acts as a section of a transmitting antenna and provides the additional length and weight needed in attaining the Explorer XI's tumbling action. The fourth stage (burned out) weighs 12·8lb.

The S-15 (Explorer XI) being lowered into the shroud covering the upper stages of a Juno II test vehicle.

Solar cells, which recharge the system's 12 nickel-cadmium batteries, are also located around the face of a 17in. dia. octagonal plate fitted on top of the box. A thin aluminium shield covers the end of the housing, protecting the telescope from damaging micrometeorites. This shield can be removed by radio command from the earth.

The gamma ray astronomy satellite tumbles end-over-end at the rate of about 10 times every minute. This motion enables the gamma ray telescope, aimed out through the end of the octagonal box, to scan a portion of surrounding space every six seconds.

Sun and earth sensors, peering out through small apertures in the micrometeorite shield, permit scientists on the ground to know at all times the exact orientation of the satellite with respect to the earth, sun and stars, thus pinpointing the direction from which gamma rays are coming. An insulated temperature sensor, also directed out through the thin shield, is designed to study the thermal radiation balance of a body in orbit.

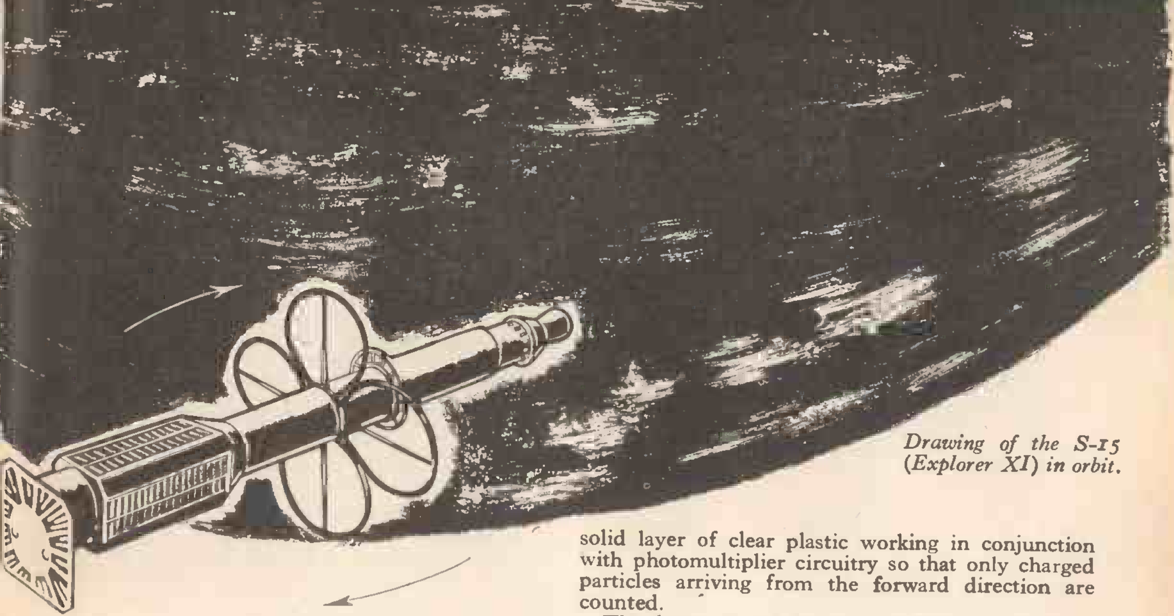
To effect this necessary tumbling, or propeller-like action on achieving orbit, the satellite was equipped with a unique damping mechanism. This device, fitted into the after end of the fourth-stage rocket's motor case, is a hollow, mercury-filled cylindrical adaptor, resembling a retainer ring. When injected into orbit, the satellite was spinning about its longitudinal axis at about 380 r.p.m. Although it would eventually slow down and begin tumbling by the very nature of its structure, scientists wanted a controlled tumble, to begin shortly after the satellite had gone into orbit.

Data Reduction

The data transmitted by the satellite, and recorded by the Minitrack stations, is processed and reduced at Goddard Space Flight Centre.

The composite detected signal is separated into five channels by the use of filters. Discriminators convert this data to voltage amplitudes, which are displayed on an oscilloscope, then recorded on 35mm. film.

An orbit's worth of data is processed in a little over ten minutes and recorded on about 36ft. of film. Also, the light pulse characteristics, elapsed time, and time marks are recorded on binary tape in a format compatible with the experimenter's com-



Drawing of the S-15 (Explorer XI) in orbit.

puter programme. A few inches of tape is required for each orbit. This data is then sent to the experimenters at the Massachusetts Institute of Technology—who developed and built the satellite's gamma-ray telescope—for final data analysis.

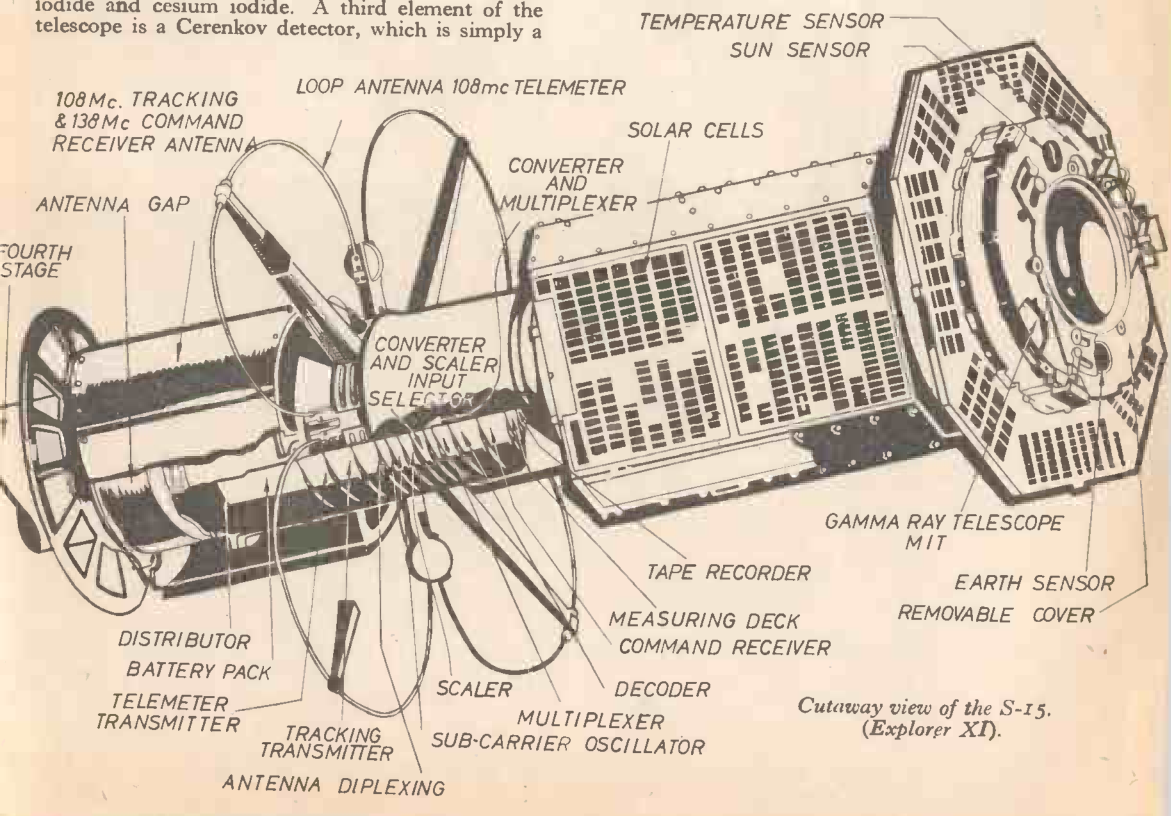
Instrumentation

The gamma-ray telescope has a plastic scintillator covering the top and sides. Inside this cover is a sandwich of crystal layers, composed of sodium iodide and cesium iodide. A third element of the telescope is a Cerenkov detector, which is simply a solid layer of clear plastic working in conjunction with photomultiplier circuitry so that only charged particles arriving from the forward direction are counted.

The heart of the telescope is the sandwich of crystals. When a gamma ray falls on these crystals, an electron and a positron are emitted. These react with the crystal structure in such a way that scintillation occurs. Other particles also strike the sandwich, but they are charged, and therefore cause light flashes in the outer plastic scintillator before striking the crystal layers.

The outputs of the photomultipliers which monitor the light flashes from these three telescope

(*Concluded on page* 603)

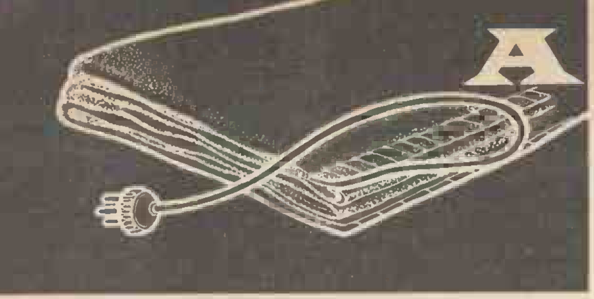


Cutaway view of the S-15. (Explorer XI).

A WARM

How to make your

By E. W. Monarch



IT is quite possible to heat a bed by the simple apparatus of Fig. 1 in which an ordinary 40W. lamp bulb is fixed inside a largish container. The inside of the tin should be painted with cylinder black paint and if plastic covered wires are used they should be tested to make sure that the heat is not sufficient to soften the insulation. The earth connection is necessary and the warmer is only used before retiring.

The larger the container the higher the wattage that is permissible. Never use a high wattage lamp unless trials are carried out IN A WARM bedroom. The heater is then working under the worst conditions and will be quite safe in a cold bedroom.

Automatic Control

This may be by a time clock, by thermostat, or both. It is also very easy to arrange for automatic switching off of any heater in a bed when a person gets in (Fig. 4). The helper springs must be very strong, motor valve springs are usually suitable and great care is necessary to ensure that the micro switch (Bulgin type S 502) is not pushed more than 0·006in. beyond the "click" or it will be damaged.

On the back of the micro switch will be found three terminals. Use the one on its own and the paired one marked "Normally closed." A master switch or time switch is necessary if the heater is not always to be on when no one is in bed.

Fitting a Thermostat

An earthed cigarette or tobacco tin fitted with an insulated thermostat set about 140 deg. F. placed 1ft. away from the warmer will give good automatic control. The wiring and the method for setting is shown in Fig. 5b, readers noting that a BATTERY and torch bulb is used in lieu of mains. The thermostat illustrated in Fig. 3 is the Magstat and costs only a few shillings from Technical Services, Banstead, Surrey.

Using Radio Mains Droppers

It is quite possible to make use of a radio mains dropper of the 0·2A. type as shown in Fig. 2. If the container is properly earthed by a green wire and a fused plug (1A) is used, the device is quite safe.

Automatic control may be by thermal balance or by a Magstat fitted as directed for the bulb heater. A suitable dropper is No. R24, available cheaply from Home Radio (Mitcham) Ltd., 187 London Road, Mitcham, Surrey.

Circuits for Simple Heaters

These are shown in Fig. 5 a suitable circuit for home use being at (a). Readers who wish to use the automatic thermostat may use circuit (b) and for absolute safety, to prevent someone getting into bed with the heater on, use circuit (c). Two pole switching may also be used for additional safety. If a metal bed (leg) is resting on the weight switch then make sure the bed is properly earthed. The black

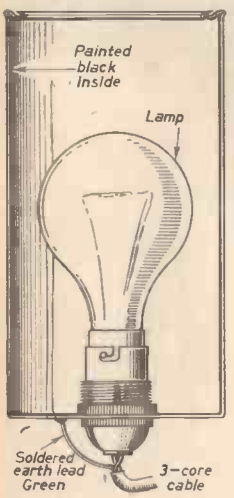


Fig. 1.—A simple bed warmer. Note the earth lead.

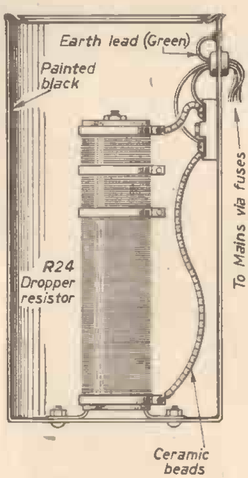
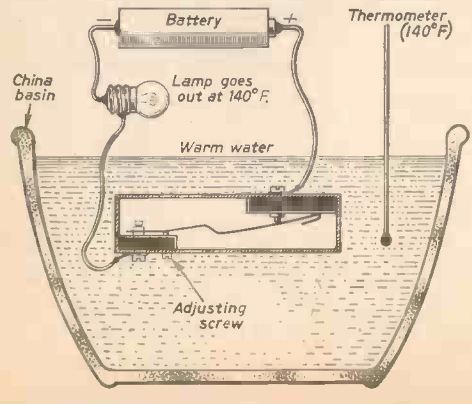


Fig. 2.—An improved bed warmer.



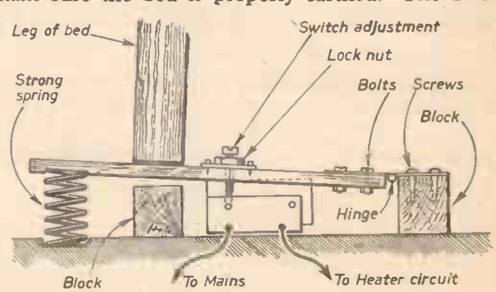


Fig. 4.—A weight-operated switch for use under the leg of the bed. Heat goes off when anyone gets into bed.

Fig. 3.—(Left) How to set the thermostat with a basin of warm water.

Bed this winter

own electric blanket

mains lead is NOT switched by the thermostat, or the weight operated switch, but may be (optional) by the manual switch.

How an Electric Blanket Works

The heat is generated in a Nickel/Chromium resistance wire which is wound helically on a nylon supporting cable (Fig. 6 top). The heat generated by the small current (under 1 A) is then thermally conducted through a thin layer of protective fibre glass to a very strong and moisture resistant plastic covering.

Readers without experience should keep to either of the designs stipulated; the double-bed one being shown in Fig. 7 and the single-bed type in Fig. 9.

The two sizes described are roughly those available commercially, and in practice work well. Generally, electric blankets are made to be placed under the bottom sheet of the bed, being tied in position with tapes under the bed. They are intended for use before retiring, and should definitely never be used when actually sleeping. A size larger than necessary is a danger, electric blankets must NOT be tucked inside a bed or folded over on top of themselves if they are too large.

MATERIALS

Base Cloth. Use strong cotton, canvas or blanket material. After hemming all round to stop fraying the size will be either 30in. × 62in. or 51in. × 62in.

Decorative Covering. This is not necessary for actual working. Twice the above size is required.

Heater Cable. Double Bed. 27yd. of 15Ω per yd. cable. Single Bed. 27yd. of 25Ω per yd. cable. It should be Nylon/Chrome-Nickel/Glass/Plastic. Suitable cable is available from Messrs. Technical Services Ltd., Banstead. No other length or resistance values should be used.

Binding. 30yd. of ½in. wide of contrasting colour to the base material. Cotton to suit.

Switch. A neon indicator type which can be laid on the pillow. The one illustrated came from Messrs. Technical Services Ltd., and the special switch (no. S.320) made by Messrs. Arcoelectric Switches Ltd., West Molesey Surrey, is very suitable. Switches without a neon should not be used.

Terminal Block. Small two- or three-way, of strong plastic.

Leads. Two way plastic and cotton covered to take 2A. Fully flexible lead is necessary. The mains plug should contain a fuse rated at not more than 1A.

The Base Cloth

The cloth is hemmed round the edges if there is likelihood of the material fraying as shown in Fig. 6 (bottom, left) or binding tape may be used as also shown. The cloth is then pinned with drawing pins down on the floor and the wire marks are carefully drawn on the material, using chalk, according to the plan of Fig. 7 or Fig. 9.

Binding tape is then sewn over the lines. The ¼in. portion in the middle of the tape acts as a tunnel for the heater wire and no stitches must enter it. Each length of tape is left with plenty to spare at one end as shown in Fig. 7.

Threading the Heater

This is done by taking five feet of garden wire, pulling it absolutely straight, making a round solder blob at one end and soldering the heater cable to it at the other.

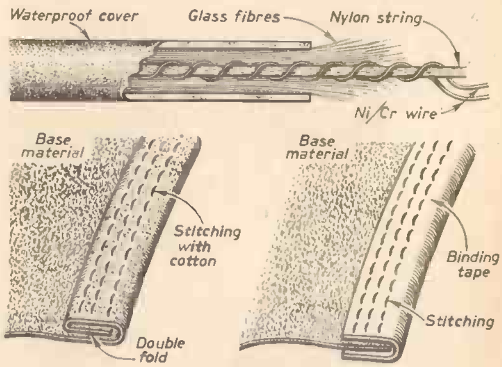


Fig. 6.—The special heating cable used in blankets. Two methods of preventing the base material from fraying while making the blanket.

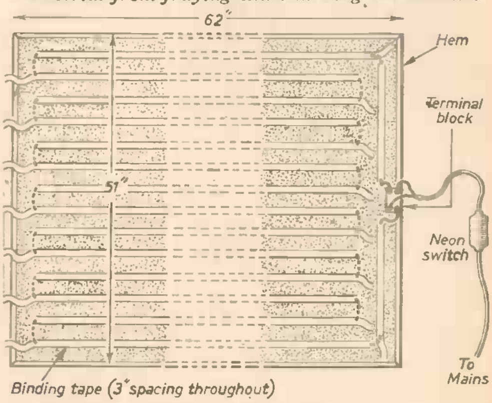


Fig. 7.—How the binding tapes are sewn in position. Make sure that no wire is less than 3in. from the edge of the blanket. Note the spare ends left free.

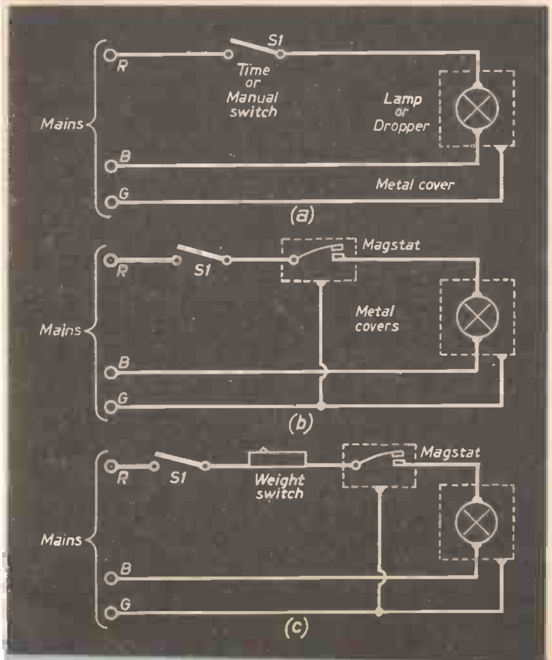


Fig. 5.—(Left) Three possible circuits for bed warming. (a) Simple arrangement, thermal balance control. (b) Thermostatic control. (c) As for (b) but with weight-operated "cut out."

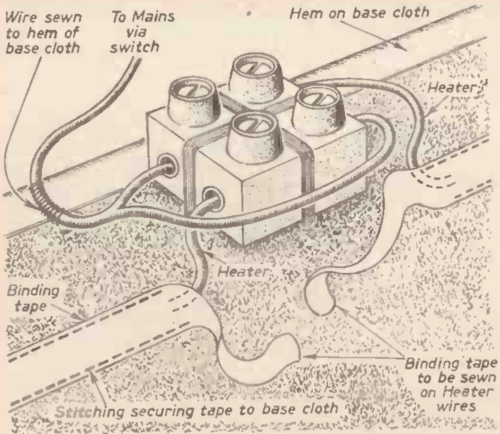


Fig. 8.—How the resistance element is prepared for fitting in the terminal block.

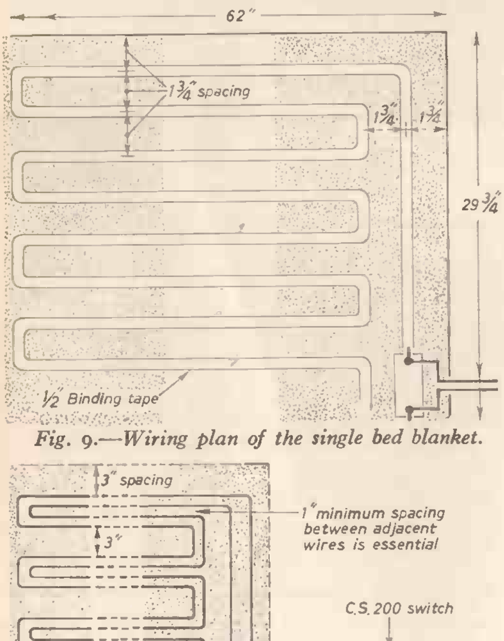


Fig. 9.—Wiring plan of the single bed blanket.

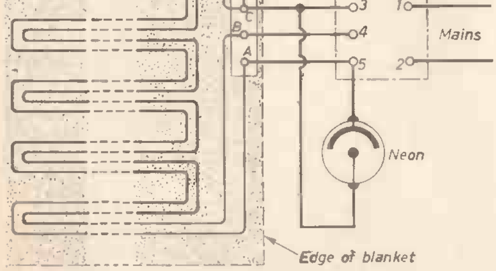


Fig. 10.—Wiring plan of the two- or three-heat blanket with connections to C.S. 200 switch and neon indicator.

The heater is threaded according to Fig. 7 and 9. When completed take up the spare cable as far as possible by allowing plenty at the bends, etc. Do not cut any away.

The tapes, left long previously, are now sewn by hand over the wires just threaded. Care must be taken not to puncture the wire.

Connecting to the Mains

The method of connecting to the mains is shown in detail in Fig. 8. A "soft" plastic 2-way terminal block (Fig. 8) is obtained from the local radio shop. The central screw hole is used as in sewing a button and the block is sewn in place on the hem of the base cloth. Use good strong thread and if necessary reinforce the base cloth with canvas to prevent tearing.

The heater cable is now cut to the length required so that connections may be made to the block exactly as in Fig. 8. The P.V.C. cover is removed for about 1½in., the heater wire is unwound carefully and the glass and nylon cut away. The heater wire is then wound helically round the P.V.C. so that when in the block the screw makes good contact and at the same time the wire cannot be removed by pulling. The wire is then covered with the binding tape in the same way as the rest of the heater.

The mains wire should be fabric covered, and is connected as in Fig. 8. No bare wires are permissible and the wire is then sewn securely along the hem for a distance of at least 1in. Reinforce the base cloth as before if necessary. Melt sealing wax in terminal "heads."

Wiring the Switch

If the Technical Services neon switch is used, the two main wires from the blanket are connected to the terminals marked "load" and the two going on to the fused mains plug (1A. or 2A. fuse) are connected to the terminals marked "MAINS."

If using the Arcolectric S.320 connect one pair of terminals to the mains, leave the others disconnected. If the neon glows wherever the switch is, then the mains are connected to the wrong pair of terminals. If the neon *is* switched, leave the mains connected, unplug and wire in the heater mains connection to the other terminals.

The wires *must* be securely anchored in both switches. Do not use switches not made for electric blankets and wire correctly with no bare wires.

Plug into the mains using a fused plug.

Switch on the blanket switch and the neon should light up. Leave the blanket *laid out flat* for five minutes, when it should feel quite warm to the touch.

Using the Blanket

After test it may be covered in a decorative cloth; this is not absolutely necessary. It is intended that the blanket be placed under the bottom sheet of the bed. It may be anchored on the mattress by means of buttons, or tapes going under the mattress, and switched on and off when required. The switch is placed under the pillow when the blanket is not in use.

Automatic Control

The two blankets described can be automatically controlled.

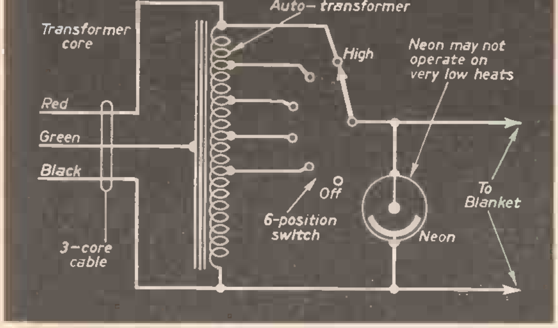


Fig. 11.—Variable control of a blanket using a six position switch and an auto transformer of suitable wattage.

The Magstat already mentioned will do this job well and may be wired in one of the mains leads going to the switch by removing one from the block (Fig. 8) and taking it to the solder tag of the Magstat and returning one from the other tag to the terminal vacated. The thermostat should be placed midway between two heater wires about 1ft. from the hem of the blanket.

It must be insulated by sewing P.V.C. material all over it and set to 140 deg. F. (Fig. 3).

The use of a time switch and a weight-operated safety switch can be arranged as in Figs. 4 and 5.

Two-heat Blankets

It is possible to arrange for one side of a bed to be heated more than the other by running the heater wire 5in. apart on one side and 2in. apart on the other. This is done with 27yd. of 25Ω per yard cable and on NO ACCOUNT should the 15Ω per yard cable be used or the hot side might overheat.

Two- or Three-heat Blankets

It is much more difficult, but quite possible, to make up a two-element blanket to the plan of Fig. 11, using two elements of 27yd. (each) of 25Ω per yard cable and joining two ends together at the terminal block at "C" (Fig. 10). The other two ends go to spare terminals on a three-way block sewn on as before. Three-core cable leads to Arcoelectric Switch C.S. 200: this is a special series/parallel 2-pole switch which will isolate the blanket at "OFF," and arrange to put in elements A and B with switch at "HIGH," element A only on "MEDIUM" and A and B in series on "LOW." The switch is mounted in a small wooden box with a warning neon lamp. The wiring of the system explained is shown in Fig. 10; the switch is clearly numbered.

No two wires of the heater network must be closer than 1in. and care is especially necessary at the connection end to keep the wires separated. 15Ω per yard cable must NOT be used on this blanket but all the details previously given are relevant.

The wattage of the blanket is approximately: Low, 40W.; Medium, 80W.; High, 160W.

Auto-transformer Control

It is possible to get very great control of the heat given by an electric blanket by using a switched auto-transformer as shown in Fig. 11. A low-wattage transformer is suitable, and one which will drive either of the single heat blankets was described in our article "Light As You Like It" in our June 1961 issue. Six heat positions are possible by rotating a switch.

BOOKS *Received*

"Aids to Machine-Shop Practice" by C. T. Bower, A.M.I.Prod.E. 192 pages. Price 18s. Published by Odhams Press Limited, London, W.C.2.

THIS book contains practical and up-to-date hints, new methods and novel ideas for engineers, machinists, draughtsmen and all concerned with engineering production. More than 200 ingenious hints and tips, designs for new devices, improved production methods, time-savers, and suggestions for simplifying work and increasing output are described. Drawings and photographs are included to show every essential detail. The items have been grouped into sections and cover the following subjects: Assembly methods, drawing office aids, drilling and tapping, gauging, grinding, handling methods, jigs, fixtures and attachments, lathework, maintenance, marking-out, milling, production methods and welding.

"Beyond the Planet Earth" by Konstantin Tsiolkovsky. 190 pages. Price 15s. net. Published by Pergamon Press Ltd., Oxford.

IT was Konstantin Tsiolkovsky's description of outer space that Yuri Gagarin claimed most resembled what he saw from his space capsule. The first chapter of the book deals with this remarkable author's work and life. The story is science fiction and tells of a successful trip to the moon. It is a fascinating story and cannot fail to be of interest to the space-minded.

"Modern Arc Welding Practice" by J. A. Oates. 293 pages. Price 30s. net. Published by Geo. Newnes Limited, Tower House, Southampton Street, London, W.C.2.

THIS book provides an up-to-date and concise source of reference for both student and professional welders. Both British and foreign welding methods are discussed as well as many techniques, such as stud welding, dot welding, submerged arc welding, etc. Welding processes as applied to such metals as titanium, cast iron, aluminium, special steels, and nickel are fully covered. The book is well illustrated and is divided into 21 chapters, with two appendices; the whole being arranged for easy reference and fully indexed.

"The Microscope and How to Use it" by Dr. Georg Stehli. 157 pages. Price 15s. net. Published by The Oak Tree Press Ltd., of London, W.1.

THIS well illustrated book provides a thorough and interesting introduction into the field of microscopy. The first chapter deals with the construction of the microscope, its maintenance and its auxiliary tools. This is followed by chapters on using the microscope, examining simple preparations such as human hair, feathers, etc. Details are also given for exploring a drop of water, insect preparations, the microscopic structure of animals. Many other aspects of microscopy are covered. The book also contains a comprehensive index.

General view of the dark-room showing the sliding doors and shelf above, etc.

A DARK

MANY photographer's use their bathroom as a darkroom and it has the distinct advantage of constant running water. It means, however, that the equipment has to be set up and dismantled after every printing session. I, too, was faced with this problem and then I thought of converting the cupboard under the stairs.

The width of my staircase measured 2ft. 6in. and this is quite a comfortable space to work in. First, I had to remove numerous built-in shelves, etc., and then plaster up the walls. The next step was to provide an enlarger bench. This needs to be a comfortable working height and will depend on whether you decide to sit or stand. Mine was 3ft. 3in. from the floor, but if you decide to sit, it will be correspondingly lower. My main reason for having it at this height was that I should be able to build a cupboard below to accommodate my printing papers, chemicals and other accessories.

The cupboard was made, using the back and two side walls. Frames were built and plugged and screwed to either side walls; then four 2ft. 6in. lengths were cut and fitted, two at the top and two at the bottom. A spirit level was used to check this framework both left to right and back to front and then a top, made of tongued and grooved boards, added.

Four supports, each 8in. long were cut and positioned on top of this shelf at each corner and two longer lengths added horizontally to support the top shelf or working top, on which the enlarger rests. This top was also made of tongued and grooved boards. This provided a place on top for the enlarger and a space underneath for a dryer,

The shelf underneath the stairs and the dishes in position. Right can be seen the dish heater.

The top and enlarger board in place. Left can be seen one of the uprights of the shelf.

ROOM UNDER THE STAIRS

trimmer and a box for negatives.

How the cupboard space below is divided up will depend on what is to be stored in it. I installed a single shelf about half-way down. Hardboard or 3mm. plywood is quite suitable for general use, but considerable strengthening will be necessary if the shelf is to support heavy bottles.

In the limited space available, sliding doors are best for the cupboard. Special double groove moulding is available from most do-it-yourself stores to use as track for the doors. These latter were merely rectangles of hardboard cut to size and fitted with suitable handles.

" Wet " Bench

To accommodate the developing trays, a shelf is made to fit under the stairs, on the other side of the cupboard, as can be seen in the photograph. The front of the shelf is supported by means of a couple of stays, suspended from one of the upper stairs, the back being screwed to the underside of a lower stair.

Now, with the exception of electrical fittings, the darkroom is complete. A plug socket will be required on the shelf side for the dish heater and on the enlarger side another will be necessary for the enlarger and the safelight.

PUZZLE CORNER

A party of tourists in Egypt met two Arabs mounted on splendid horses. A wag in the party suggested to the Arabs that they should ride a race but that the prize of £5 should go to the owner of the horse that *came in last*. The challenge was accepted but it was soon seen that the race would last for hours. The Arabs, too, realised this, and dismounted and conversed together. Then, to the tourists surprise, they remounted and rode off like the wind. The race was run, the £5 paid out, and everybody was content—even the Arabs. Can you explain?

Answer

Realising the race would never finish under the conditions set down, they changed horses when they remounted. Thus, the owner of the horse which came in last would, in reality, be the rider of the horse which came in first.

L.B.S.C's 3½in. Gauge EVENING STAR

Part 7. deals with the piston valve cylinders.

READERS building *Evening Star* have the choice of fitting either piston-valve or slide-valve cylinders. The full-size engine has, of course, piston-valve cylinders with long-travel valves, and this is the kind I prefer. At the same time, some folk —especially beginners—seem scared of tackling piston-valves because it is essential that the bobbins on the valves should be turned to an exact fit in the steam-chest liners. Actually, the job is no more difficult than turning the pistons to fit the cylinder bores, and that has to be done anyway, so why worry? Another argument is that piston-valves soon wear out, and start to blow badly; they cannot be packed like the pistons, as packing would catch in the ports. This is another illusion, as the following experience will show.

Some 26 years ago, I built a 2½in. gauge 4-6-2, to which I fitted a pair of experimental piston-valve cylinders of a special type in which the valves could be set by sight. The valves were ⅜in. dia. and to test the relative wearing qualities of the two metals, I made one valve of rustless steel, and the other of drawn phosphor-bronze. The liners were turned from cast gunmetal, bored and reamed in the usual way, no special treatment such as lapping or honing being used. Both valves were just turned to an exact sliding fit in the liners. The engine has one of my mechanical lubricators feeding into the cross steam-pipe between the cylinders, at the point where the steam enters from the boiler. The steam picks up the oil and carries it to the steam-chest of each cylinder as a fine spray.

A few evenings ago, time of writing, that same locomotive was tearing around my little railway, hauling my weight at a speed equal to about 90 m.p.h. in full size, the valve gear almost in middle, and the exhaust sounding like a cat purring. There was not the slightest sign of a blow, *yet nothing has been done to either valves or liners since the day they were put into the cylinders.* I have had them out several times, at long intervals, for examination. Neither shows any appreciable wear. The simple explanation is, that the valves and liners have never been in actual contact; there has always been a film of oil between them, preventing wear and sealing the microscopic clearance against any passage of steam.

There isn't the slightest reason why anybody of average skill should not get the same results with piston-valve cylinders on *Evening Star*; but as it is my aim to try and please the greatest possible number of the good folk who follow my notes, I will describe a suitable pair of slide-valve cylinders for the benefit of those who prefer that type. No alterations will be required in the dimensions of the valve gear. Simply reverse the connections at the top of the combination lever, and set the return cranks to lead the main cranks instead of following them.

Machining the Cylinder Castings

On lathes of the Myford type, the easiest way of setting up the cylinder casting for boring and facing, is to mount it on an angle-plate as shown in Fig. 39. If the contact side of the casting isn't flat, smooth it off with a file. Check the location of the two coreholes. If approximately to the positions shown in Fig. 40, all right, let them be. If they are much out, smooth off one end of the casting with a file, plug the ends of the coreholes with bits of wood, mark out the correct centres of the bores on the wood, coat the cleaned-up end of the casting with marking-out fluid, and strike two circles showing the main and steam-chest bores, with a pair of dividers. Bolt an angle-plate to the lathe faceplate, and put the cylinder casting on it, securing it with a bar across its back, held down with a bolt at each end. If the slots in the angleplate don't come right for the bolts, drill holes in the angleplate to suit. I've an angleplate which has become "more holey than righteous," and find it mighty handy!

Set the casting at right angles to the faceplate—easily done by application of a try-square—letting the end overhang the angleplate by ¼in. or so; then tighten the clamp bolts. Next set the larger corehole, or the marked circle, as the case may be, so that it runs truly. If the bolts holding the angleplate to the faceplate are left just slack enough to allow the angleplate to be moved, this is an easy job. I can set it by eye, in two wags of a dog's tail, having done so many of them; but a scribing-block, or surface-gauge, standing on

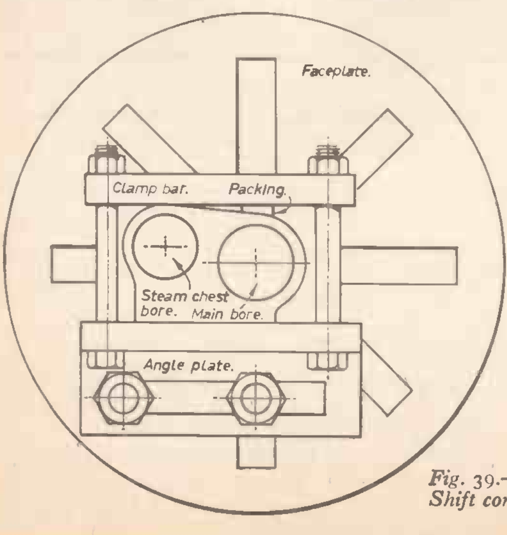


Fig. 39.—Cylinder casting set-up for boring. Shift complete assembly to bore steam chest.

the saddle or lathe bed, with the needle set to the edge of the corehole or marked circle, will show at a glance the amount and direction of adjustment needed. Be careful to avoid moving it when tightening the bolts.

It will be seen from Fig. 39 that the assembly is well off the faceplate centre, and if the lathe is started, there will be a fine imitation of an earthquake in the workshop. To prevent this, bolt a balance-weight of some sort to the faceplate, opposite the assembly. I use lead weights of various sizes and diameters, cast in lids of discarded tin cans, or in cut-down cans; the melted lead is poured in, left to cool, and then drilled ¼in. or so through the middle. Slip the lathe belt off the pulley, and spin the mandrel by hand; you'll soon see if the job is balanced sufficiently

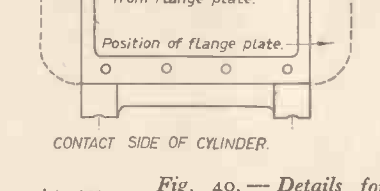
With a roundnose tool set crosswise in the slide-rest tool-holder, face off the end of the casting, taking off half the difference between length of casting and finished job. Then set up a good stiff boring tool, and take a cut through the bore sufficiently deep to get well under the skin of the casting. Run at fairly slow speed, to avoid tool chatter, and have the cutting edge of the tool slightly above the centre-line, to avoid rubbing. Myford and similar lathes have self-acting movement to the saddle, and this should be used, with the gearwheels set up to give the finest available feed. If there is no self-act, the top slide must be used, and set so that it produces a parallel bore, before the casting is set up. This is easy. Chuck a piece of rod about ⅜in. dia. in the three-jaw, with about 2½in. projecting. Set the top slide parallel with it, as near as you can judge, and with a narrow-ended roundnose tool, take a fine cut 1/64 in. or less, along the rod. Take the diameter of this at each end with a " mike " or a pair of callipers. If the " mike " shows a variation of half a division (0.0005in.) or less, or you can't detect any difference in the feel of the callipers, the slide is O.K. for the boring job. If there is any variation, adjust the top slide and repeat operation until you get it right. It will be time well spent, as the bores *must* be parallel.

If a 1¼in. parallel reamer is available, bore until the business end of the reamer will just enter. If not, bore to finished diameter, taking the last two cuts without shifting the cross-slide. Then slacken the bolts holding the angleplate to the faceplate, and move the whole assembly until the steam-chest corehole, or marked circle, is running truly; tighten the bolts, and repeat the boring operation. Don't on any account slacken the bolts holding the clamp bar, or the two bores will be out of line. To face off the other end of the casting, chuck a piece of rod a little over 1¼in. dia. and turn about 1in. of it to a tight fit in the cylinder bore. Put the cylinder on it, rough end outwards, and face off with a roundnose tool until the casting is 2⅜in. overall length. It is advisable to centre the rod with a centre-drill in the tailstock chuck, and support it with the tailstock centre while facing off, owing to the overhang. I use a Lecount expanding mandrel for this job, but such gadgets are not usually found in home workshops—too expensive nowadays!

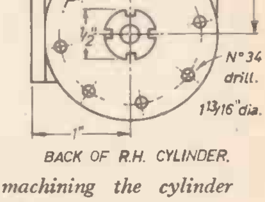
Contact Side and Passages

Up-end the cylinder on the angleplate, putting a piece of thin sheet copper under it to prevent damaging the end. Fix it with a long bolt through the main bore, with a big washer and another bit of thin copper under the nut. Set the contact side parallel to the faceplate; a depth gauge applied at each end easily does that. Adjust the angleplate until the casting is central with the faceplate, to maintain as good balance as possible, then face off with a roundnose tool until the contact side is exactly ¼in. from the edge of the main bore, as shown in the cross section (Fig. 40).

If the passages between cylinder bore and steam-chest are not cored out in the casting, they must be drilled. File a flat in the edge of the bore, opposite the steam-chest, a full ⅜in. long and ⅛in. wide, and make three centrepops on it, ⅛in. apart. Hold the casting in a machine-vice on the drilling-machine

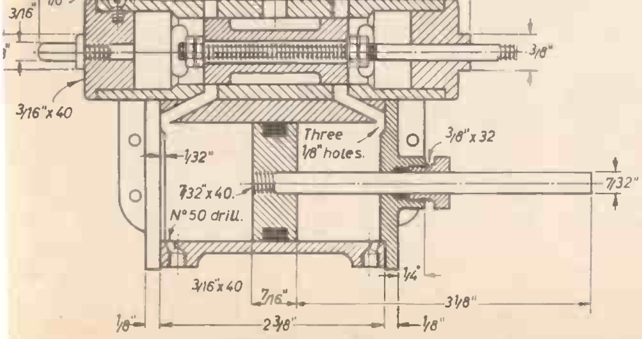


CONTACT SIDE OF CYLINDER.

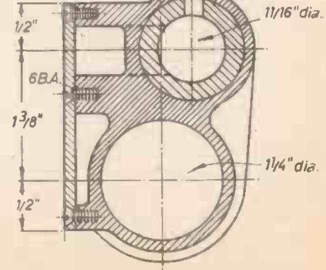


BACK OF R.H. CYLINDER.

Fig. 40.—*Details for machining the cylinder castings.*



SECTION OF CYLINDER



CROSS-SECTION OF CYLINDER.

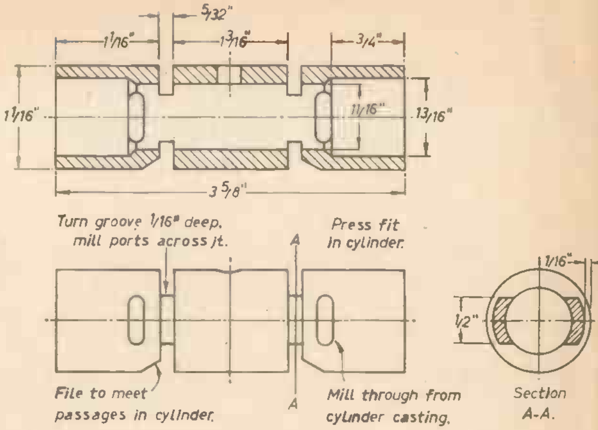


Fig. 41.—Steam chest liner.

table, set at such an angle that the line of the passage-ways will be vertical. Then drill with $\frac{1}{8}$in. or No. 32 drill, into the bore of the steam-chest, see longitudinal section (Fig. 40). The holes can also be drilled by hand, if the casting is held in the bench vice so that the line of the holes is horizontal. If the hand brace is then held horizontally, the holes will break through into the steam-chest in the right place.

Steam-chest liners

The liners (Fig. 41) can be turned either from castings, or from drawn bronze or gunmetal rod $1\frac{1}{8}$in. dia. Cored stick, as used for making bearing bushes in automobile and similar work, can also be used, as it resists both heat and wear. Two pieces $3\frac{3}{4}$in. long are needed. Chuck in the three-jaw and, if solid rod or casting is used, face the end, centre, put a pilot hole through with $\frac{1}{4}$in. drill, then open out with $\frac{5}{8}$in. drill. A cored casting, or piece of cored stick, should be opened up with a boring tool, in the same way as the cylinder casting was bored.

Next mount the liner on a mandrel between centres. A piece of $\frac{3}{4}$in. round rod about 5in. long is centre-drilled at each end, put between lathe centres with a carrier on one end, and about 4in. of it turned down to a tight fit in the liner blank. Drive the liner on to it, not too tightly or you may damage it when getting it off. Put the lot between centres, and turn the outside of the liner to a press fit in the steam-chest bore, by the method I have already described for turning pins and wheel seats to a press fit, viz. turn about $\frac{1}{8}$in. of the end to a tight push fit in the steam-chest bore, and the rest with the collar on the cross-slide handle within half-a-division of its original setting. If the lathe has no self-act, the top slide must be set to turn parallel by aid of " mike " or callipers applied to the ends of the liner.

Remove from mandrel, and chuck in three-jaw as truly as possible. Take a facing skim off the end, then bore to $\frac{13}{16}$in. dia. for $\frac{3}{4}$in. depth. Turn it end-for-end, and repeat the operation, bringing the overall length to $3\frac{5}{8}$in. Now be very careful about the next bit. At $1\frac{1}{16}$in. from the end, turn a groove $\frac{5}{32}$in. wide and $\frac{1}{16}$in. deep, with a parting-tool, and at $1\frac{3}{16}$in. farther along, turn another similar groove. The important thing is, that the width of the grooves, and the distance between the inner edges, *must be exactly as shown*, as they locate the steam ports. If a milling-machine is available, put a saw-type cutter $\frac{5}{32}$in. wide on the arbor, grip the liner in a machine-vice on the table, and mill straight across the grooves to $\frac{1}{4}$in. depth in one cut. Turn the liner over in the vice, and mill across the grooves again, so that the slots are exactly opposite, as shown in the cross-section of the liner. The openings left by the cutter in the bore of the liner, form the ports.

The job can be done in the lathe in similar fashion, with a $\frac{5}{32}$in. cutter on a spindle between centres, and the liner held in a machine-vice at correct height, with the vice bolted to the lathe saddle. The slots may also be hand-filed with a thin flat file, the liner being held in the bench vice, bits of soft copper sheet being put between jaws and liner, to prevent damage. Chuck the liner again, and bore out the centre part to a shade under $\frac{11}{16}$in. dia. so that the slightly-tapered end of an $\frac{11}{16}$in. parallel reamer will just enter. Finally, file two clearances across the outer ends of the grooves, as shown in the drawing, to allow steam from the ports to get to the passages in the cylinder.

The liners can then be pressed into the steam-chest bores in the cylinder castings, using the vice as press, as previously described. Put pieces of soft sheet copper between jaws, and ends of liner and cylinder. Take great care to insert the slightly-reduced end of the liner in such a position that the clearances will line up with the passages in the cylinder when the liner is right home. Press in the liner until the entering end has gone right to the end of the cylinder. As the end projects through the casting for $\frac{5}{8}$in. length, a block of metal or a piece of thick-walled tube at least $\frac{3}{4}$in. long, with a $1\frac{1}{8}$in. hole in it, must now be placed between the end of the cylinder and the vice jaw, where the end of the liner will come through. The pressing can then be completed, the end of the liner entering the hole in the distance-piece as it emerges from the cylinder. Both ends should stand out exactly $\frac{5}{8}$in. from the cylinder.

Reaming by Hand

The reaming should, by the good rights, be done in the lathe, when the cylinder is set up for boring; but the hole through the mandrel of the Myford or similar lathes usually found in home workshops, is far too small to allow reamers of the requisite sizes to be put through the bores. The only thing to do, is to ream by hand. Grip the cylinder in the bench vice, setting it level. Put a big tapwrench on the end of the reamer shank, enter it in the bore, and slowly turn and push at the same time. The great thing to watch, is avoiding any side or down pressure on the reamer, otherwise the bore will either become bell-mouthed or tapered. Hold the tapwrench loosely as it is turned and pushed, so that it kind of " goes its own way." A drop of cutting oil is a great help in getting a smooth finish. Don't attempt to reverse the reamer and pull it out, carry on until the business end goes right through the bore; then take off the wrench, and remove the reamer from the far end of the bore.

The narrow part of the liners can be reamed in the same way. It may be thought by inexperienced workers, that these might have been reamed before pressing in, but pressing always causes slight distortion, so it is preferable to ream after pressing.

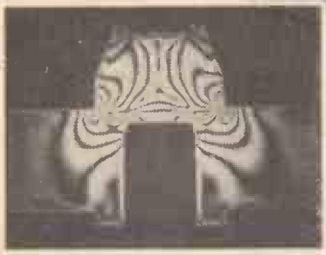
There will be an oval boss on top of the casting, to which the steam pipe is attached. Smooth this off with a file, centrepop it, and drill an $\frac{11}{32}$in. hole right through into the liner. The exhaust ways are cut through into the liner from the extreme ends of the upper recess in the contact side of the cylinder. These

(*Concluded on page* 591).

SCIENCE NOTES

Sharples Polariscope

THE Sharples $5\frac{1}{2}$in. dia. Polariscope is unique in that it can be used as a diffused light or as a transmission instrument. The instrument has been designed for serious research work, university and technical college lecture purposes and as a practical engineers' tool for the assessment of designs. It is a very compact instrument mounted on its own



(Right). An example of photo-stress analysis.

The Polariscope.

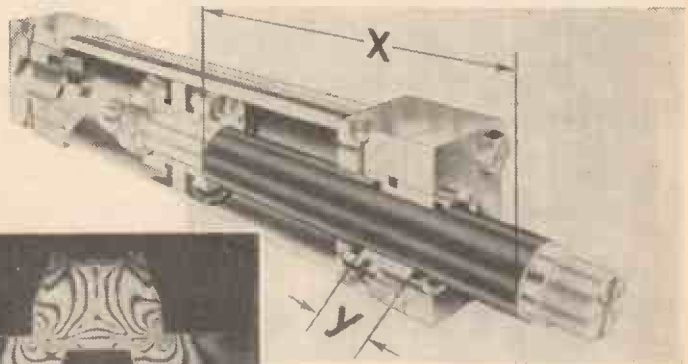
cabinet, which contains ample storage space for models and special loading equipment, etc.

Space Flight Rehearsal

THE photograph on the right shows the mating of a Mercury capsule to an Atlas vehicle. The spacecraft is being placed on top of the Atlas rocket prior to the flight which took place some months ago. It was the first attempt by the National Aeronautics and Space Administration to put an unmanned Mercury spacecraft into an earth orbit. On this particular flight something went wrong with the Atlas rocket carrying the capsule, in which was a "dummy," and it exploded into flames. According to the experts if a man had been inside the capsule he would have survived.

Bronze Case

A new rod material called bronze case in combination with hardened steel bushings is a new American engineering concept for piston and guide



Bronze case piston rods.

rods and similar linear applications. Bronze bearing material is put on the large area of the shaft instead of being confined to the bearing area within a bushing. This provides substantial reductions in the cost of bushing and rod replacements and materially reduces down-time production losses. In the photograph Y represents the area usually bronzed and X the area bronzed in the new process.

Mating of a Mercury Capsule to an Atlas vehicle.

Fig. 1.—The dressed doll in working position.

Make a VENTRILOQUIST'S DOLL for a few shillings

THE doll frame is completely joined (Fig. 3) so that the figure can sit, stand, bow and shake hands, etc., as the routine demands. Cut the shoulder block from a piece of 3in. × 2in. planed wood to the 12in. length given. Slope the shoulder section at 4in. stations and taper them down to 1½in. at the ends of block. Drill 1in. dia. holes as shown—two blind holes for the dowel frame at 9in. centres and a central through hole for the doll's head stick.

A 12in. length of 2in. × 2in. wood forms the base of the body frame and this is also drilled with two 1in. holes. Before fitting the two 12in. dowel rods into shoulder and base blocks, the body former—this is an oval piece of plywood 12in. long by 4in. wide—must be drilled and glued to the dowels. Locate the body former halfway up the rods.

The Arms

These are made from four pieces of 2½in. × ½in. wood each 8in. long. Round off the corners of the two upper arm pieces and mark out and fret the hand and finger shapes as shown in the inset detail. Hand profiles are worked over with rasp and sandpaper to produce rounded knuckles and wrists. The complete forearms are attached to the upper arms with spring-loaded pivot bolts so that the arms will readily move and stay in any desired position. These pivots are 2in. long ¼in. coachbolts with short coil springs under the washers and wingnuts. Fix the units to the shoulder-block with woodscrews put through drilled holes. The woodscrews also act as extra fastenings for the body dowels. Arms should move freely on the screws but without much sideplay.

The Legs

The thighs are made from 3in. × ½in. section wood 9in. long; the lower legs from two 9in. lengths of 1in. dia. dowel. Shape the flat strips and attach to the base block with woodscrews. Drill and bolt the dowels to the knees, tightening the nuts of the pivot bolts just enough to permit the legs to hang straight under their own weight.

Saw the shoe formers from pieces of ½in. thick wood—plywood is best—measuring 4in. × 2½in. and drill and glue them to the bottom of the leg dowels. Toes of the shoe formers are pointed so that the dummy can either be dressed with or without actual small shoes.

Doll's Head

An oval and a disc of ⅜in. plywood are used to make the doll's face. Fig. 4. The oval piece measures 8in. × 6in. across the widest points. Notice how the face tapers towards the jaw while the 6in. wide dimension is measured 2½in. down from the top edge.

Mark out the movable jaw—2in. deep × 1¾in. wide—and cut away cleanly with a fine fretsaw blade. This piece is fitted back into the head as shown by means of a pair of guide blocks and a slide strip which is screwed behind the movable jaw. The slide strip is a piece of ¼in. plywood 2½in. long × 1in. deep. It operates in the guides that are built up of ¼in. plywood strips with thin plywood retaining pads. Sandpaper the components so that the jaw slides smoothly.

A light tension spring is screwed behind the head and jaw to keep the mouth closed. Operation of the jaw is effected by a thumb ring and an 8in. length of black cord which is attached to the rear of the sliding strip.

A 6in. dia. disc of plywood is sawn across the middle to make the two hat formers. These are fastened front and back of the head using strips of ½in. square

Fig. 2.—The body frame and head ready for assembly.

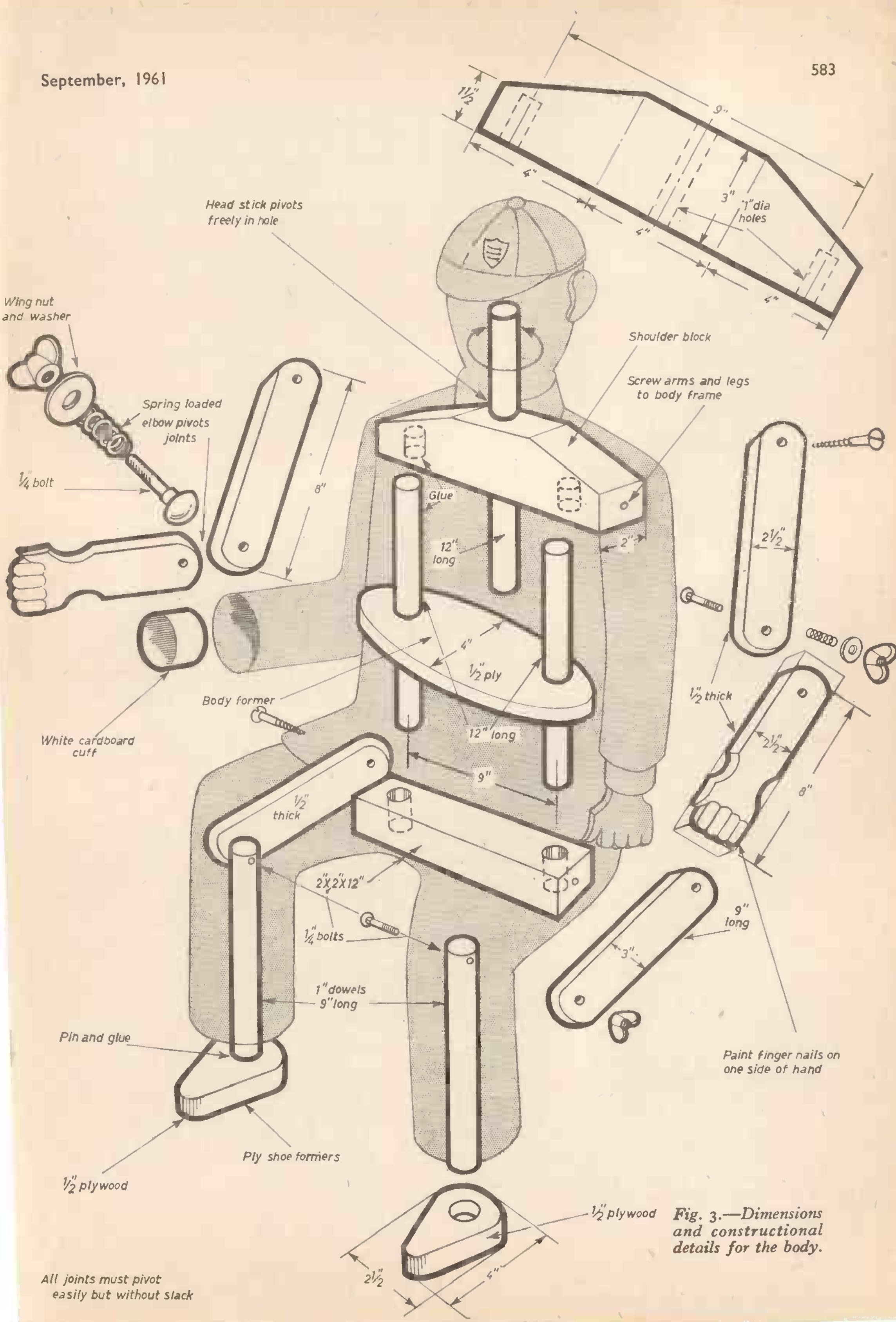


Fig. 3.—Dimensions and constructional details for the body.

wood for corner supports. Similar wooden blocks, sawn from ¼in. plywood, are attached behind the ears, which are located 5in. up from the base of the face. The head is operated on a 12in. length of 1in. dowel which is secured to the back of the face via. a 2in. cube wood block. Drill the dowel hole off-centre to give plenty of clearance between the head stick and the sliding jaw. Wood screws put in from the front of the face fasten the block in position.

Facial Details

Carve the doll's nose from balsa wood and glue it to the face covering the heads of the screws that hold the head-stick block. Mix up some light pink paint—the eggshell type of emulsion paint looks most realistic—and give the face one or two coats overall. The red lips are painted with a fine brush but it is best to colour the tip of the nose and cheeks with a little red paint on the tip of a finger.

Mark out the eyes and brows with black paint and finish with blue eyes having black pupils. The ears are pink too, but the centres are finished in a darker shade. At this stage, the hands and wrists of the doll should be painted and the finger nail markings put in. Hands are clenched so the nail marks are applied to the insides of the hands only.

The painted head is fitted to the body frame through the hole in the shoulder block and the dowel should be an easy fit. Cord and thumb ring pass in front of the shoulder block and are operated by the right thumb; while the right hand holds and works the head-stick (Fig. 4).

Dressing the Doll

The cheeky schoolboy type of character always appeals and it is suggested that the doll be dressed to suit.

Collar and cuffs can be made from stiff, white cardboard and the completed collar is cut away to fit across the shoulder block. A tie and a piece of "shirt" material are attached to the collar prior to fastening into the figure and a schoolboy cap completes the dummy (Fig. 4).

Seat the doll on your right knee by grasping the head-stick through a cut-away portion in the back of the dummy's coat. You'll quickly learn how to handle the figure by making him jump off your knee on to the floor and taking a bow. Practice the lip movements slowly by repeating the patter—both your own and the doll's—aloud without trying to hide your own lip movements. Get the feel of the thumb cord and twist the face each time the doll speaks to you. Normally, he looks at the audience.

The Art of Ventriloquism

A simple method of controlling your lips is to lightly touch your teeth together and part the lips slightly in a smile. This is the basic method used by performers although deviations are introduced to get over certain difficult letters. Repeat the alphabet keeping your lips still and you will find the only really difficult letters are B, M, P and W. B and P can be pronounced as HE . . . example Hetter instead of Better and Hancake instead of Pancake. Pronounce M as N—Nichael in place of Michael—and say duggleyou for W.

All difficult words should be avoided and material should be written with this dodge in mind. Try to pitch your ventriloquist's voice a little high. Practise the script patiently and try to create the illusion of a real, cheeky boy.

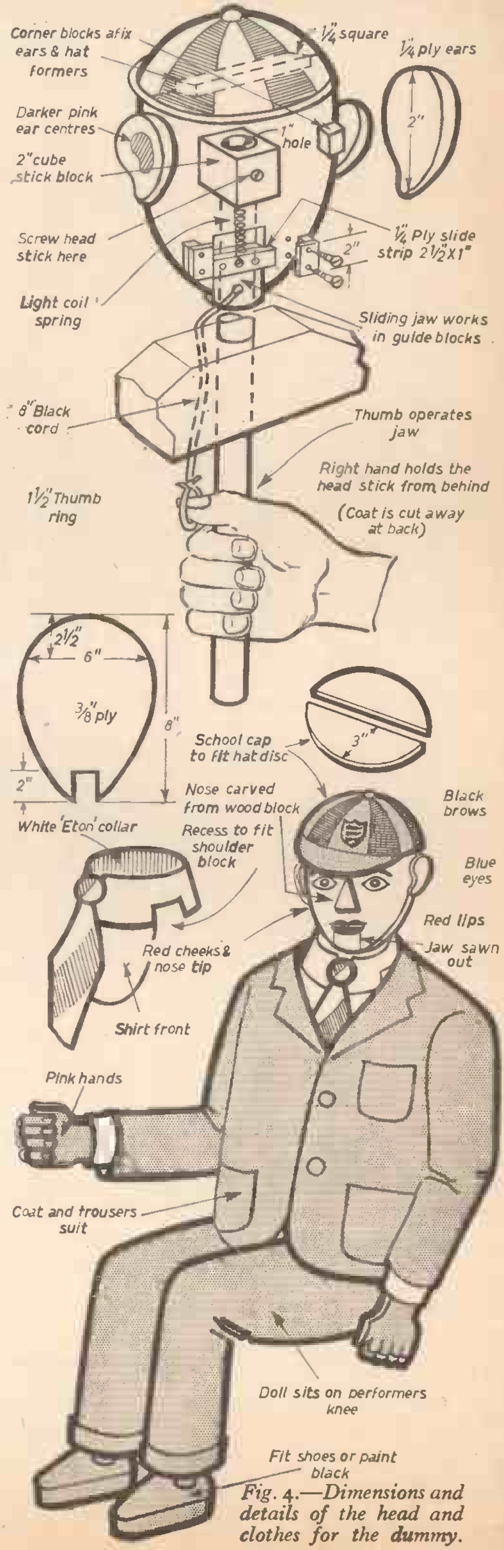
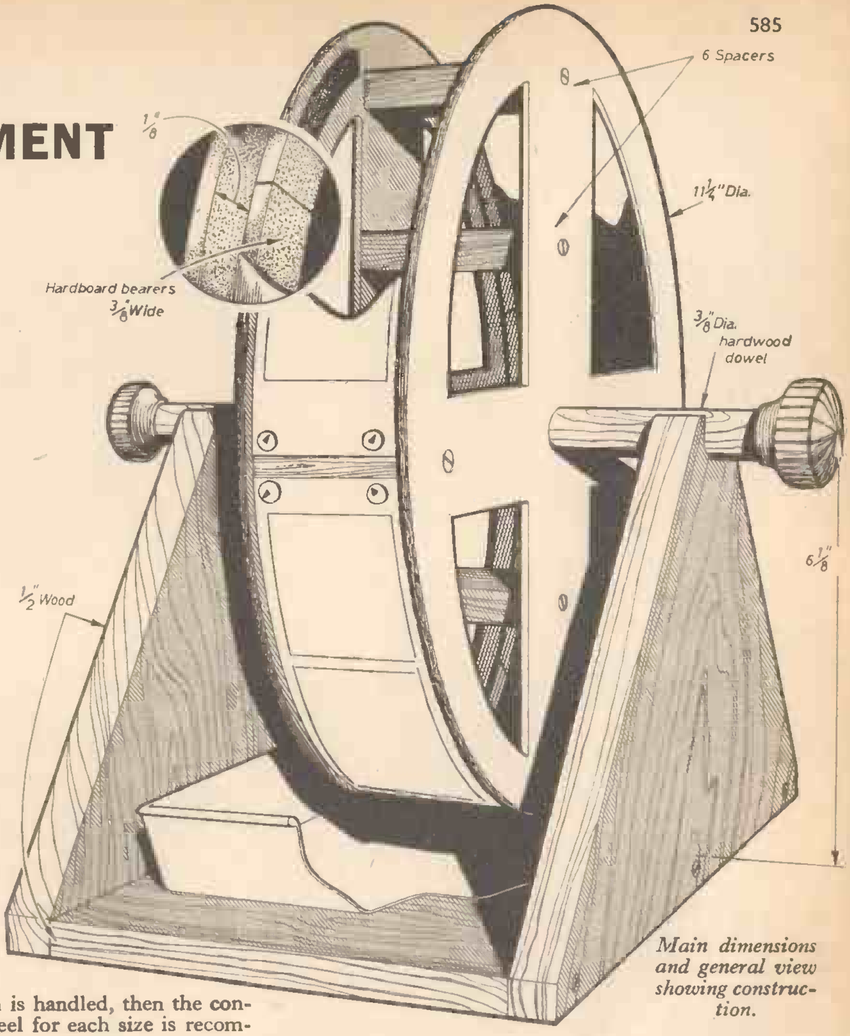


Fig. 4.—Dimensions and details of the head and clothes for the dummy.

A DISH DEVELOPMENT AID

By "Helios"



Main dimensions and general view showing construction.

THE apparatus described here has been evolved to facilitate developing in darkness and at the same time provide for momentary inspection by the light of the dark green safelight. The method has been styled "Blackpool" because of the resemblance of the appliance to the Big Wheel at that resort.

Dimensions may be varied to suit the size of film normally handled by any particular user. A wheel capable of adjustment to take any width and length of film would be unduly complicated and, if more than one size of film is handled, then the construction of a suitable wheel for each size is recommended. They are very simple to make.

Construction

Start by cutting two 11¼in. dia. discs of water-resistant hardboard and removing four sectors as can be seen in the sketch. Attach further segments of hardboard to form a rim ⅛in. from the edge of the discs, using waterproof adhesive. This forms a track in which the film will lie. The discs are made into a drum (segments inside) by screwing to six pieces of ½in. × 1½in. section wood, using nickel-plated screws. The distance between the inner sides of the two discs must be 2¼in. for 120 and 620 films. Three spacers are fixed about ¼in. in from the hardboard rim and one, shown inset in the sketch, is fixed level to the outside edge of the hardboard rim. It is to this spacer that the ends of the film are pinned. The other two spacers are fitted nearer the hub of the wheel.

The axle consists of a ⅜in. dia. hardwood dowel and the operating knobs are of wood or any convenient material. The stand on which the wheel turns is made of ½in. thick wood and the three pieces comprising it are fixed together with plated wood screws. There should be about ½in. clearance between the lower edge of the wheel and the top surface of the stand base.

The apparatus must be given two coats of cellulose paint before being used.

Using the Apparatus

Three dishes are filled to the correct depth with developer, plain water and fixer respectively and placed in a predetermined order close under the darkroom safelamp. The developing wheel, in position on its stand, should be on the darkroom bench at some distance. Switch off all lights including the safelamp and load the film on to the wheel in complete darkness. The free end, as it emerges from the spool, is pinned on first. Then the wheel is slowly rotated as the spool is unwound so that the film is wound on to the wheel *emulsion side outwards*. The end of the film attached to the paper backing is removed and pinned to the wheel which will now have turned full circle. The loaded wheel is now lifted from its stand, the dish of developer placed in position and the wheel replaced. The wheel is rotated during development, rinsing, fixing and washing by slowly twisting the knobs on the ends of the shaft. The fingers will not become contaminated by the solutions. Switching on the safelight for a short period will enable inspection of the film to be made, either on its emulsion (outermost) side or by looking at the reverse side through the cut-away sides of the wheel.

After use, wash the apparatus briefly and stand in a warm room to dry.

By D.S.C. FRASER

Supersonic Airliner Engines

MORE speed means more efficiency. If this can be accomplished with fewer moving parts, together with economies in running operations, so much the better. These requirements appear to be fulfilled by the ramjet engine, and American aircraft designers are working today on ramjet engines that may be used for the 2,000 mile-per-hour airliners of tomorrow. (Fig. 1).

Airliners that can fly at such tremendous speeds are already in the advanced design stage, and it is only a matter of time before they will be built and put into operation. Such aircraft would travel from New York to London in two hours. Flights half-way around the world would take no more than half a day.

The Ramjet

The ramjet, engineers are now convinced, is one type of aircraft engine that can make such fast flights possible.

Ramjets are engines that operate most efficiently at speeds of 1,200 miles an hour and more. They are sometimes called " flying stovepipes " because of their cylindrical shape and simple interior arrangements.

Their simplicity of design eliminates complex control and lubrication systems, and they are potentially reliable because they have few moving parts. Other factors which make them interesting to aviation engineers are low initial cost, fuel efficiency, simple fuel control and light weight.

According to Mr. J. F. Drake of the Marquardt Aircraft Company—a leading American builder of ramjet engines—ramjets designed for use in aircraft will operate at low temperatures with the emphasis on efficiency and long-life, rather than on maximum thrust. He said that long-service reliable ramjets for planes should not be too expensive or difficult to develop. (See Fig. 3.)

How It Operates

What is the difference between a ramjet engine and a turbojet? In a turbojet, a compressor operated by a turbine wheel, rotated at high speed by expanding hot gases, draws in great quantities of air. As the air is compressed, its temperature rises. The highly-compressed, heated air is fed into a combustion chamber, where it is mixed with fuel, and the mixture ignited. The hot gases of the combustion pass out of the rear of the engine at very high velocity and create a powerful forward thrust.

A ramjet is much simpler. The engine is, in effect, no more than a metal tube open at each end, and as can be seen from Fig. 2. there are few parts. Air enters the diffuser and is compressed by the ramming action of the high forward speed. Fuel is pumped through injectors and mixes with air as it passes to the flame holder, where burning starts. The high temperature expands the exhaust gases, which pass through the exit nozzle and are accelerated to several times flight velocity. Thrust results from the tremendous increase in the air's velocity between intake and exhaust.

There is one big snag: these engines will not function when standing still, and are inefficient at moderate speeds. They must move forward at very high speeds in order to compress the intake air sufficiently.

Fig. 1.—(Left) Artist's drawing of a ramjet liner of tomorrow.

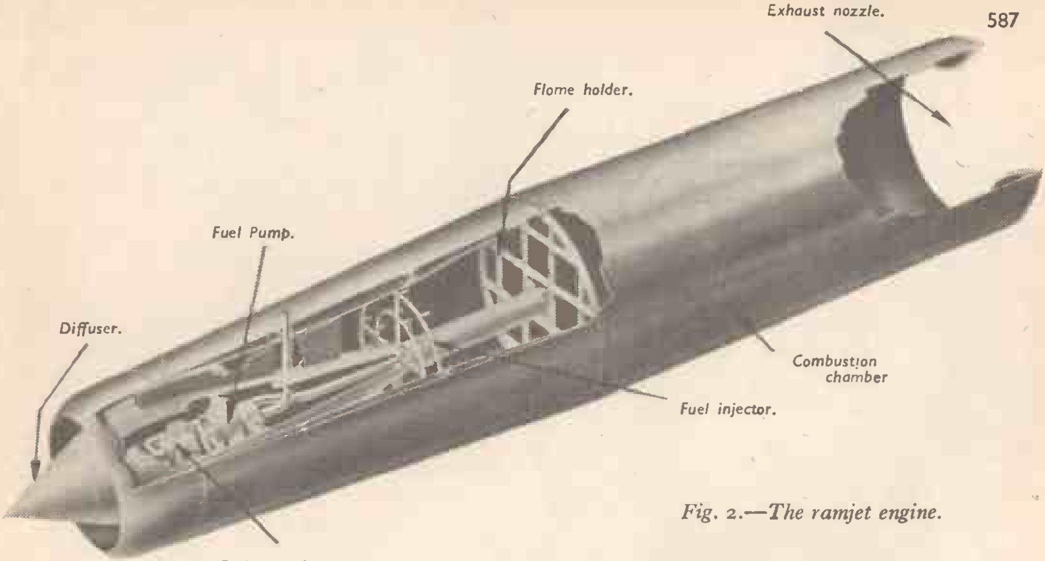


Fig. 2.—The ramjet engine.

Engineers are, however, busy with plans to overcome this basic drawback and some methods are already undergoing laboratory tests.

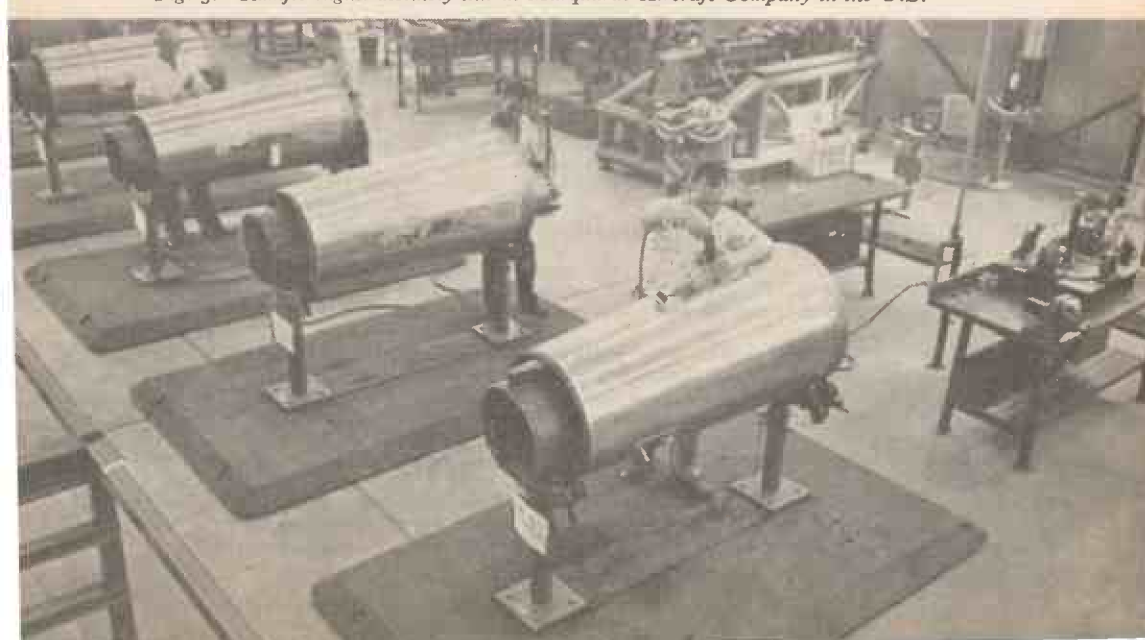
Ramjet turbojet

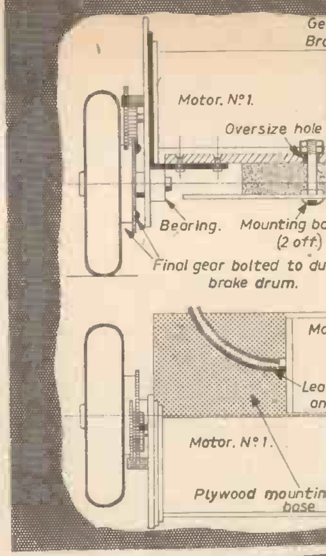
The Marquardt Aircraft Company is not relying exclusively on the use of new devices as a means to launching a ramjet plane. In one approach to the subject, it considers that conventional turbojet engines might be used on a 2,000-mile-an-hour jet airliner to take off, climb to altitude and pick up speed. Then, the pilot would shut off the turbojets and turn on the ramjets.

A possible ramjet-turbojet airliner for the 1970's, according to Marquardt officials, would probably be the size of the Boeing 707 or the Douglas DC-8, and would carry 140 passengers, about the same as present-day jet airliners. At altitudes of 10 to 15 miles, the planes could cruise at three times the speed of sound (sound travels at 660 miles an hour at these heights). The ramjet would be cheaper to operate than today's jets, and 20 per cent. cheaper than a 2,000 mile-per-hour airliner powered entirely by turbojets.

One key claim made by Marquardt engineers is that at 2,000 miles an hour and at 60,000 ft., the ramjet engine will produce three to four times more thrust per pound of engine weight than the turbojet will. This greater thrust, they say, would pave the way for important savings in fuel costs. It is the ramjet's much more efficient power, they contend, that also would make possible non-stop flights of 6,000 miles.

Fig. 3.—Ramjet engine assembly line at Marquardt Aircraft Company in the U.S.





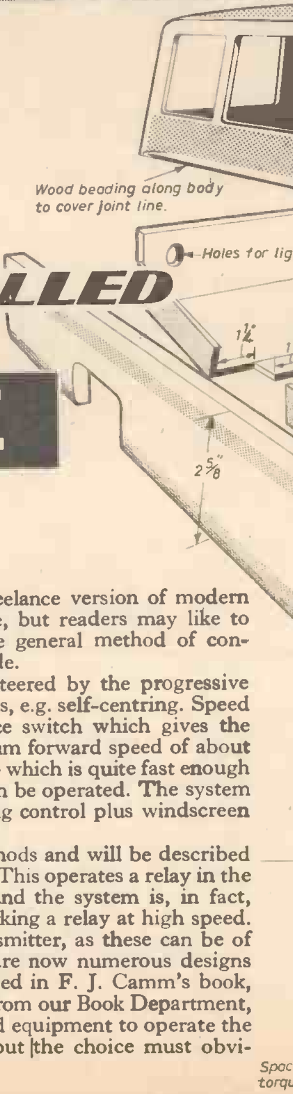


Fig. 3.—Axle

A RADIO CONTROLLED MODEL SHOOTING BRAKE

By D. W. Aldridge

THIS radio controlled model shooting brake is a freelance version of modern styling and is not a copy of any particular make, but readers may like to vary the general chassis dimensions given. The general method of construction should suit readers with only hand tools available.

The radio control system enables the model to be steered by the progressive method which has been found preferable to other systems, e.g. self-centring. Speed control is by means of the author's reversible sequence switch which gives the model three forward and two reverse speeds. A maximum forward speed of about 4 m.p.h. is obtained (equal to about 40 m.p.h. scale speed) which is quite fast enough for control purposes. In addition, the lights and horn can be operated. The system could be further elaborated to include additional lighting control plus windscreen wipers, etc.

The radio control system used is based on pulse methods and will be described later. The radio receiver used is a multi-valve superhet. This operates a relay in the same manner as a simple super regenerative receiver and the system is, in fact, equally suitable for use with any receiver capable of working a relay at high speed. No details will be given either for the receiver or the transmitter, as these can be of any type preferred by the reader, and of which there are now numerous designs available. The simple transmitter and receiver described in F. J. Camm's book, *Radio Controlled Models*, which costs 13s. 6d. by post from our Book Department, will work very well in this model. The use of tuned reed equipment to operate the servos described could produce a more compact model but the choice must obviously be left to the constructor.

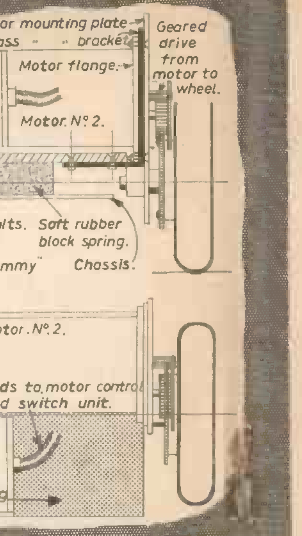


Fig. 1 (Left).—Details of the mounting.

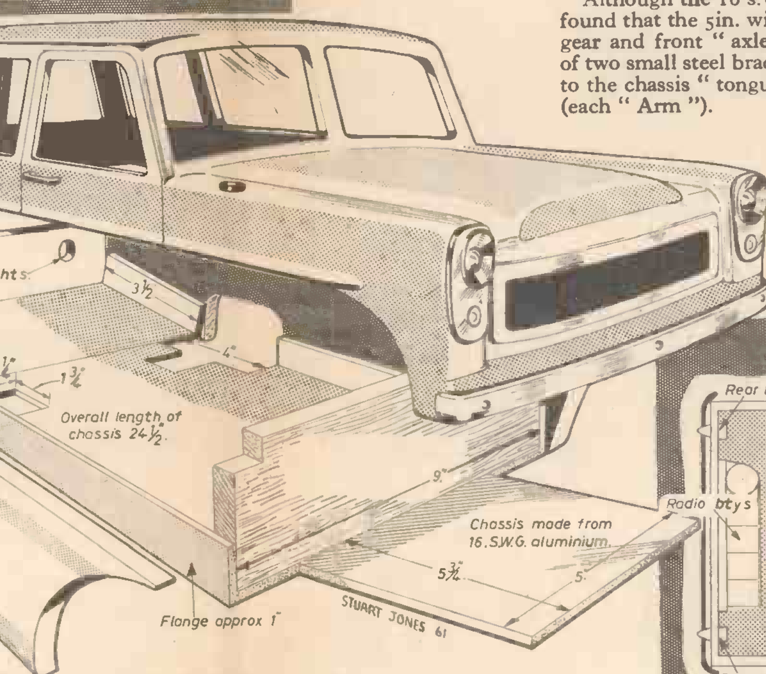
Fig. 2 (Below).—Chassis and body details.

The body and chassis fit together so that the whole of the mechanism is readily available for adjustment, should the need arise. The chassis, made from 16 s.w.g. commercial aluminium sheet, is cut and formed as shown in Fig. 2. It also constitutes the lower portion of the body to which, after the addition of wooden side and cross members, the top section simply fits by means of clips at the back and a single nut at the front. The removal of this nut, therefore, enables the body top to be removed for adjustments to be carried out.

The writer had the work of cutting and flanging the aluminium carried out by a local tinsmith. As the metal was cut in a guillotine and flanged in a press, this produced a very accurate and true chassis on which to build the model. The work could also doubtless be carried out by one of the firms who now specialise in the fabrication of radio chassis to customers' requirements.

After the wheel cut-outs have been made, the wooden portions forming the lower part of the body, sides and back can then be added, together with the partitions for the radio receiver, as shown in Fig. 4. These partitions strengthen the chassis and the front one also serves as a useful splash guard preventing road dirt from getting into the radio and mechanism. This front partition also serves as the mounting platform for the limit switches required for the steering mechanism.

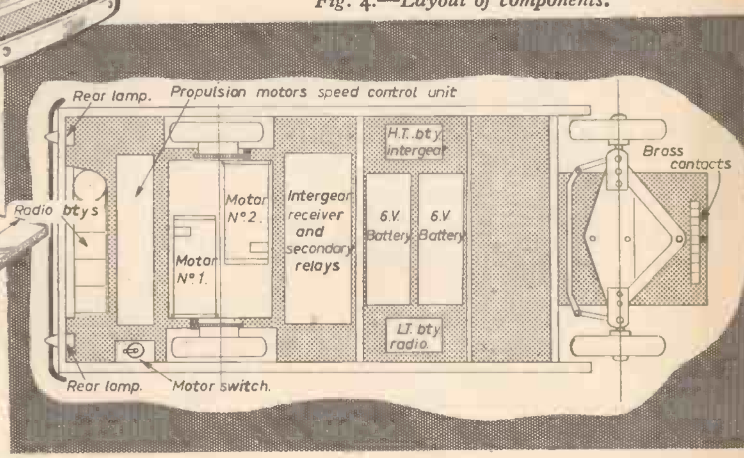
Although the 16 s.w.g. aluminium chassis is amply strong for the model it was found that the 5in. wide " tongue " which extends at the front to carry the steering gear and front " axle " needed a little extra support. This was given by means of two small steel brackets bolted on one arm to the front partition and on the other to the chassis " tongue." The brackets used were approximately 2in. × ½in. wide (each " Arm ").

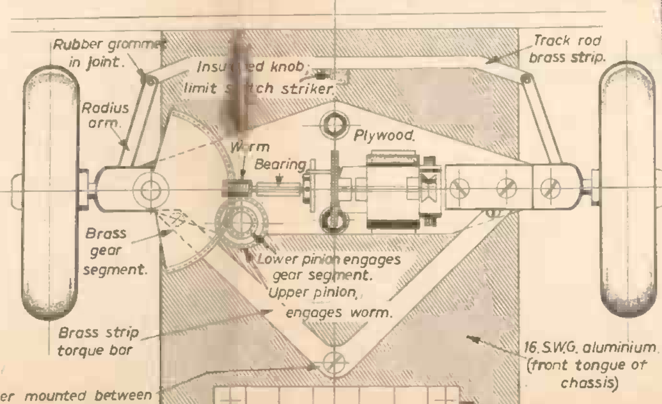


The Body

This was constructed of plywood and the general boxlike shape of modern cars is helpful to the builder as it is much simpler to make in this form. The roof took the most time to make, due to its double curvature. The only satisfactory way to do this is to form ply strips shaped and fitted into each other.

Fig. 4.—Layout of components.





details.

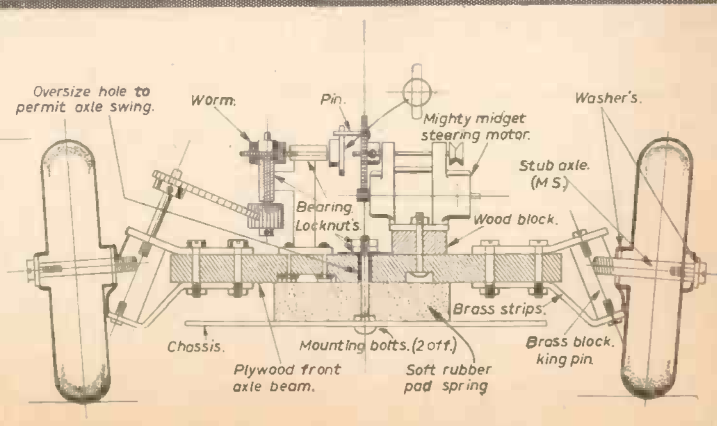


Fig. 5.—The prototype model.

These were reinforced inside with bandages glued to the wood with "Cascamite." Several layers were applied at right angles to each other. So far as the remainder of the body is concerned the general shape of a vehicle was copied and copious use was made of wood fillers to achieve the rounded form before painting. The general outline employed is shown in Figs. 2 and 5.

The radiator shell and lamp surrounds were made from sheet aluminium and the bumpers from aluminium tubing pressed nearly flat. The head-lamps are the business ends of two hand torches, complete with reflectors and bulbs, and the rear lamps are two-cycle-type plastic rear lamps of the older type, suitably cut down.

Celluloid (from a model shop) was used for the windows. One window at the back, was, however, removed later as it was found useful for getting in quickly to switch on or off.

Rear "Axle" and Propulsion Unit

In building a model vehicle one of the difficulties to be faced is that of providing a differential between the two driven wheels to allow for the different distance each has to travel when turning a corner. The conventional mechanical method using bevel gears is all very well for those with workshop facilities, but a simpler method is necessary for the ordinary experimenter. The solution to the problem turned out to be quite simple and two electric motors were employed, one driving each rear wheel. Thus no mechanical differential was needed, the effect being obtained electrically as each motor drives as hard as it can when a corner is turned.

The motors used were Hughes 12V. motors obtained, complete with gear assembly (final drive speed 150 r.p.m.), from Midland Instrument Co., Moorpool Circle, Birmingham 17. These are quite cheap and could be considered as being handmade for the job, being used almost without modification, the final drive shaft fitting into the dummy brake drum and wheel used. The wheels are 3½in. dia., and are of the type used for model racing cars. As an alternative, tyre manufacturers are willing to supply model-sized replicas of their goods and naturally these look very realistic. Facilities are then required, however, to turn wheels to fit.

Springing

Springing of the conventional type would require workshop resources and, as before, a simple method has been evolved. The solution found was to mount both front and rear "axle" components on a piece of plywood and to pivot these at (at least) two points down the centre-line of the vehicle chassis. (Fig. 1.) The pivoting is done simply by means of bolts fastened securely to the aluminium chassis but in oversize holes on the axle assemblies. The axles can, therefore, rock from side to side. The "spring" is

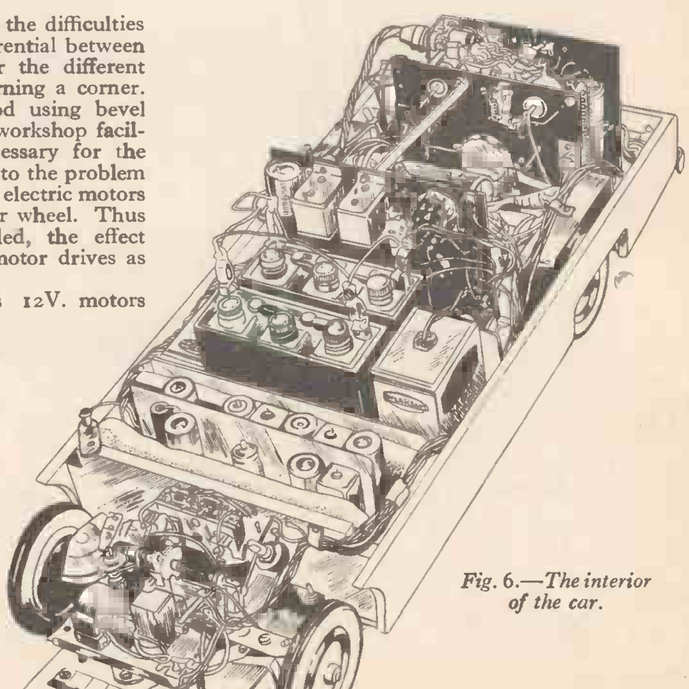


Fig. 6.—The interior of the car.

produced by compressing a piece of soft sheet rubber into the space between the "axle" board and the chassis. Transverse springing is thus provided and, in the writer's model, enables obstacles up to approximately 1in. in height to be driven over without a wheel leaving the ground. No lateral springing is provided but the performance of the model with this simple method has been found to be quite acceptable.

Front Axle

This is constructed on a shaped piece of ½in. thick plywood and carries brass brackets at the ends to pivot what would be described in automobile practice as the "king-pins." The wooden "axle" also carries the steering motor and gearing. Fig. 3 shows the general arrangements used and readers will see how the line of the king-pin pivots, if extended, will meet the point where the tyre runs on the road. This ensures that when the steering is operated the wheels turn on fixed points (i.e. they do not roll round). The king-pins are made from ½in. square brass filed to suit and drilled and tapped to take the stub axles, pivots (top and bottom) and the radius arms for the steering. Due to the angle of the king-pins, the radius arms describe arcs approximately 20 deg. from the horizontal and in opposite directions. thus making it a difficult job to fix a track rod to link them together. The ideal solution would be ball and socket joints or universal couplings. However, the writer made do with pin joints—the pin working in a rubber grommet to permit the necessary freedom of movement. This is not an ideal solution but is practical in the circumstances. Springing is arranged as already described, but to provide the effect of a torque bar (to stop the axle deflecting when striking an obstacle) a V-shaped piece of brass strip is also used to provide a third pivoting point. This is fastened securely in the centre and thus the whole axle is stabilised. The track rod (joining the two radius arms together for steering) is made of brass strip and carries an insulated striker to operate the two limit switches mounted behind on the wooden partition.

Steering Motor

A "Mighty Midget" motor is used for steering and provides adequate power through the gearing used. As in a full-sized car, the steering cannot be turned with the model stationary (except on polished floors) but when the model is moving steering is quite satisfactory.

The question of linkage from the wheels to the steering motor caused some difficulty but was solved as shown in Fig. 3. One of the "king-pins" was extended upwards and fitted with a brass gear segment. This was cut from a large brass gear wheel taken from a piece of ex-Government equipment. It meshes with a pinion and a further worm gear reduction unit, finally being driven from the Mighty Midget motor. It will be seen that the whole of the steering gearing and drive is mounted on the front axle board. This makes a compact unit and saves additional linkage which would be required for a separately mounted unit. It is unlikely that readers will have available exactly similar pieces of gearing to those used by the writer but reproduction, using gears from model maker's suppliers or from mechanical construction toys, should enable the problem to be overcome.

Propulsion Batteries

Two scooter batteries are used to provide the 12V. required for the propulsion motors. These have ample capacity for most purposes and enable the motor to be operated for over an hour (probably much longer) before needing recharging. They provide power also for the servo motors, lights, hooter, etc.—in fact, all except the radio receiver and high voltage portion of the intergear unit. A conveniently placed switch should be provided to cut power off the propulsion motors when tuning up and separate switches both for the radio and for the intergear equipment. These could be combined.

Brakes

No brakes are fitted to the vehicle. It was found that there is sufficient drag in the gearing and motors, mainly caused by the pressure of the motor brushes on the armature, to bring the vehicle to a halt very quickly after power is switched off. The drag is sufficient to hold the vehicle even on a moderate gradient. The difficulty of providing braking as a separate radio controlled feature, is therefore, avoided.

Electrical Linkage

Although most of the electrical equipment is contained in the lower chassis a small amount of the wiring, viz. that to the headlamps and hooter, is carried in the upper body. Linkage between the two, is, therefore, necessary and was arranged at the front of the chassis. Fixed contact strips are provided mounted on a piece of plywood and these are contacted by flexible brass fingers in the upper body which press on them when the two halves come together. A similar arrangement is used for the aerial which plugs into the upper body but requires connecting to the radio in the lower chassis. Users of super regenerative receivers will need a different arrangement here due to the much greater effect of the aerial on this type of receiver.

Next month a description will be given of the control equipment used.

L.B.S.C's 3½in. Gauge
EVENING STAR

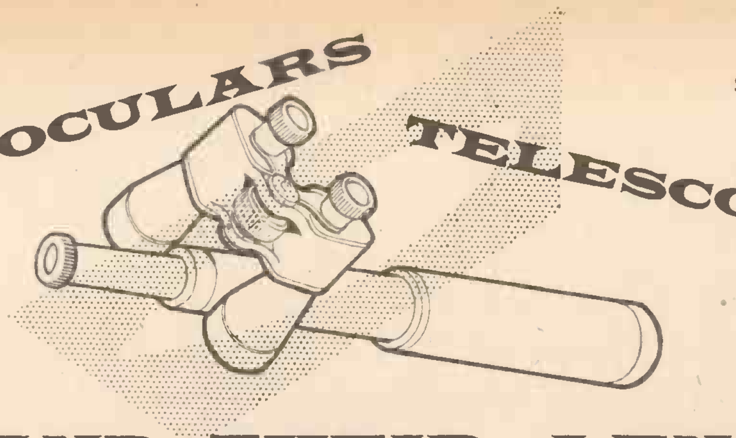
(*Concluded from page* 580)

may be slot-drilled. Bolt an angleplate to the vertical slide on the lathe saddle, and set the cylinder end-up on it, securing with a bolt through the bore as previously described. The contact face is set at right angles to lathe centres; put on the faceplate temporarily, and when the contact face is parallel to it, setting is O.K. A $\frac{5}{32}$in. slot drill with just two cutting edges, held in the chuck, is the best tool for a quick clean cut. Adjust the vertical slide until the slot-drill is at the extreme end of the recess, then feed into cut by moving the lathe saddle, and traverse the casting across the slot-drill by moving the cross-slide. Cut the slot at the other end of the recess in same way, and put the reamer through the liner again to remove any burring.

If a vertical slide isn't available, the job can be done by hand. Drill three $\frac{5}{32}$in. holes at the extreme ends of the recess, right through into the liner, and run them into a slot with a rat-tail file. Their exact position doesn't matter, as all they do is to let the steam out. The admission and exhaust are controlled by the piston-valve sliding over the ports.

(*To be continued*).

BINOCULARS TELESCOPES AND THEIR LENSES



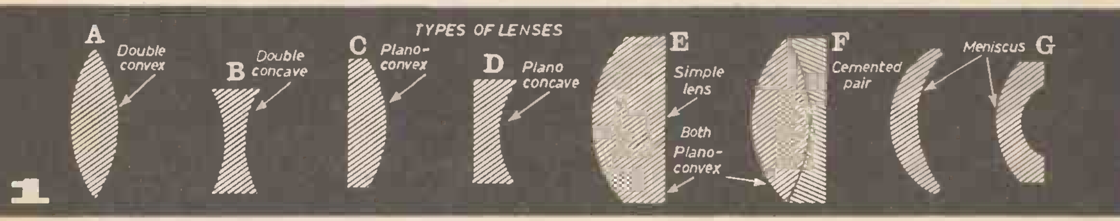


Fig. 1.—Various types of lenses.

EFFICIENT telescopes and similar items are not difficult to construct, when the principles are understood. Surplus or other lenses can thus often be put to good use.

Some of the most usual lenses are shown in Fig. 1. "A" is a double convex lens, and will magnify. "B" is double concave, and is termed a reducing, or negative lens. It cannot throw a real image, but may be employed for various purposes. "C" is plano-convex, and has one flat side. It is a positive, or magnifying lens, similar to "A". The plano-concave lens "D" is negative, or reducing, in the same way as "B".

An actual lens may be a simple, single glass, as shown at "E", or it may consist of more than one lens, as shown at "F". When the simple lens is used, it tends to break up light into a spectrum, in the same way as a triangular prism. As a result, objects away from the centre of view are not seen so well. In addition, the simple lens has a curved field—that is, rays passing obliquely through it are not all brought to the same point of focus. These defects are reduced by the lens at "F", which is really two lenses of dissimilar glass. It is so made, that errors in one part of the lens are compensated for by the other part of the lens, As a result, it gives better definition, especially away from the centre of the field of view. Lenses which do not break up light badly are called achromatic.

Another lens is the meniscus, which is concave one side, and convex the other. If it is thicker in the middle than near the edges, it is positive, or magnifying. But if thinner at the middle, it is negative, or reducing, like "B" and "D" in Fig. 1.

Focal Lengths

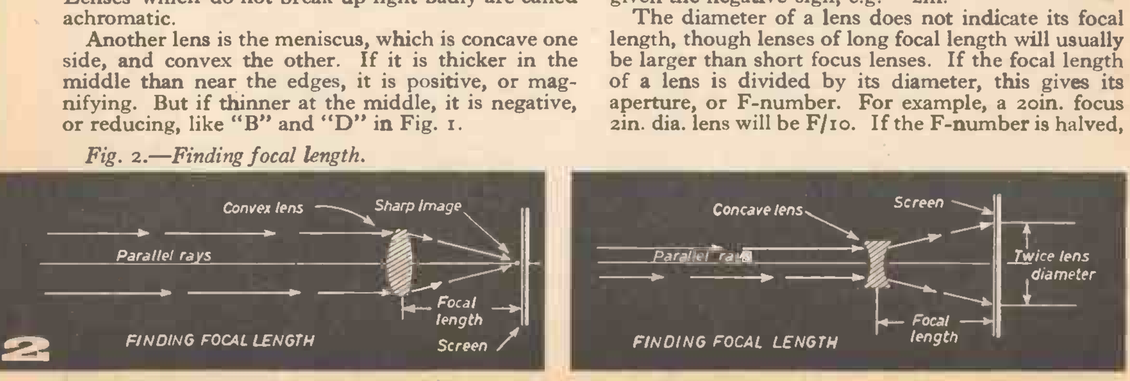
The magnification of the telescope or other instrument will depend largely on the focal lengths of the various lenses. If some lenses are to hand, the approximate focal lengths can be found as shown in Fig. 2.

Double convex, plano-convex, or convex meniscus lenses will throw a real image. When parallel rays enter the lens, the distance from lens to image is the focal length. The parallel rays should theoretically come from an object at infinity. In practice, some bright object a good distance away (such as the sun, or a distant lamp at night) will be convenient. White paper may be used for the screen. The distance between lens and screen is adjusted until the image is sharp, then measured. Lenses of long focal length have less sharply curved surfaces than do lenses of shorter focal length.

Negative lenses do not throw an image. Their focal length may be found with sufficient accuracy by measuring their diameter with compasses, and using this setting as the radius to draw a circle on the paper. That is, the circle is twice the diameter of the lens. The distance between lens and paper is adjusted until rays from a bright distant object are spread to fill the circle. The focal length is then measured, as explained. The focal length of negative lenses is often given the negative sign, e.g. -2in.

The diameter of a lens does not indicate its focal length, though lenses of long focal length will usually be larger than short focus lenses. If the focal length of a lens is divided by its diameter, this gives its aperture, or F-number. For example, a 20in. focus 2in. dia. lens will be F/10. If the F-number is halved,

Fig. 2.—Finding focal length.



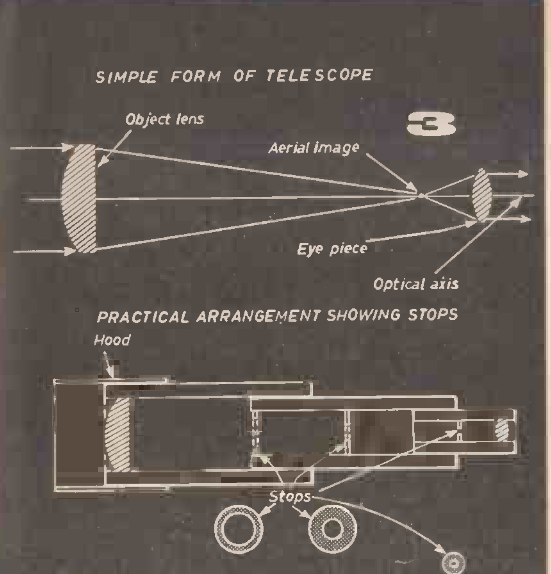


Fig. 3.—Simple form of telescope.

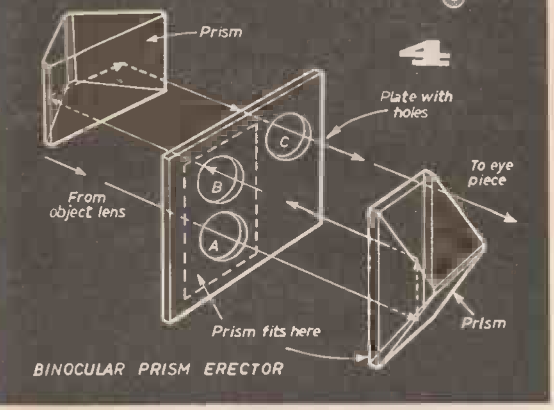


Fig. 4.—Binocular prism erector.

the light transmitted is multiplied by four. A telescope with a 20in. focus 2in. dia. object lens (F/10) would thus provide four times the brilliance of one using a 1in. dia. 20in. focus lens (F/20). Both would, however, give the same magnification.

Telescope Magnification

The simplest form of telescope is shown in Fig. 3. To find its magnification power, divide the focal length of the object lens by the focal length of the eye-piece. For example, a 15in. focus objective and 1in. eye-piece would give × 15.

It will be seen that magnification can be increased by using an object lens of longer focus, or an eye-piece of shorter focus. For example, a 30in. focus object lens with the 1in. focus eye-piece would provide × 30. The 15in. object lens with a ½in. eye-piece, would also give × 30 magnification.

The object lens throws an image, as described for Fig. 2. If a screen were placed here, this image would be seen. Instead, however, the eye-piece is focused upon this point, termed the " aerial image " in Fig. 3. The tube length needed, for infinity, is thus seen to be the object lens focal length, plus the eye-piece focal length. For objects nearer than infinity, the eye-piece has to be slightly farther from the object lens. A sliding tube or similar means of adjustment is thus required.

Stray light reflected from the inside of the telescope, etc., would degrade the image. To prevent this, stops are placed at fairly frequent intervals, as in Fig. 3. The holes in these stops are just large enough to allow the required light rays to pass. The stops and inside of the tubes should be painted dull black.

Definition of the simple telescope can be improved by using achromatic lenses. The eye-piece may consist of two lenses, close together. Two lenses close together have a shorter focal length than either used singly. The combined eye-piece thus has a short focal length, which gives more magnification, with a given object lens, as already described.

The telescope in Fig. 3 is termed an astro, or astronomical telescope. It inverts the image. This is frequently considered of no importance in astronomy, but would be very undesirable for a terrestrial telescope. For this reason, the latter type has an erector system, which results in the image being the right way up. A terrestrial telescope can, of course, be used for astronomical observations.

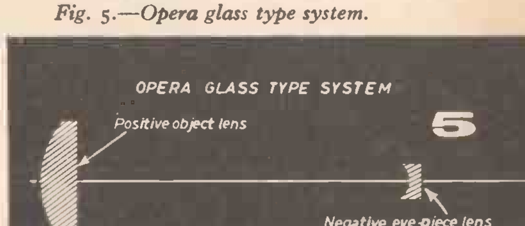
In a telescope, lens erectors are usually employed, and are described later. An erector is practically essential in a telescope for ground observation, to provide an upright image. But there is some loss of light, and possibly of definition, in the erector system. It may therefore be decided to omit any erector lenses, when the telescope is for celestial observation only.

Binoculars

These are virtually two small telescopes, side by side. They may have individual focus, or may be coupled by a common focusing mechanism. Binoculars are usually given figures which denote the magnification, and object lens diameter in millimetres. For example, a 6 × 30 pair have a magnification of 6, and the working diameter of the object lenses is 30mm.

For a given power, larger object lenses gather more light, and thus give a brighter image A simple way of comparing brightness is to divide the object lens diameter by the magnification. The larger the resultant figure, the brighter the image. For example,

Fig. 5.—Opera glass type system.



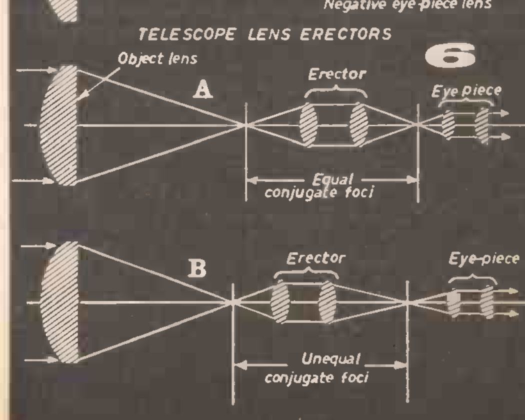


Fig. 6.—Telescope lens erectors.

with the 6 × 30 binoculars, the result is 5; with 10 × 40 binoculars, the result is 4. The 10 × 40 binoculars would thus magnify 10 times, compared with 6 for the 6 × 30 binoculars, but the relative brightness would only be 4, compared with 5. This figure may be converted to geometrical luminosity by squaring it, which gives 25 for the 6 × 30, and 16 for the 10 × 40 binoculars.

The same calculation can, of course, be used with a telescope. Magnification can be found as described, and the working diameter of the object lens can be measured.

Binoculars are used for ground work, and an erect image is needed. Prism erectors are usually employed, and Fig. 4 shows how they are arranged. Light from the object lens passes through hole A, and is reflected back through hole B, where it reaches a second prism, which directs it through hole C. From there, it goes to the eye-piece. The prisms are mounted directly on the plate, or may be fixed together without a plate. One such assembly is necessary for each half of the binoculars. The prisms give no magnification, but result in the image being upright. It is possible to use prisms in this way in a telescope, and the instrument is then termed a prismatic telescope. A lens erector system is then not needed.

Another method of obtaining an erect image is shown in Fig. 5. The eye-piece is a negative lens, of shorter focal length than the positive object lens. As a result, this simple system gives an erect image. It is, however, limited to a useful magnification of about 2× to 4×. It can have very good light transmission, and is thus often used in compact " opera " glasses, where limited magnification and a bright image are satisfactory. The object lens, or both object lens and eye-piece, should be achromatic, for best results.

Lens Erectors

Fig. 6 shows an erector consisting of two similar small lenses, fixed a small distance apart. The telescope tube is longer, so that the erector system can focus upon the aerial image thrown by the object lens. After passing through the erector, this image is turned over again, and is thus seen the correct way up.

Conjugate foci are those two distances from the lens which result in sharp focus. Referring to Fig. 2, one focal point will be very far away indeed, while the other is on the screen. As the object in front of the lens is brought nearer, the screen has to be moved slightly farther away, to maintain sharp focus. This continues until both object and screen are at the same distance from the lens. The distance from the object to the lens, or from the lens to the screen, will then be twice the lens' focal length. That is, the object will be four times the focal length of the lens away from the screen.

This is the condition of equal conjugate foci, shown at "A" in Fig. 6. The magnification of the telescope is then unchanged, though the image is erect.

If the object were now brought even nearer the lens in Fig. 2, the screen would have to be farther away, but the image on the screen would be enlarged. The conjugate foci now provide additional magnification, as shown at "B" in Fig. 6. As the distance between object lens and erector is very little changed, the telescope tube must be longer, to allow the eye-piece to be farther from the erector.

Practical Tests

When experimenting with various lenses, a simple optical bench will be useful. In its most easily constructed form, this can be a board with V-groove, or two pieces of board nailed together to form a V-groove. Lenses can be set up in this groove, and held in small pieces of Plasticine. Various combinations can then be tried, and measurements taken.

Very high magnification is easily obtained, but is not wise with small lenses, because the brightness will probably be too low. When high magnification is wanted, a large diameter object lens is needed, as this gives a brighter image, as explained.

Lenses may have one flat side, or unequal curvature. If so, the effect of turning over the lens should be tried. With simple lenses, the breaking up of light described cannot be eliminated. But if definition is very poor, check that the various lenses are as accurately as possible along the same optical axis, and not tilted or twisted.

For a fairly small telescope, the object lens will usually be about 15in. to 30in. focus. Lenses of much longer focus are used when high power is required. The lens will usually be some 1in. to 2in. in diameter, for a small telescope, though 2in. to 3in. will allow a brighter image to be obtained, as explained. For binoculars, or a single binocular-sized telescope, a much smaller object lens would be satisfactory, with a focal length of some 6in. to 8in. or so.

A positive eye-piece will usually have a focal length of 1in. or less. Short focal lengths increase magnification, but reduce brilliance. A pair of plano-convex lenses fixed with the convex surfaces facing each other will be suitable. Using two equal lenses, a suitable separation distance will be two-thirds the focal length of one lens.

Very many eye-piece combinations exist, with a view to obtaining high magnification, with good definition. When really excellent results are essential it is best to obtain a complete eye-piece. This will have two, three, or more lenses, accurately fitted, and arranged to compensate for each other. However, perfectly satisfactory results are obtained with home-made eye-pieces, if a little care is exercised.

A SELF-TENSIONING TRIPOD

—by J.C.Lowden

"THIS tripod," says its designer, J. C. Lowden, " folds into a small space, is light, compact and, most important of all, stable. It can be made at home using simple hand tools."

Construction

Each leg consists of three members, the split lower member and two upper side members. Use only well-seasoned hardwood, such as oak, ash or mahogany, for their construction.

Prepare one length of timber measuring 25in. × $\frac{7}{8}$in. × $\frac{13}{16}$in. Set a marking gauge to half width of the broader face ($\frac{7}{8}$in.) and scribe a line down the length of the timber, from one end, for a distance of 20in. Along this line cut a fine saw-kerf through the thickness of the timber. The saw-kerf should be kept to minimum width. A fine-set, sharp tenon saw will remove the least wood, but many workers will prefer to have the cut " circular sawn," possibly at the timber supplier's.

At the lower (closed) end of the saw cut a No. 8 woodscrew, $\frac{5}{8}$in. long, well countersunk and fully driven, will preclude any accidental splitting of the member.

A notch measuring $\frac{1}{4}$in. wide by $\frac{1}{4}$in. deep must be cut across the upper end of the member. The length ($\frac{7}{8}$in.) of this notch must run transversely across the saw-kerf, as shown inset in the sketch. The unsawn " foot " should be tapered off gently to a round section at the end. (See Fig. 1a.)

The Upper Side Members

Prepare two pieces of wood, each measuring 25$\frac{1}{2}$in. × $\frac{13}{16}$in. × $\frac{7}{16}$in. (see Fig. 1b). Round off the lower ends. Working on the broader face, set a mortice gauge to a $\frac{1}{4}$in. chisel. Scribe a double gauge line on the working face, beginning from the rounded end, for a distance of 4in. Square across at a distance of 1in. from the rounded end. Beginning from this line, work a groove exactly $\frac{1}{4}$in. wide and $\frac{1}{4}$in. deep along the face of the timber for a distance of 3-4in. The groove should " step-down " quite abruptly at the lower end, but at the upper end of the groove the " floor " may rise gently. At the upper end of the groove too the walls should be cut away to form finger recesses.

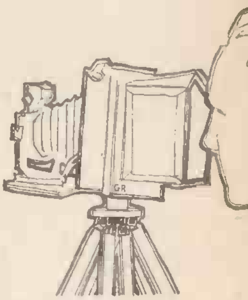
A shorter groove to accept the free end of the spacer rod must be worked in the opposing face of the other upper side member.

At the upper (square) end of the first member, on the working face, gauge a line centrally, from the end, for a distance of 6in. along the length. Beginning at a point 1$\frac{1}{2}$in. from the square end, using the heel teeth of the tenon saw, cut a clean saw-kerf 4$\frac{1}{2}$in. long and $\frac{1}{2}$in. deep. This cut should be $\frac{1}{16}$in. wide, as it is to accept a thin locking bar. At the lower end of the saw-kerf, work similar finger recesses to those on the lower groove, this time to give access to the locking bar.

A similar saw-kerf must now be cut on the opposing face of the other upper side member.

The spacer rod is merely a length of metal rod 2$\frac{3}{4}$in. long × $\frac{1}{4}$in. dia. At a point $\frac{1}{8}$in. from one end, drill a pivot hole large enough to accept a stout panel pin. Round off this end and square off the free end. Fit as shown, crop off the projecting head of the pin and punch down neatly.

The locking bar is prepared from a scrap of metal $\frac{1}{16}$in. thick, 1$\frac{1}{4}$in. long × $\frac{1}{4}$in. wide. Notch at one end, and drill at the other, as shown. Drive a panel pin through to act as a pivot. Another pin to engage the notch must be positioned in the other upper side member, in the same way.



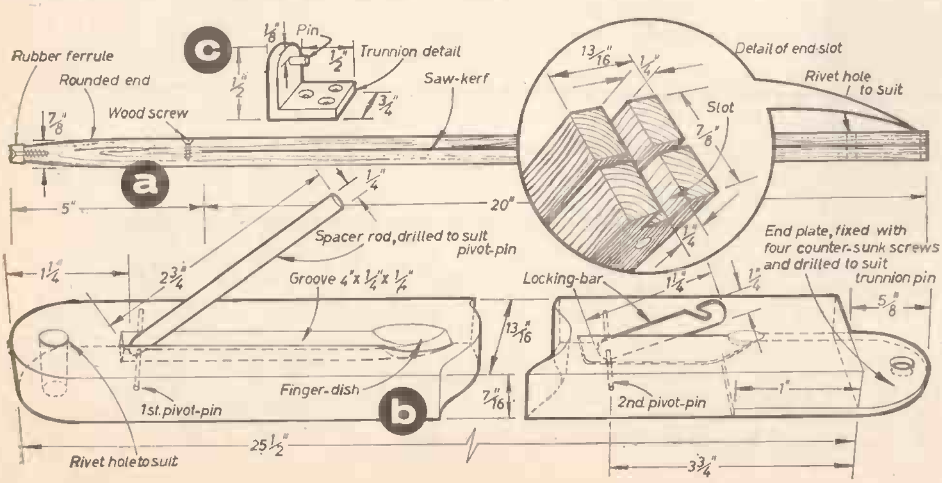


Fig. 1.—(a) Lower leg split member. (b) Upper leg side member fitted with spacer rod. (c) Details of the trunnion.

The Upper Plates

Prepare two similar plates from metal of about ⅛in. thick, 1⅝in. long, and 13/16in wide. On the centre line, ⅜in. from one end, drill a hole ⅛in. clear dia. Draw a line across ⅝in. from the same end. This length will project above the end of the upper side member, and should be rounded off. Rebate the end of the wood and secure with three or four woodscrews.

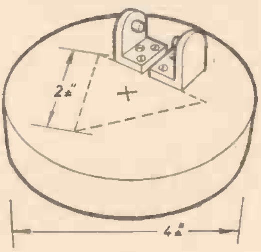


Fig. 2.—The underside of the tripod table with one pair of trunnions in position.

Assembly

Provide two metal rivets at least 1in. long and not exceeding 3/16in. dia., with a single fine washer for each. Drill the two lower members, at the rounded ends, to accept these rivets. The centre of the rivet hole should be ½in. from the extreme end of the member.

To locate the rivet holes in the lower split member, place the two members together and set the spacer firmly and squarely across the notch. Mark off through the rivet hole in the side member and drill. Before riveting, give the wooden parts one or two thin coats of French polish. Do not attempt to interpose a washer between the side members and the split member. Close up the rivet firmly so that there is a positive hold between the members, just allowing a pivoting action.

Repeat the entire operation twice more to make three legs.

The Trunnions

Each trunnion is made as shown at Fig. 1c from a ¾in. length of ½in. angle. One face is drilled and countersunk to take two stout woodscrews. The other face is drilled centrally and tapped ⅛in. Screw into this hole a small bolt for the full extent of the thread, leaving the unthreaded shank protruding within the angle. Cut off most of the thread which protrudes, and spread over the remainder to form a screw rivet. Cut off the head of the bolt, leaving about ¼in. protruding within the angle. Provide six such trunnions, rounding off the bearing face of each.

The Tripod Table

This is made from a disc of stout plywood of about 4in. dia. (Fig. 2). Around the centre of the disc, describe an equilateral triangle of sides 2in. The trunnions are located evenly, in pairs, along these sides, with 1¼in. between each pair of bearing faces.

These measurements will vary slightly for each individual worker, because of differences in timber, etc., but they are a useful guide. The trunnion pins will also have to be adjusted for length in each case.

The reader's favourite style of pan and tilt head, ball and socket camera carrier can be secured to the upper surface of the tripod table in the manner most suited to himself.

A pair of light straps of webbing or leather will secure the three legs into a compact block for storage or carrying.

A Morse Practice Set

By Jameson Erroll

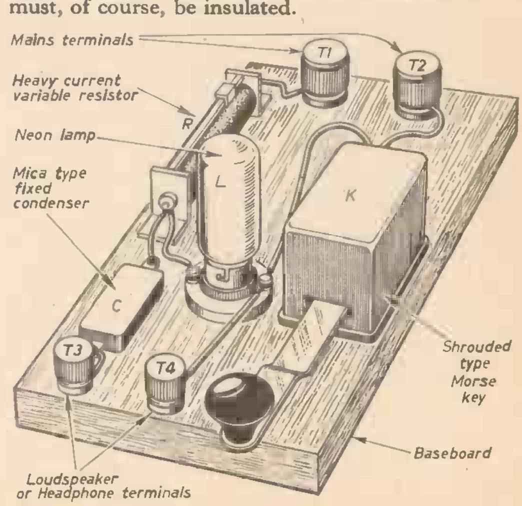
A NEON lamp is capable of generating high-frequency oscillations and, with the aid of a simple auxiliary apparatus, can be made to generate almost any frequency.

The apparatus shown in the sketch is connected to the mains and will work a loud speaker (low resistance for preference) or, of course, head-phones. T1 and T2 are mains terminals; R a variable grid leak of from 0.25 to 7 MΩ of the carbon-pellet variety since it has to carry a relatively heavy current; L is the neon lamp; K is the morse key; C a good quality ruby mica condenser of from 0.003 to 0.005 μF capacity; and T3 and T4 are the loudspeaker or head-phone terminal.

Care must be taken to shroud live terminals and connections and the key should have an ebonite knob and all metal parts enclosed in some form of insulated casing.

The lamp will pass less current when the smaller element appears to be glowing. Tuning by means of the variable grid leak will bring the note to the desired pitch; it can be varied from a few ticks per minute to many hundreds. A high pitch is more audible than a low one and is much easier to read.

By duplicating the apparatus and connecting the local terminals T3 and T4 to the distant speakers, two people may communicate with each other over a considerable distance, either from separate rooms or from each end of a garden; these connecting wires, must, of course, be insulated.



A TAPE recorder presents a particularly interesting problem to the amateur constructor, for it involves problems of widely differing kinds: electrical and electronic as well as the purely mechanical. It is hoped in this article to cut these problems down to size.

The suggestions which follow are made with the intention of *simplifying the construction*, but there is no reason why the result should not be comparable with the best domestic recorders in performance, if not ease in operation, assuming sufficient care is taken in building.

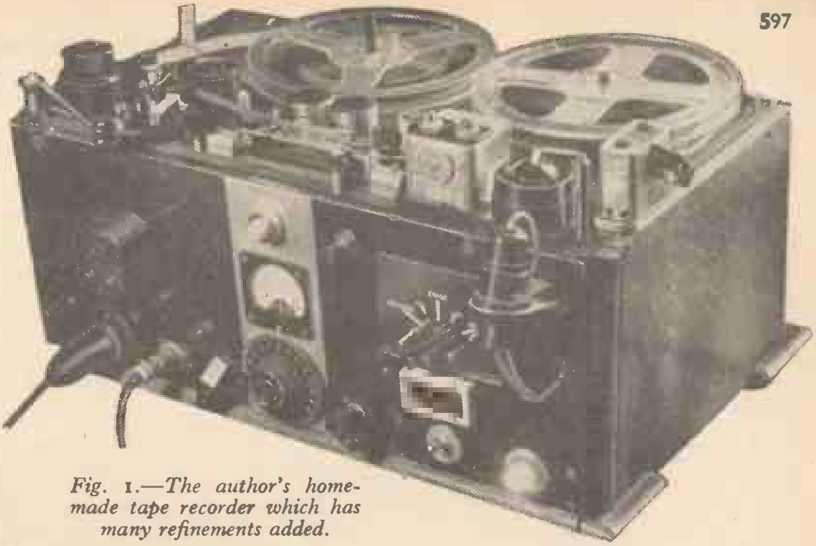


Fig. 1.—The author's home-made tape recorder which has many refinements added.

Building a TAPE DECK

BY J. H. B. GOULD

Only the "bare bones" of the machine are given, but these essentials allow a wide scope for future additions and refinements. Fig. 1, in fact, shows such a recorder, built in 1955, which has been subsequently modified both to increase its scope and to make operation easier.

Layout

The general form of the proposed layout can be seen from Fig. 2. The centres of the tape spools must be over 7½in. apart from each other and more than 3⅝in. clear of capstan, tape heads and other objects projecting above the deck.

The distance between capstan and heads must be kept as small as possible to avoid vibrations in this, most sensitive, stretch of tape. Unfortunately, the capstan motor gives rise to a magnetic field which can be picked up by the replay head to produce an objectionable "hum" and this, together with the previous consideration, can present a dilemma. The hum field due to the motor is largely directional in effect, however, so that any hum due to this cause may well be reduced by "swinging" the whole motor about the capstan spindle, fixing it temporarily and testing, until a position is found where the hum is at a minimum. It may be further reduced by mounting the power transformer feeding the electronics as far from the heads as possible.

Capstan Motor

The capstan is the pulley which draws the tape past the heads, the tape being held in contact with the capstan by means of a rubber-faced pressure roller. The prime requirement of the motor driving the capstan is constancy of speed, without short term variations or long term drift. It is perfectly possible to use a *geared* gramophone motor to which must be added a capstan of suitable size in place of the turntable. The recorder illustrated in Fig. 1 employs a variable speed type of gram motor without turntable, and the short term speed variations appearing under use were measured as of the order of 0.1 per cent.

Capstan

The capstan itself can be turned from any reasonably hard material: metal, plastic or even wood. The diameter depends on both the gram motor speed and the desired recording speed (see table 1). The usual choice of tape speeds for domestic recorders is between 1⅞ and 3¾in. per second; the former being economic, the latter providing a higher maximum recording sound frequency useful for recording music. Both these alternatives could be made available by means of interchangeable capstans or a single stepped capstan arranged to slide vertically on the motor shaft.

The arm carrying the pressure roller must be of rigid construction, as any uncertainty in its shaft tends to cause the tape to wander up or down the

TABLE 1

Tape Speed (inches/sec.)	Capstan Speed (r.p.m.)	Capstan Diameter (inches)	Take-up Pulley Diameter (inches)
1⅞	78	0.46	4.3
	33⅓	1.07	1.9
3¾	78	0.92	2.2
	33⅓	2.13	0.95
7½	78	1.84	1.1
	33⅓	4.25	0.47

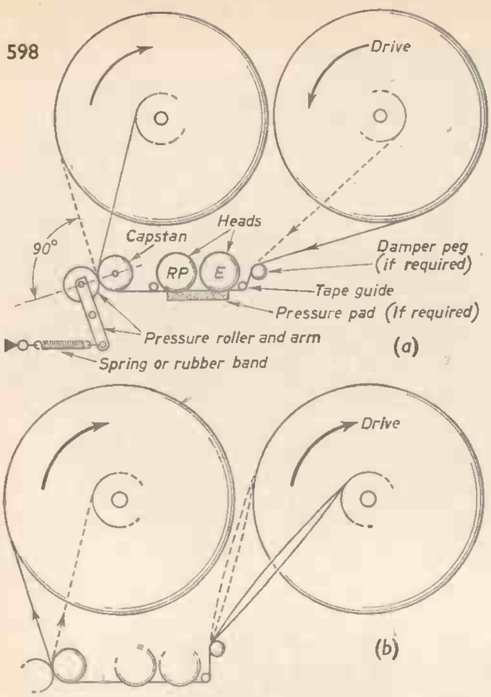


Fig. 2.—Suggested layouts.

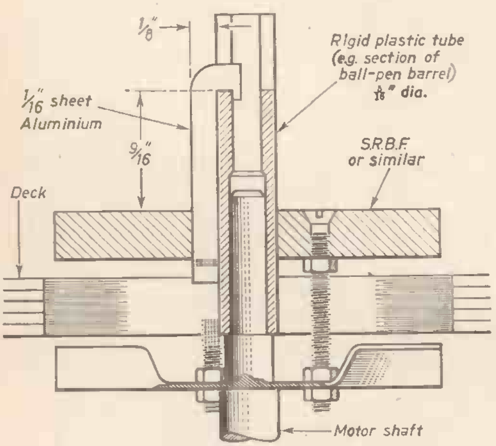
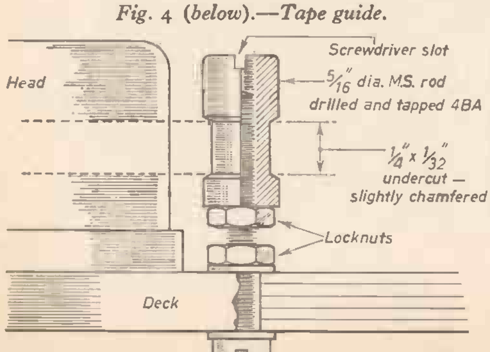


Fig. 3.—Suggestion for feed and take-up reel mountings.

Fig. 4 (below).—Tape guide.



capstan. A double arm with twin bearings is the safest design. The simplest journal or needle bearings are suitable for the pressure roller as long as they are capable of withstanding the thrust. Ball or roller bearings should not be used due to the noise they generate. Failing anything more elegant for the rubber tyre of the roller, a ⅛in. layer of black insulating tape will serve, if the overlap is smoothed down with a file.

Feed and Take-up Spindles

The feed spool is accommodated on the shaft of the re-wind motor, (see Fig. 3). The best type of motor for this duty is a small induction motor such as is used to drive a gramophone (less any gearing). The commonest form of gramophone motor has a clockwise drive, which is unfortunate. A few motors of this type having anti-clockwise drive are available and, if one of these can be obtained, so much the better. If not, the difficulty can be solved by the method suggested in Fig. 2(b) which demands a twist in the tape. If this method is adopted, sufficient distance should be allowed between the full reel *in situ* and the entrance to the head unit to allow this twist to be maintained, especially on fast rewind. 6in. or 7in. between the reel centre and the input guide should be enough for this purpose. Additional guide pegs or rollers may be necessary, but this is unlikely.

Regardless of the particular direction of rotation of the motor chosen, the principle remains the same, namely: that with the tape in place, *the motor must drive in a direction opposed to the normal run of the tape through the machine.*

Apart from its use in fast rewind, this motor is lightly energised throughout the whole time that the recorder is switched on (see Fig. 5), this prevents the reel pulling round in jerks while the tape is running and also holds the tape under slight tension. No mechanical braking of any kind is envisaged. For this reason, the tape takes a finite time to stop when the drive is removed. This time lag may be a fraction of a second or even two seconds. If such a delay is considered objectionable some from of mechanical breaking or capstan declutching can easily be designed. It should be noted, however, that any vibrations arising from mechanical braking or control will be transmitted to the tape and will thus appear in the output; so that neither should be applied during normal running.

The Take-up Spool

Unlike the feed spool, its drive is not critical as regards vibration in the tape. Moreover, the drive is clockwise in direction.

Two forms of drive for this spindle are possible. In the first, power is taken from a pulley mounted on the capstan shaft and transmitted via a spring belt to the take-up spool. Assuming a capstan pulley diameter of 2in., the appropriate take-up pulley diameter is given in Table 1. As the effective diameter of the take-up spool continually increases as the tape is wound on, some form of friction drive between pulley and spool is necessary. The problem here is that the clutch must have sufficient stiffness to drive the spool under the high-slip conditions existing when the reel is fully loaded whilst still allowing it to be driven back by the tape on fast-rewind. Needless to say, this

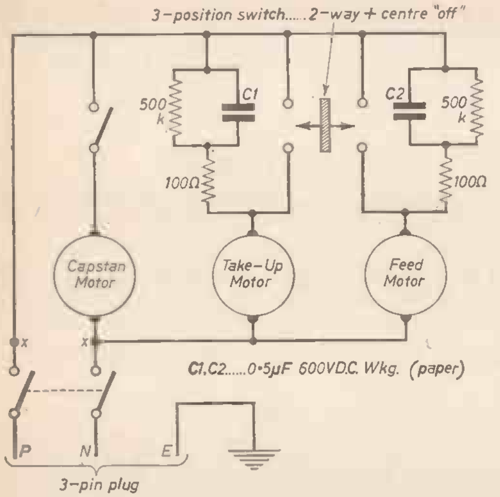


Fig. 5.—Power circuit diagram.

method of drive offers considerable scope for ingenuity.

A far more satisfactory form of drive is by means of a separate motor, and in this case a fast-forward drive can be arranged (see Fig. 5).

Heads

The record/replay (RP) head consists essentially of an electromagnet having a gap width of less than one thousandth of an inch, and it is across the edges of this gap that the tape is drawn in order to record or play back. The common form of erase head is similar in appearance, but with a wider and longer gap. The magnet gaps are stabilised by the insertion of metal shims which can be seen in the highly polished surface of the pole-pieces, and it is these which must be brought into contact with the moving tape.

In setting up the heads, they should be mounted with the above mentioned gaps as nearly vertical as can be judged, and level with each other (with the vertical centre of both RP and erase pole-pieces the distance above the deck).

Unless long leads are necessary between tape deck and amplifier, a high-impedance head winding is to be preferred. Although it is being assumed that two heads are to be used (RP and erase) there is a large choice of differing types and combinations available. For example, three separate heads may be employed or all three functions may be combined into one head. Your supplier will doubtless be pleased to advise you on a suitable choice.

Remember that the quality of the RP head chosen will set a limit to the quality of the whole recorder so, before you buy, think what your aiming for. If your purpose is to record music you will need to pay more than would be necessary for a head to copy dictation. If you are a " hi-fi " enthusiast, the cost will be still greater.

Mu-metal or alloy screen-cans are often available to help in cutting down interference from stray magnetic fields. Although it is good economics to try the recorder before buying these, it is good sense to leave enough room about the heads to accomodate them should they later be found necessary.

One final word about the tape heads themselves.

(Concluded on page 604).

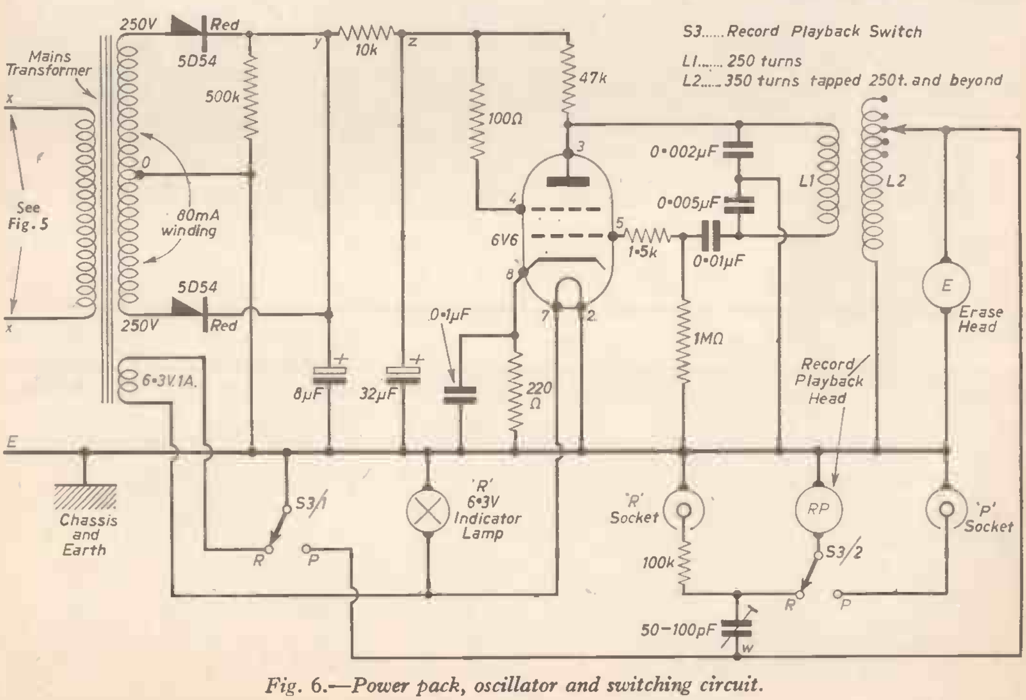
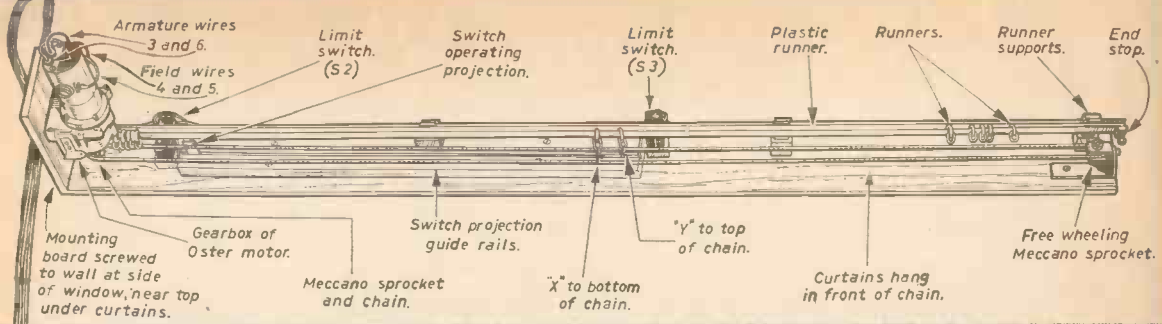


Fig. 6.—Power pack, oscillator and switching circuit.



AUTOMATIC operation of curtains

The curtains close and open with dusk and dawn. By E. V. King

THIS device will automatically draw the curtains in a room or a house at dusk, according to a pre-set photo-transistor control. When dawn arrives the curtains will automatically withdraw themselves to their former position.

Besides the obvious saving in labour this is a device which has certainly got the effect of making a house look occupied when it is empty.

How it Works

Refer to Fig. 1. A small electric motor operates on 24V. D.C. and is geared down to drive a Meccano sprocket on which runs an endless chain which stretches right across the window about ½in. under and ½ in. behind the plastic curtain runner. When the motor runs, one side of the chain goes one way while the other side goes in the reverse direction. The curtain (or curtain hook) is attached to the chain (see *X* and *Y* in Fig. 1).

When the motor is running the curtain is prevented from being overdrawn by the limit switches S2 and S3 which are pushed to "OFF" by a small metal strip attached to the chain which is shown in Fig. 4 pushing S2 OFF. The gap between S3 and S2 is the amount the curtains will be moved. The motor will reverse if the connections to the field winding are reversed. This is done automatically with darkness or light by the control box. At the same time the control box bridges the limit switch contacts so that once reversed the motor will start as required.

Any number of curtains may be pulled either way; the practical limit is about 8ft. and is dependent on the strength of the endless chain. The motor is more powerful than is really required, but gives a slow steady motion unlikely to tear the finest of fabrics.

Adapting the Oster Motor

All the mechanism working the push rod and tappets is removed and both cams are cut off, leaving ⅜in. of shaft on one drive. This operation can be done by holding the *cam*, not the motor, in the vice and using a hacksaw. However, the bearings inside are very brittle and it is best to take the gearbox to pieces, noting where the parts go and to cut the cams off while the bearings are quite free to move.

A small toy construction kit sprocket is then drilled to fit the projecting spindle and soldered in place using Baker's Fluid flux (Fig. 1).

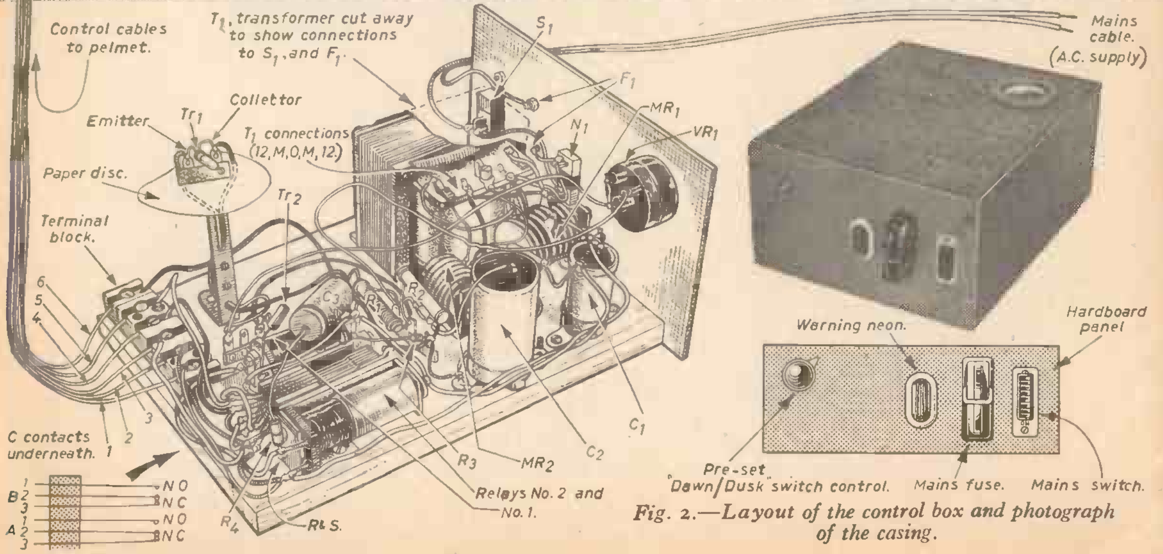
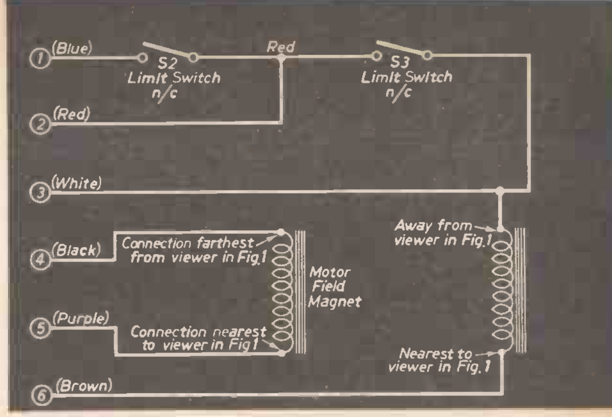


Fig. 2.—Layout of the control box and photograph of the casing.

Fig. 1 (Left).—The motor, chain drive and curtain runner fitted with limit switches.
Fig. 3 (Right).—Circuit of motor and limit switches under pelmet.



WORKING NOTES

The cost of the unit in consumed electricity will be little more than 1d. per week. It is left "on" continually.

The transistor is sensitive to heat and must not be placed in a hot place near a stove or fire, in a very hot loft or in *direct sunlight*. There is plenty of tolerance on working conditions and heat-wave periods will not give trouble.

The chain drive should be lightly oiled, but do not oil the fibre gears in the gearbox.

The motor is attached to a small board by passing screws through into the four holes behind the gear-box and the one behind the motor. This board will be fixed eventually on the left of the window, near the top, and may be covered (or almost covered) by the pelmet.

The motor field connections have to be severed to allow for external connections (labelled 4 and 5 in Fig. 1). Fig. 7 shows the two wires labelled "*F*" which have to be cut or unsoldered. The other wires must all be left intact.

Fixing the Chain Mechanism

The chain is not quite suitable as purchased and each link must be slightly closed up with pliers to make it more solid and stretchless. It need not be freely flexible as there is plenty of power available. Lengths are joined to make the requisite circle as in Fig. 1. A small bracket is made up to take another sprocket mounted on a spindle or nut and bolt and this is fixed on the other side of the window alcove (see Fig. 1).

A small metal plate is cut roughly to the plan of Fig. 5, using metal between $\frac{1}{16}$in. and $\frac{1}{8}$in. thick. This is bolted to the chain tightly and the bolts slightly riveted and filed smooth. The purpose of this metal strip is to actuate the spring levers of the limit switches (see Figs. 1 and 6).

Although the mechanism will function without, it is as well to fit some wooden guides (Fig. 5 (b)) to keep the metal strip on a horizontal path so that it cannot get out of alignment with the limit switches.

Fixing the Micro-switches

These may be fixed in any position provided that they will be operated by the metal strip on the chain and the distance between the spring leaves is exactly the pulling distance required on each curtain. Note, all curtains on one length of chain will pull the same distance either way.

The Control Box

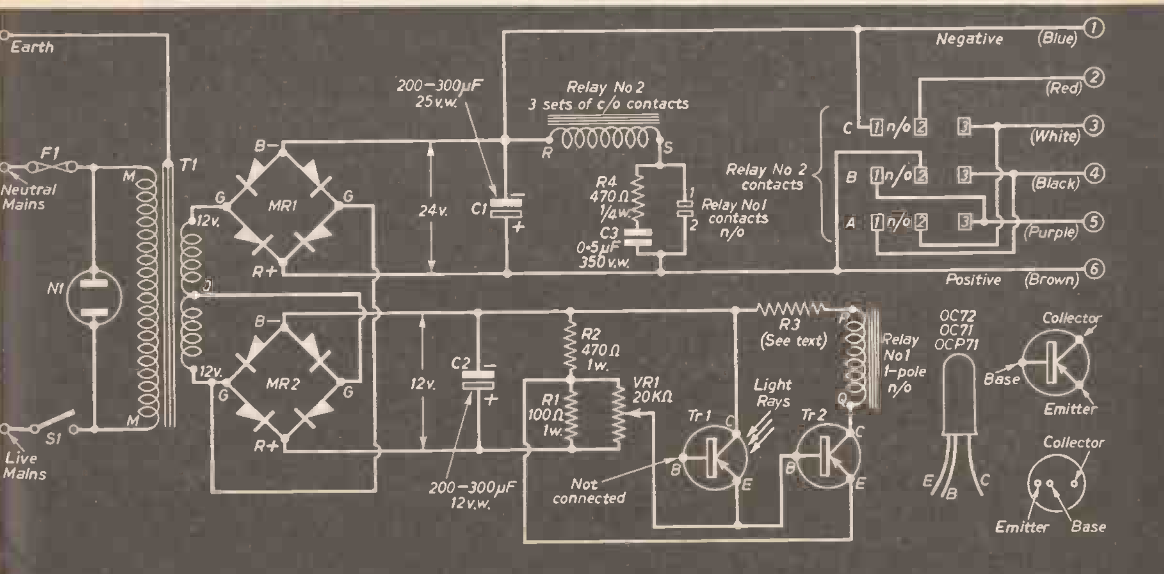
It is possible to do away with some of this and to use a time switch. The light control, however, does take account of the actual conditions prevailing. In dark stormy weather the curtains will be drawn somewhat earlier; time switches will not do this.

The prototype box made by the author is shown in Figs. 2 and 8. The case is made of wood, hard-board and peg-board. Adequate ventilation must be provided and the small watch-glass window can be in any suitable position. The unit shown is made to be placed on a cool window-sill situated under the stairs. Naturally it cannot be placed where room lights will operate the curtains! Sufficient data for construction is shown in Fig. 8.

Mounting the Components

The layout is in no way critical. The box completely wired and the component positions are shown in Fig. 2. Dimensions of the panel holes for the parts used (see the parts list) are given in Fig. 8.

Fig. 4.—Circuit of control box.



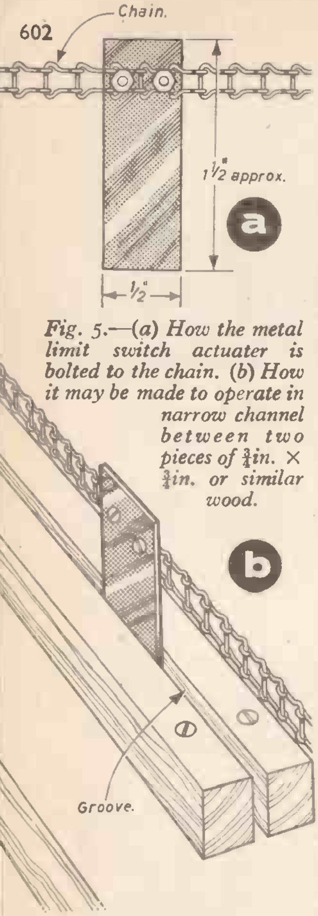


Fig. 5.—(a) How the metal limit switch actuater is bolted to the chain. (b) How it may be made to operate in narrow channel between two pieces of ¾in. × ¾in. or similar wood.

The rectifiers are mounted on brackets; make sure there is air space all round and that the original tension of the plates, as set by the manufacturers, is not altered. Inspect them before mounting to be sure of the red, black and green tags.

The electrolytic condensers are mounted on clips which should be obtained when ordering the components. R1 and R2 are soldered (use cored solder only) to the tag strip as shown in Fig. 2.

The transistor (Tr2) is soldered to the other tag strip by the two wires which are near together (base and emitter of Fig. 4) as shown in Fig. 2. Transistor, Tr1, has the centre lead cut short and it is soldered to a tag strip as shown. There is no connection to the base of Tr1. This tag strip is mounted on a piece of strip metal so that when the cover of Fig. 8 is put on the photo transistor (Tr1) lies horizontally under the glass with the collector junction uppermost (if in doubt do not worry at this stage). A piece of white paper may be placed under Tr1 if used in dim lighting conditions.

The transformer is firmly mounted after an inspection to make sure of the mains and the 12-0-12 voltage points. If it is a 12V. transformer with two windings they must be joined in series (in phase) and the resultant voltage must be 24V. If connected out of phase the resultant voltage will be zero. Check on a lamp or A.C. voltmeter.

The Relays

Relay No. 1 is of vital importance. If the one used in the prototype becomes unavailable, Relay No. 371 from Messrs. A. T. Sallis, 93 North Road, Brighton, whilst heavier, will be ideal. The points may have to be changed round; one is metal and one plastic. Relay must be normally open.

Before mounting the relay make sure of the coil connections (P and Q) and the contact connections. If the resistance of the relay is less than 1,000Ω a resistance to make it up to this value must be inserted in one coil lead (R3). It is not required with the 371 relay mentioned.

Testing Relay No. 1

This relay must be tested as working before fixing. Connect the coil to a battery of 4V. Adjust so that the relay pulls in nicely and the contacts make. Remember to insert R3 if necessary. With the Siemens H.S. type adjustment is very critical and if it will work on 6V. it will suffice, but aim at 4V. operation if possible. Make sure the relays do not stick in. If they do, the " normal " contact should be screwed in to hold the armature off the magnet. It is *useless* to build the unit unless this relay is properly adjusted.

Relay No. 2

If purchased from a reputable dealer no testing will be required. A mounting bracket has to be made and the contacts very carefully sorted out before mounting.

In the wiring diagrams the contacts are numbered. The centre contact of each set is numbered 2, and the normally open contact is marked 1 whilst the normally closed contact is marked 3. (Fig. 2, bottom left).

Thus in each case contact 2 is connected to 3 when the relay is not energised and to 1 when it is.

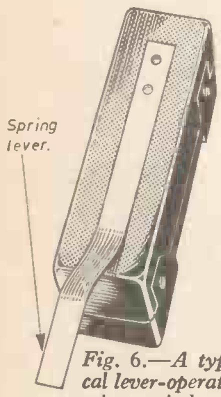


Fig. 6.—A typical lever-operated micro-switch.

Wiring

Use Polythene-covered copper wire. If it is stranded, be very careful with the connections to the No. 2 relay to ensure no " whiskers " can cause short circuits. Readers with theoretical knowledge can work directly from Fig. 4. The positions of the actual wires on the board are unimportant. Others may get help from the perspective drawing.

Testing the Unit

Having made sure the control box is working, it is fitted with the lid. A book may be used to simulate darkness by sliding it over the glass. Work near a window or under a good 150W. electric lamp.

The three Oster motors bought by the author all had windings wound in one direction, but it is possible that others do exist. If so, they may revolve the wrong way and the limit switches would not stop the motor, the chain would break or the switches would be broken. It is best to have a trial *without* the chain. The motor should then revolve either way according to dark or light.

Inspect to make sure that with the drive as it is, the chain will move the metal plate correctly to cut out the motor. Try pushing the limit switch by hand first. One will operate with light and one with dark only. If the direction of rotation is wrong all that is required is a reversal of the field connections (black and purple wires).

When fitted up, the length of draw may be altered by the gap between S2 and S3.

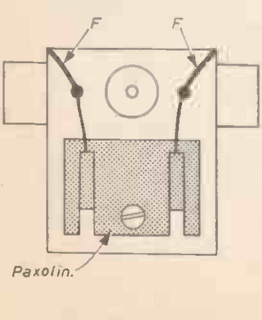


Fig. 7.—The field connections are cut or unsoldered at F and F. The other wires are left intact.

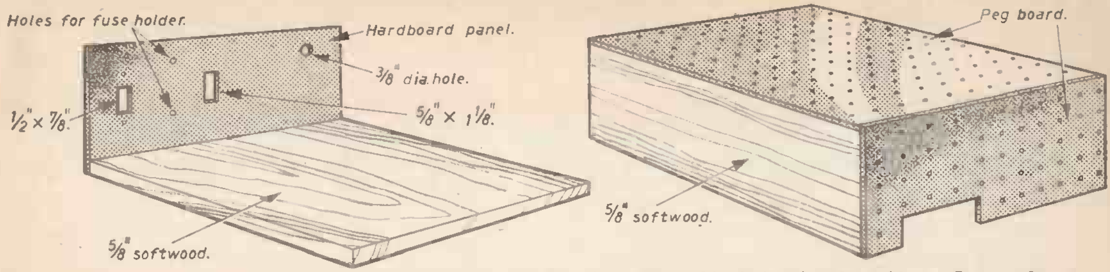


Fig. 8.—A suitable design for the cabinet. It must be well ventilated.

Operating all Curtains from One Control Box

This is done by fitting separate relays (as Relay No. 2) and motors, chains, limit switches, etc., for each set of windows. The relays are operated by an additional pair of n/o contacts on relay No. 2. Each unit will take 1A. approx. of current when running and MR1 will thus have to be made larger accordingly.

COMPONENTS

Motor. Oster type with gears and cams intact. 24V. D.C. Obtainable from numerous surplus dealers for about 20s. The prototype uses No. S137R from Messrs. Milligans, 2 Harford Street, Liverpool, and No. 863 from Messrs. H. W. English, Rayleigh Road, Hutton, Brentwood, Essex. One motor only is required per unit.

Drive. Toy construction kit chain twice the length of the curtain run and two small sprockets.

S2 and S3. Micro switches with levers. Change-over type will suit, one set of normally closed contacts is required in each case. Obtainable from Messrs. Henry's Radio Ltd., 5 Harrow Road, London, W.2.

Wiring. A quantity of coloured connecting wire is required (see text), preferably blue, red, white, black, purple and brown. Walk-round stores can often supply this.

Curtain Runners. Plastic type which are self lubricating. Obtainable at walk-round stores.

Fuse (F_1). Any small type will suit; i.e. S141f from Messrs. Milligans.

S1. Slide type mains switch. Arcolectric S645. Obtainable from Messrs Arcolectric Switches Ltd., West Molesey, Surrey, or from dealers.

Neon, N1. Arcolectric S.L.50.

Transformer, T1. Any type to suit mains, having 24V. 2A. secondary with a centre tap. Other taps will do no harm but are not necessary. NL121b from Messrs. Milligans would suit or use TMM1 from Home Radio, 187 London Road, Mitcham, Surrey.

MR1. Metal rectifier, 24V. at 1 or 2A., bridge type, full wave. Prototype uses No. 362 from Messrs. Benson, 136 Rathbone Road, Liverpool, 15.

MR2. Metal rectifier, 12V. at ½A., bridge type, full wave. Prototype uses No. 363 from Messrs. Benson.

C1. Electrolytic capacitor. 25V. working, 200 to 300μF. Any type will suit, Messrs. Home Radio's EC8A will suit.

C2. Electrolytic capacitor. 12V., 200 to 300 μF. Any type will suit or use Home Radio's EC10.

Relay No. 1. Any relay which will positively pull in on 5 or 6mA and fall out on 1 or 2mA with a resistance of 1,000Ω or less. The prototype uses one of 100Ω obtained from Messrs. W. H. English which will operate easily on 2mA. Siemens H.S.500 plus 500 ohms will suit when carefully adjusted and is obtainable from Messrs. L. Wilkinson Ltd., 19 Lansdowne Road, Croydon, Surrey.
This relay is the most important part of the equipment.

Relay No. 2. P.O. Type 3000, 200Ω, three sets of change-over contacts. Obtainable from Messrs. A. T. Sallis, 93 North Road, Brighton, Sussex, or other surplus dealers. The relay only trips once per 24 hours, so heavy-duty points are not strictly required; switching is, however, inductive at 1A.

R1. 100Ω 1W. or more.

R2. 470Ω 1 W. or more.

R3. If relay No. 1 is 1,000Ω R3 is omitted (i.e. a wire is used in lieu) otherwise R3 is made of such a value as to make the relay up to 1,000Ω. In the prototype it is 680Ω. ¼W. is suitable.

R4. 470Ω ¼W.

C3. Paper type condenser, 0·5μF. 350V.

VR1. Potentiometer, 20KΩ in prototype, 10KΩ will suit.

Tr1. Photo transistor. Mullard OCP71 will suit. Prototype uses ordinary OC71 with the paint scraped off.

TR2. Mullard OC72 or similar.

Terminal Block. 6 terminals. Any type will do or use two of block 263 from Messrs. H. Franks, 58 New Oxford Street, London, W.C.1, or use a tag strip.

A few odds and ends are also required; strip metal, tag strips, watch glass 2in. dia. or a similar piece of Perspex, nuts, bolts, screws, washers, wood, peg board, hardboard, insulating tape, etc.

A SPACE OBSERVATORY

(*Concluded from page 571*).

components are fed into the electronic system which includes auto-coincidence circuits. These circuits, when commanded to do so from the ground, will cancel out all light flashes not related to incoming gamma rays from the forward direction.

The electronic system is quite versatile in that the experimenter on the ground can, by issuing the proper commands, observe other particles impinging on the telescope. The experimenter can also observe the performance of different parts of the electronic system.

Orbital Data

Explorer XI was launched from Cape Canaveral by means of a Juno II rocket, into a planned elliptical, low inclination orbit in order that (1) the initial spin axis of the payload would be in such a direction that the telescope would scan the sun during the early part of its lifetime; (2) it would have a lifetime in excess of six months; and (3) an appreciable fraction of the time would be spent below the inner Van Allen radiation belt.

Scientists planned that the satellite would orbit at an inclination near 28 deg. to the equator. Its lowest point above the earth is 300 miles and its highest about 700 miles. It is entended, in this orbit, to circle the earth every 98 minutes. Its orbital lifetime should be over three years.

Building a TAPE DECK

(*Concluded from page 599*)

Although mechanically rigid, they should not be knocked about. Impacts can have an unfortunate effect on the magnetic properties of the iron circuit. Never touch the heads with a magnet or apply a direct current to the windings, as a " magnetised " head can introduce noise into the recording.

Tape Guides

These (see Fig. 4) are mounted at the points where the tape enters and leaves the heads, and they should be positioned as close to them as practicable. The function of these guides is to hold the tape at the correct level to cross the pole-pieces. They are adjustable for height, being set so that, in use, the gap of the RP head works within the strip of tape which has previously travelled over the erase gap. With double-track heads, the erase pole should neatly cover one half of the tape width.

The tension in the tape obtained from light energisation of the feed spool is often sufficient to hold the tape in intimate contact with the heads. It may be found, however, that this contact is insufficient (poor treble response), or that vibrations are set up in the tape due to lack of damping. In either case it will then be necessary to arrange a felt pressure pad to hold the tape in contact with the heads. The pressure on this pad must be as small as will correct the fault, as the active surface of magnetic tape is highly abrasive, and undue pressure would result in rapid wear of the heads.

Record/Playback Circuits

S3 is a two-pole, two-way switch of either toggle or rotary wafer type. (See Fig. 6.)

One and the same amplifier is used for the functions of recording and playing-back. In use, a screened or coaxial lead is carried from the " P " output of the recorder to the (high impedance) input of the amplifier. The output of the amplifier is lead to the " R " input. The actual connection of this lead at the amplifier depends entirely on the type of amplifier used. If it has a high impedance output, connection is made to this. If, as is more often the case, only loudspeaker terminals are available, one of the methods illustrated in Fig. 7 must be applied. The use of a microphone or L.S. transformer to match impedances may not be in the best interests of " fidelity " but it has the great advantage of requiring no modifications to the amplifier itself. If method 7(c) is used, *three* poles will be needed on switch S3

Power Pack and Bias Oscillator

The purpose of the erase head is to " clear " the tape of any previous recordings so that it can be used again. Most erase heads require a supply of high frequency current to enable them to do their job. There are types of erase head which operate on permanent magnets, but even with these, an h.f. supply is necessary to " bias " the recording head.

It is normal practice to erase and record at the same time, and it is for this reason that the erase head is in the leading position; any other arrangement would be frustrating!

The schematic diagram of the oscillator and its power supply is given in Fig. 6. The coil L1 may be layer wound on a ½in to ¾in. former in a length of 1½in. to give a frequency of about 50 kc/s. L2, the secondary winding, is wound upon L1, the two windings being insulated from each other by a layer of empire

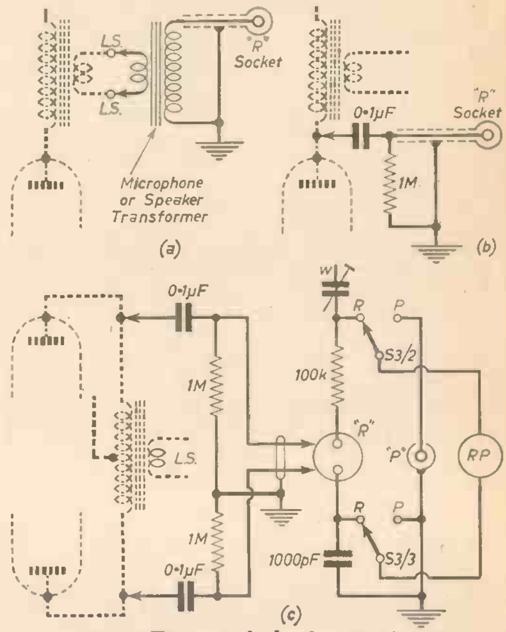


Fig. 7.—Three methods of connection to output stage of amplifier for " Record " input.

cloth or similar insulation. The number of turns on this secondary winding relates to high impedance heads, the tappings being to permit of adjustment to the levels of bias and erase voltage.

One pole of switch S3 automatically cuts out the bias and erase voltages when set to the playback position.

Final Warning

Apart from the dangers of electric shock which must always be faced when mains and h.t. voltages are present, mention should be made of one unusal hazard: The feed and take-up reels on fast running can attain a speed of the order of 1,000 r.p.m. Whatever method is used to mount these reels on their motors, it must be *rigid* and not introduce any serious unbalance, otherwise a tape reel may go flying across the room.

All metalwork with the exception of current carrying conductors should be earthed.

TRADE NOTES

A REVIEW OF NEW TOOLS, EQUIPMENT, ETC.

Butane Blow Lamp

FROM Taymar Ltd., 2 Bombay Street, Manchester, 1, we have received details of a new Butane blowlamp. The Taymax lamp, which is shown on the right, has a polished brass burner and will burn continuously for approximately 4 hours on the "throw away" cartridge. With the Standard burner shown, the cost is 35s. 6d. In addition a pencil flame burner for fine work (6s. 6d.) and special burners for paint removing and soldering (4s. 6d. and 7s. 6d. respectively) are available. Butane refills cost 4s. 6d. This versatile unit cannot fail to be of use in any small workshop.

The new Taymax lamp, fitted with standard burner.

The new screw pitch gauge.

Screw Pitch Gauge

MOORE & Wright (Sheffield) Ltd., Handsworth Road, Sheffield, 13, have recently added another screw pitch gauge to their range. It is a combination of Whitworth and Unified Gauges, each section having separate compartment. The tool contains 58 blades comprising 30 Unified blades and 28 Whitworth blades. The retail price is 26s. 6d.

New Stanley Blade

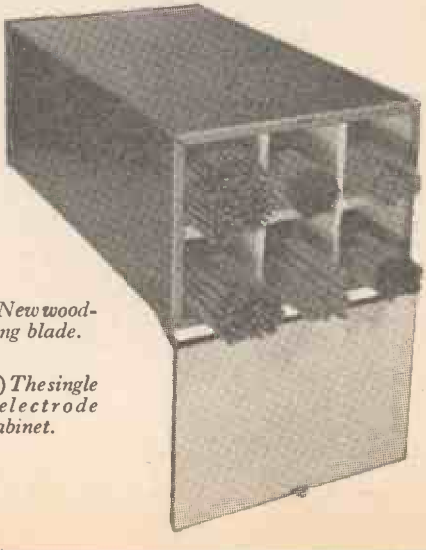
SHOWN in action below, the new blade, for Stanley shapers, designed for faster stock removal on timber. It costs 3s. and is interchangeable with the general purpose shaper-blade which should be used on harder materials such as metals. The manufacturers are Stanley Works (G.B.) Limited, Sheffield, 3.

Electrode Cabinets

THE photograph below shows the first electrode cabinet of its kind made. Marketed by Evanor Developments Ltd., of 2 Cecil Court, Enfield, Middx., it contains special density thermal plastics compartments of a beehive nature which ensure complete indifference to outside atmosphere, electrodes may be stored indefinitely at ambient temperatures.

(Left) New wood-cutting blade.

(Right) The single size electrode cabinet.



YOUR *Queries* ANSWERED

RULES

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.

Heavy Wax

COULD you please supply a formula for a heavy wax to be applied liberally, which would protect the coachwork of a car against corrosion from salt spread on the roads during winter snow ?—B. A. Allen (Lancs).

THE following ingredients should provide a good protective wax for the purpose you have in mind:

Material	*Parts/Wt.*
Paraffin	45
Tapan Veg. wax	30
Rosin	10
White pitch	10
Tallow	5

The paraffin can be replaced by a mixture of Vaseline and ozakerite, the ratio being adjusted to give the required consistency. Melt on boiling water-bath and stir until the whole mixture is homogeneous. Pour into suitable moulds.

Storing and Drying Salt

I HAVE had delivered to me 1 cwt. of crystal salt (aqua) for use in a water softener, what vessel is best to store it in that will not rot, but will also keep the crystals dry? Also, the salt is rather damp, is there a method of drying it without impairing its properties.—A. E. Kimber (London, E.12).

A WOODEN keg or cask with a lid, as used in the heavy chemical industry for storing inorganic chemicals, is the most suitable vessel for storing your salt. You will not impair the properties of the salt by whatever method you use to dry it. You can do this by spreading it out in a thin layer on a warm dry day on boards, or you can batch dry it in the oven on metal trays. However, we do not think it is worth your while to trouble to dry it, as salt is just as effective whether damp or dry.

"Satin" Finish to Wood

I AM making a bedroom suite and wish to obtain details of the new type of "satin" finish which is being used on modern furnishing. It has the appearance of wood that has been buffed and does not carry the high shine of wax polish. I would also like to know whether a filler is used on the oak before the finish is prepared.—I. Jones (Lancs).

THE satin finish to which you refer is normally a synthetic resin or sprayed cellulose application. The former is obtainable from Messrs. Floor Treatments Ltd. under the proprietory name of "Gleem" and a single application only should be given so as to avoid the brilliant gloss that two coats will give. Sprayed cellulose is too well known to require much explanation, but it should of course be a single application of clear type. The timber should be rubbed down starting with a fine glass paper and then finishing with a very fine and "wet" and "dry" paper. This will afford an exceptionally smooth finish which does not normally require fillers.

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.

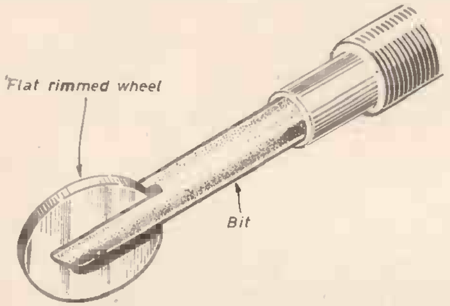
"Practical Mechanics" Advice Bureau. COUPON
This coupon is available until Sept. 30th, 1961, and must be attached to all letters containing queries, together with 6d. Postal Order. *A stamped addressed envelope must also be enclosed.*
Practical Mechanics. September, 1961

Sealing Polythene

I HAVE tried sealing polythene chemically, but without success. Can you tell me how it can be done using a hot iron?—R. W. Rubie (Bristol).

THE usual way of sealing edges of polythene is to use a heated wheel and run this along the seam. In some cases the wheel is serrated, and giving the impression of sewing.

Take a fairly heavy soldering iron and insert a small flat-rimmed wheel through the " bit " on an axle or cylindrical metal rod. The heat from the iron element will be conveyed to the wheel and the transferred heat from this will make a perfect seal.



Evacuating TV Tube

I WISH to start processing TV tubes. My difficulty is to know how to extract the air back out of tube.—E. Dawes (Yorks.)

THIS process can only be carried out by using a Diffusion pump which will reduce the vacuum within the tube to the order of 10^{-6}mm. mercury. This is approaching an absolute vacuum. Makers of this type of pump are: W. Edwards & Co. Ltd., (High Vacuum), Manor Royal, Crawley, Sussex.

Colouring Glass

SOME time ago I designed an imitation stained glass door, using lead strip and adhesive, but I have been unable to obtain transparent colours which do not fade. The door faces south. The colours are red, blue, and the greater part, amber. The colours supplied by the manufacturers of the lead strip almost faded away in a month, except the blue which retained its colour. Could you please tell me where I could obtain some fadeless colouring to suit my purpose.—R. Wilkinson (Hants).

THE colouring matter in the solution painted on your door are aniline dyes and all of these are destroyed by the actinic rays in light, the blue and violet end of the spectrum being least affected. The remedy lies in avoiding all dyes and adopting artists tube colours as supplied by Winsor and Newton. Their range of permanent oil colours contains sufficient variety of colour to suit your purpose.

In use the colours must first of all be thinned out with a mixture of turpentine and Japan gold size, rather more than half of the latter, and worked up into a syrup-like consistency. The colour can then be floated on to the glass with soft camel hair brushes. The glass must be laid horizontally and kept so until the colour has set, which will take three or four hours. If the first coat is not deep enough a second can be applied when the first is quite dry. The gold size and turpentine can also be obtained from Winsor and Newton.

Damp Course

THE old house in which I live has no damp course. I am told that slate is the best material to use but this is expensive. What do you advise?—E. Featherstone (Lancs).

WE strongly advise the use of slate as damp course. It should be possible to pick up an odd lot of broken slate which you could trim to your purpose at not too great an expense.

The standard bituminous felt type is the next alternative. Write to the Building Centre, Store Street, Tottenham Court Road, London, W.C.1. for further particulars.

Anodising Aluminium

I WISH to produce a bright anodised finish on small aluminium parts, could you please give me details of the process.—W. H. T. Green (Durham City).

THERE are many processes that can be used for anodising aluminium; but a simple and straightforward method is to make up an electrolyte of:

Phosphoric acid (d.1.70)	1,000 c.c.
Hydrogen peroxide (30%)	50 c.c.

The treatment time is 5 minutes. If used anodically, an e.m.f. of 11V. is employed at approximately 15A./sq. ft. This is for pure aluminium only. On duralumin type alloys the bath is used hot (70° to 80° C.) at 4V., 100 to 120A/sq. ft. for 1 to 2 minutes. In all electrolytic processes care must be taken to have the work clean and free from grease. Trichlorethylene is a good degreasant. After anodising wash well. Agitation of solution can be done by compressed air or mechanical stirrer. An aluminium-magnesium alloy —3 to 5 Mg. is the most satisfactory composition for the anode.

INFORMATION SOUGHT

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

Bicycle Water Skis

I AM a water skiing enthusiast and have heard somewhere of water skis being fitted to a bicycle. Can you tell me how this was done or perhaps one of your readers could oblige?—G. Hyslop Helensburgh).

SALES AND WANTS

The pre-paid charge for small advertisements is 9d. per word, with box number 1/6 extra (minimum order 9/-). Advertisements, together with remittance, should be sent to the Advertisement Director, PRACTICAL MECHANICS, Tower House, Southampton Street, London, W.C.2.

MODEL PARTS

"EVENING STAR" in 3½" G.

'Wilwau' will make the complete range of castings for this fine L.B.S.C. 2-10-0 loco. S.A.E. with enquiries appreciated.

W. K. Waugh, 31 Hillfoot Drive, Bearsden, Nr. Glasgow. Bea 2985

HOBBIES

CATALOGUE NO. 14 Government Surplus and Model Radio Control, over 500 illustrated items. 2/6d. (refunded on purchase).—Arthur Sallis Radio Control, North Road, Brighton.

NEWTONIAN TELESCOPE MAKING, 6", 8½", 11¾" Glass discs, Grinding Kits, Plano-convex lenses, optical flats, Ramsden eye-pieces, Barlow lenses. S.a.e. for lists.—L. J. Mays, 20 Clover Road, Timperley, Altrincham, Cheshire.

PHOTOGRAPHY

BELLOWS, Camera, Enlarger, Process, Industrial Collapsible Machine Guards.—Beers, 4 St. Cuthbert's Road, Derby. (Tel. 41263).

PROJECTORS. Home Assembly Kits all types and sizes and Stereo from £6 2s. 6d. Fan Base Kit £3 7s. 6d. Opticals: Screens. S.a.e. Marshall Smith Ltd., 64 Norwich Avenue, Bournemouth.

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Tubes for All British-made Sets

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Deposit 20/- plus 12/6 carriage. Tubes for ALL H.M.V. and Marconi sets at reduced prices.

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RADIO Television Service Sheets. All Types valves. S.A.E. list, John Gilbert Radio, 20 Extension Shepherds Bush Market, London, W.12. SHE 3052.

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PRECISION Screwdrivers 0.50 mm. to 2.2 mm. 10 sizes 12/6 set. Quality Eyeglasses 4/- each. Fine Hairspring Tweezers 12/6 pair. Electric soldering irons for precision work 24/-. Valuable Materials Assortments. Watches, Bracelets, Straps, etc., and we do a complete repairs service.—Send for free illustrated lists to J. J. LAWSON, 95 Godwin Street, Bradford, 1. (Phone 32075.)

WATCH PARTS

For all makes of watches, tools, instructional books, etc. Special Kits for beginners. Send 6d. for "Super Bargain Catalogue." T. G. LOADER (Dept. B.), Watchmakers' Mail Order Service, Milestone Road, Carterton. Oxford.

FOR SALE

ASTRO TELESCOPE MAKING.—Standard Ramsden Push-in Eyepieces, ¼in., ½in., ⅔in., focus, 35/-, with R.A.S. thread, 42/6 ea. S.A.E. list, Object Glasses, Newtonian Mirrors, Diagonal Mounts, Focusing Mounts, Tripods, Mountings and Terrestrial Telescopes.—W. Burnet, Grand Sluice, Boston, Lincs.

HYPODERMIC SYRINGES, brand new 2 c.c. SIMA, excellent for oiling etc., 4/9 each. Also needles, sizes 12, 17 and 18 at 4/- per dozen.—G. Roger Smith, 16 Clyde Street, Liverpool 20.

SCREWS, nuts, washers. Grand assortment Brass, Steel. B.A., Whit., B.S.F., well below list price. Post Free, 2 lb.—7/-. Also 3½ lb.—11/-. 7 lb.—20/-. both sent in storage tins.—R. G. McClelland (P.M.), 1 Beulah Road, Epping. Essex.

STEAM Sports Car—modern—excellent performance, easy starting, no gears, silence, economy. Description in magazine, colour plate, also steam boats. Your copy with illustrated lists of drawings, castings, complete power units—only 5s, post free—"Steam Power," Kirk Michael, Isle of Man, U.K.

CATALOGUE No. 41. Over 4,000 items, electrical, mechanical, material etc. 9"×3" S.A.E. please.—K. R. Whiston (Dept. P.M.S.), New Mills, Stockport.

OXY-ACETYLENE SETS
An exceptional Ex-Govt. bargain

B.O.C. type CH, complete WELDING and CUTTING outfits, in elaborate fitted wooden carrying cabinets 24" × 18" × 10½", wt. 60 lbs. containing regulators, hoses, set welding tips, cutting nozzles, spanners, goggles, key and four extra gauges, etc. Slightly used, but guaranteed. £20 C/F.

CUMMINS & JENNINGS
Tillingham (Tel 224), Southminster, Essex

FOR SALE *continued*

Brand new ex M.O.S. electric gramophone units in heavy gauge metal cases fitted carrying handles and locks, finished black crackle. Heavyweight 200-250 volt A.C. motor, pick up, 78 r.m.p. only, cost £20 each, case alone worth more than my price, 35/- plus 5/- carriage. Ditto used 20/-.

Brand new Dallmeyer 4in. projection lenses especially designed for 35 mm. transparency projectors, but will cover up to 2¼in. square, original price £7, only £3, post 1/6.

2in. Bi-Convex Glass Condensers 2/6 each, post 6d.

Epidiascopes from £20 each.

Brand new Avominor moving coil Multirange A.C./D.C. Test Meters (ex M.O.S.) solid hide case with shoulder strap, leads and test prods, in original tropical packing list over £11, price £5, post 2/6.

Brand new Kodak (ex Admiralty) 7 × 50 Prismatic Telescopes, focusing, in fitted wooden case with binocular eyepiece, fitted filters, cost over £50, due to another buge purchase, lower than ever price, £4 10 each, carriage 5/-.

Brand new Exide (ex A.M.) 12 volt, 25 amp batteries. These are R.A.F. general purpose lead acid accumulators, and are similar in construction to normal car battery. Very suitable for cars and vans, will start any vehicle. Never been filled and in original tropical packing. First charge instructions included, cost about £10, only £2 10 each, carriage 5/-.

Ex Admiralty brand new Pocket Stopwatches by Waltham and Smiths. Fully jewelled movements, ⅕th second, 60 seconds per rec., 30 minute recorder dial, winding button start, stop and re-set, value £8, 45/-, post 2/-. Ditto, tarnished cases, but brand new 37/6, plus 2/- post.

Ex Admiralty brand new Pocket Stopwatches, Waltham, 6 seconds per rev., no recorder dial, accuracy greater than 1/10th second, jewelled movement, in original box, winding button start, stop and re-set, cost over £12, 19/6, post 2/-.

Ex R.A.F. Aerial Film 9½in. × 300ft. Pan, £3. 160ft. 35/-, 5½in. × 47ft. 8/-, 24ft. 5/-. Ideal for cutting to smaller sizes. Perfect condition. Post 1/6.

Ex A.M. G.45 Gun Cameras 24 volt, 2in. fixed focus lens, 50ft. magazine loading, complete with magazine, new £2 15, ditto used £2. Both post 2/6.

Ex A.M. GGS Mark 3 Recorder Camera.. 16 m.m., made by Specto. Latest model with three shutter speeds, 2 or 16 f.p.s., bloomed 1½in. lens F.1.9 with iris to F.16, 24 volt, 50ft. magazine loading, complete with magazine in original tropical packing, absolutely brand new, only £5, post 2/6. Ditto used £3 10, post 2/6.

All goods supplied on 14 day money back guarantee

R. SANKEY, Regal Cinema, ATHERSTONE WARWICKS. *Tel.: Atherstone* 2220/3210

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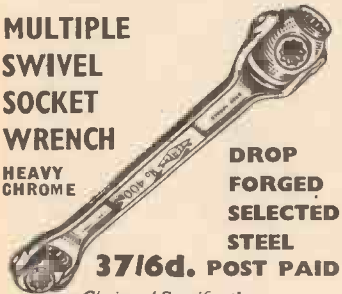

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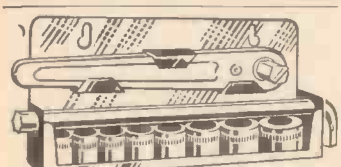

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