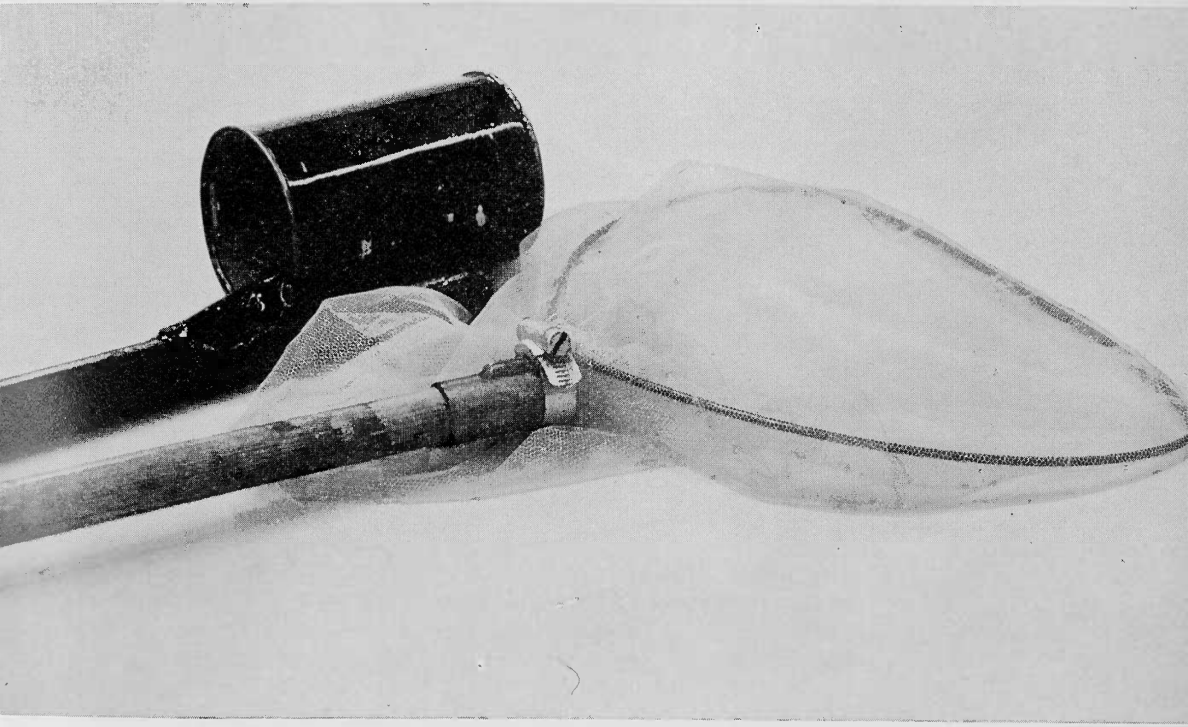
Section 2

# *Biological apparatus*

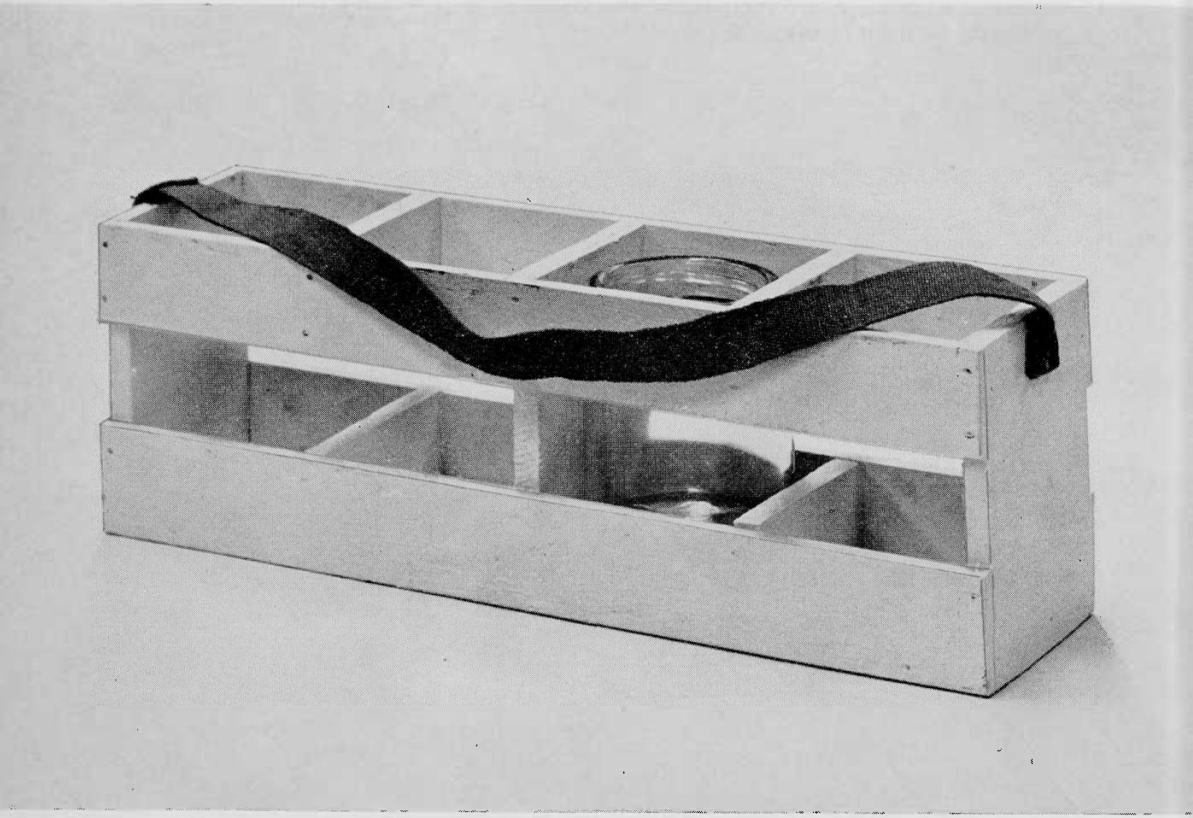
## 1. Pond dipping A

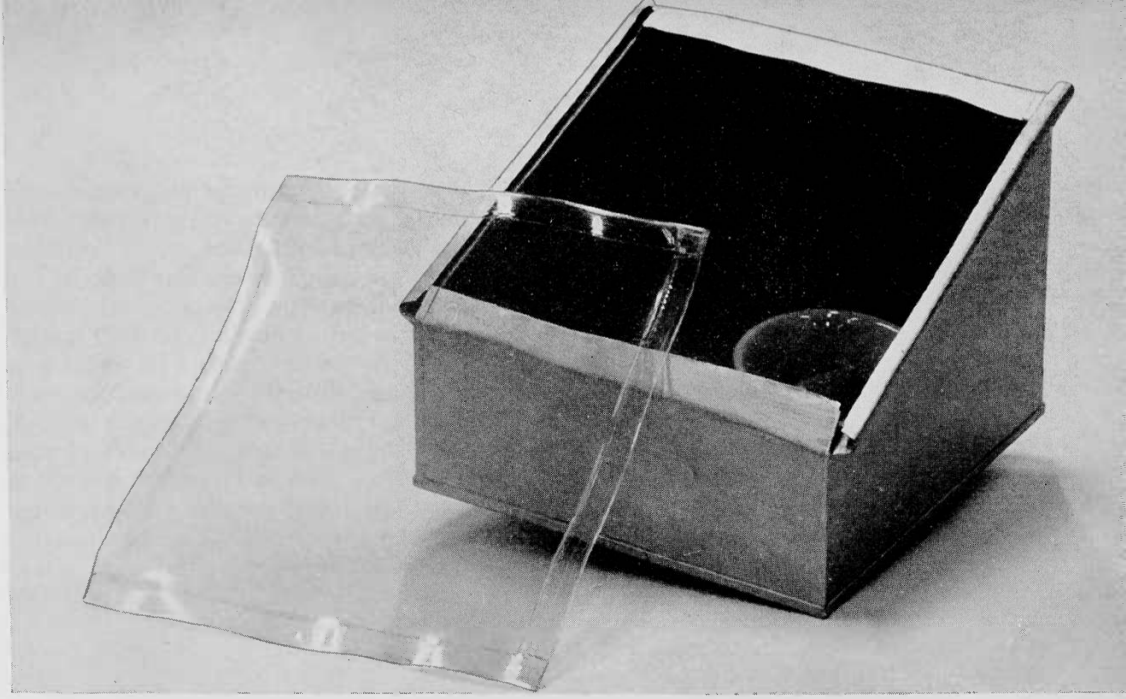
Ponds and streams are good sources of living material for children to study. This illustration shows two pieces of essential apparatus for this work. One is a dredger and 'slasher', a well known crude piece of schoolboy apparatus which still serves very well. It consists of a broomstick with a tin can nailed to the end of it. It brings up a rather mixed catch, but it is useful when weed, mud, and stones form obstacles for the more refined types of net. The other illustration is of a net made round a piece of galvanized wire shaped suitably and fastened through a hole drilled in the end of an ordinary chimney-sweeping rod. The wire is held in place firmly with the Jubilee Hose clip; 1 inch in diameter is the ideal size of clip for this purpose. If a long reach is required, several rods can be connected to each other to give a wide sweep to the net. Nylon net of a suitable gauge should be sewn firmly to the metal frame.



## 2. Pond dipping B

Whilst plastic containers are the best for transporting a catch from ponds and streams to school, jam jars are still convenient. Furthermore, they are useful at school as individual aquaria for small creatures. If they are used, some form of protection is needed for them, both when they are being carried and in storage in school. The illustration shows a very simple type of holder. It is merely a box long enough to take four jars made up with partitions to keep the individual jars in place. The container can be made from scrap material salvaged from another wooden box, and tacked together with ¾ in. nails or pins.



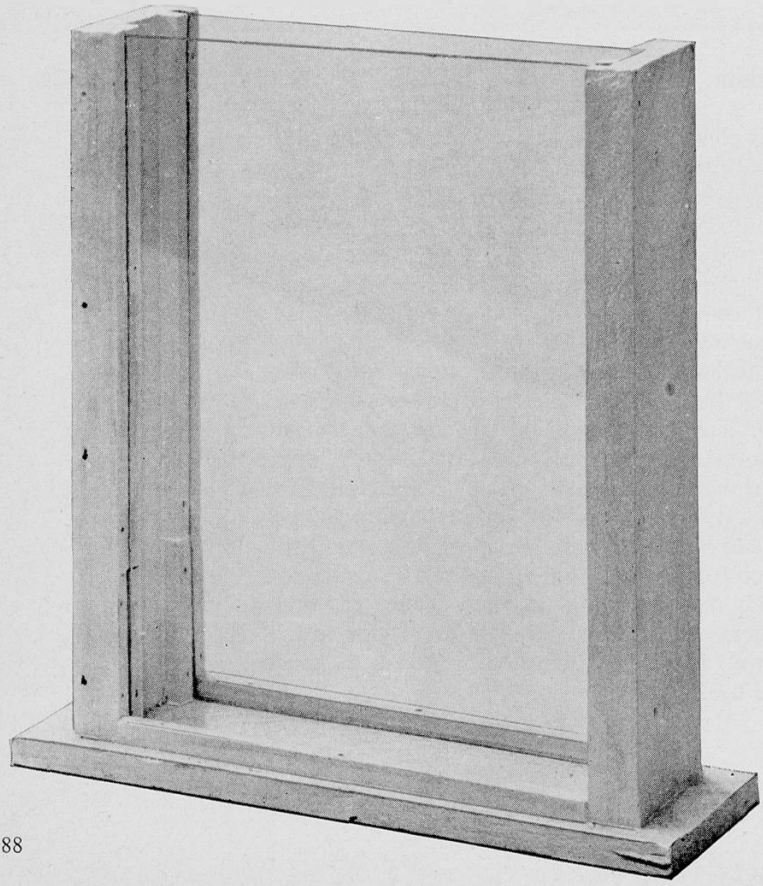


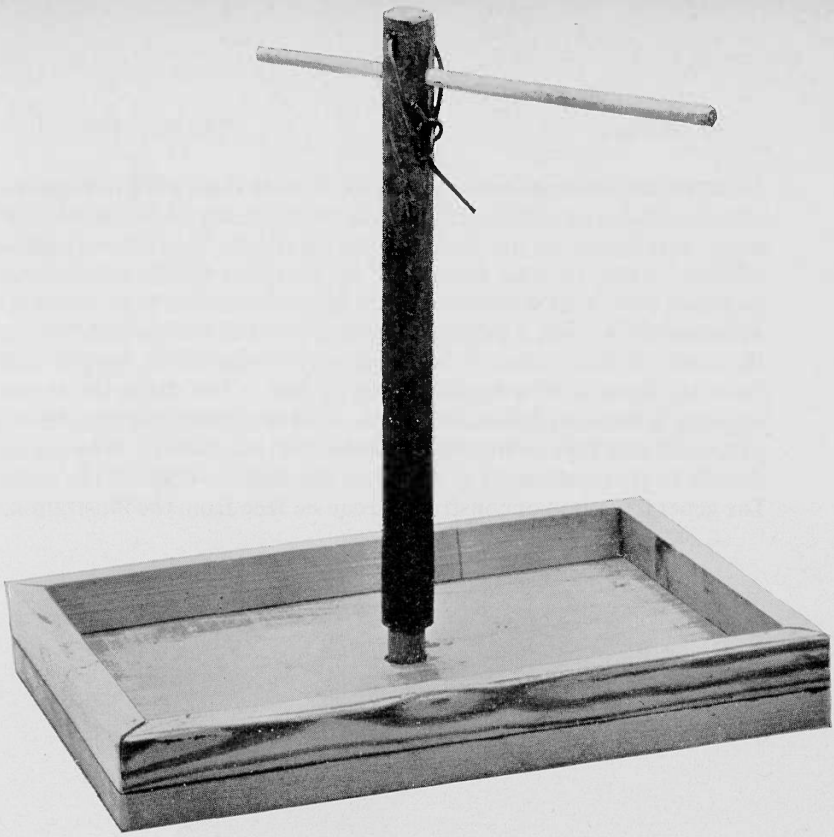
### 3. Biscuit tin vivarium

Animals needing humid conditions, such as frogs and toads, snails and slugs, and the inhabitants of damp turf, should have special provision. The photograph shows an easily made portable container. This is not meant to provide permanent housing for the larger animals such as frogs and toads, but will certainly serve during transport, and as temporary accommodation. The container is made from a biscuit tin cut to a suitable size with tin shears. Leave 1 in. flaps all the way round after making the preliminary cutting to shape. The side flaps, as the illustration shows, can then be easily formed round a file held flat, to make the runners which will accept the acetate sheet. The front and back flaps are bent towards the inside of the tin, both to prevent the occupants from escaping and also to keep a tension on the acetate sheet. An acetate sheet cover is much to be preferred to glass. Not only is it unbreakable, but it is also entirely safe to handle. A small pudding basin put inside the tin will form a place for aquatic animals and this can be surrounded by damp moss if very humid conditions are required. Alternatively, turf dwellers can be housed by simply placing turf of suitable size inside the tin. It is advisable to paint the tin well with aluminium paint before use.

## 4. Wormery

A narrow glass-sided container for earth, animals, or plants is often of great use in the classroom. The frame can easily be made from scrap wood. The baseboard, ideally $\frac{3}{8}$ to $\frac{1}{2}$ in. thick, needs to be 5 in. by about 1 ft. The sides should be made from similar material and be 4 in. wide and not more than 12 in. high. To allow the glass to slide in and out easily, $\frac{1}{4}$ in. square-section beading, suitably spaced is tacked to these side pieces whilst they are lying flat. Panel pins will be needed to fasten the beading. When the sides have been made these are screwed into place on the baseboard with long thin wood screws. Two screws to either upright will suffice. A piece of $\frac{1}{4}$ in. beading should be fastened to the front and back of the baseboard to hold the bottom of the glass in place and to keep the contents of the box from escaping. If the overall height exceeds 12 in. the apparatus becomes unstable when it is filled with soil. If the top shows a tendency to spring apart, it may be held in place firmly with a strong elastic band or a tie of Sellotape.



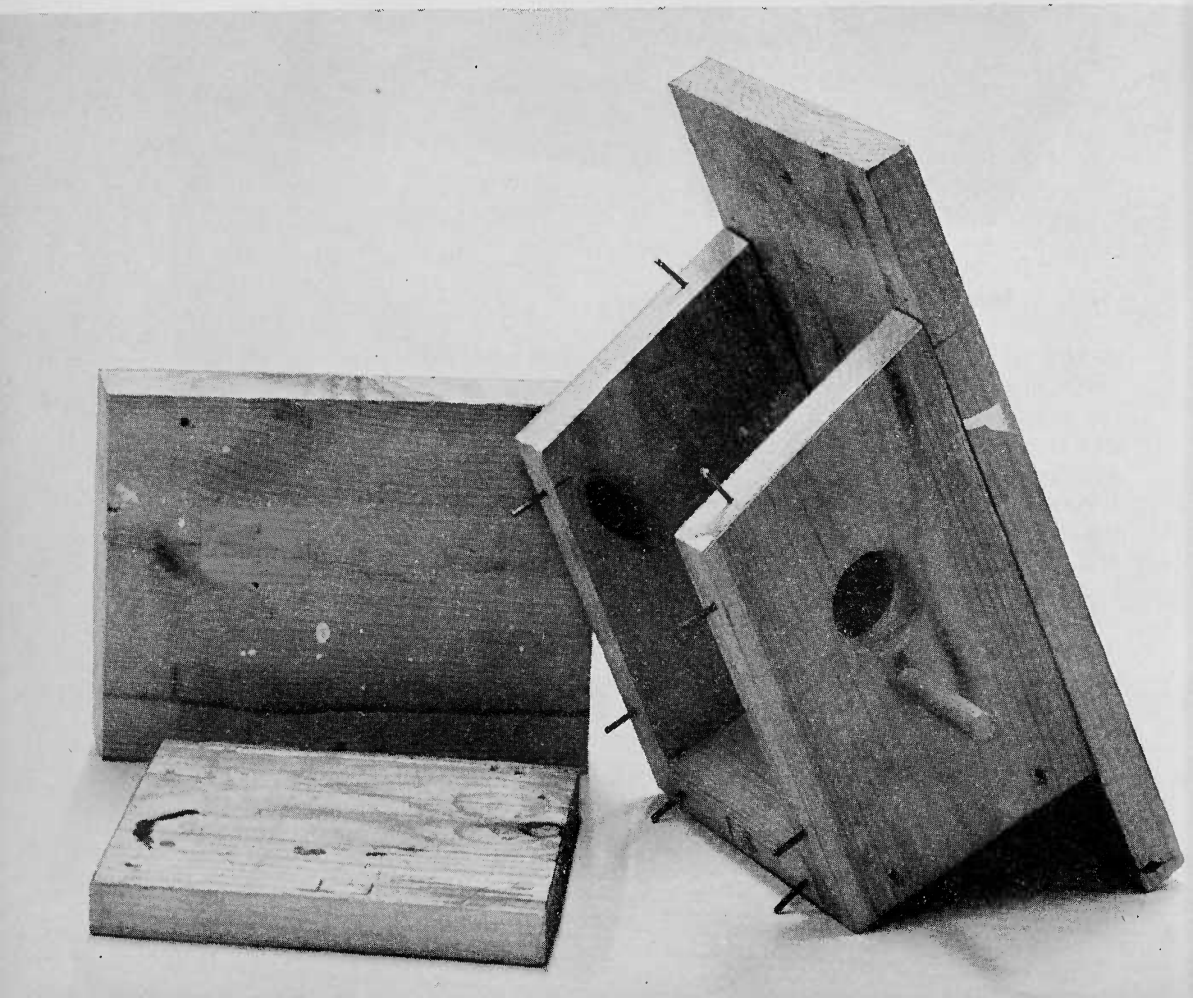


## 5. A hanging bird table

A bird table, set out in a suitable place for general observation, is useful in any school. But although the obvious place may seem to be the middle of an open space, sometimes it is preferable to put a table in a tree or hang it from some convenient point near a classroom window. A simple hanging type of bird table is illustrated here. It consists basically of a wooden tray with a $\frac{3}{4}$ in. hole drilled through the centre. A piece of broomstick is shaped to go through this hole and protrude through the bottom for about $\frac{1}{2}$ in. A hole is drilled laterally through this protruding end of the broomstick to accommodate a 3 in. nail, which, when inserted, will prevent the baseboard from falling off the stick. If a similar hole is made near the top of the stick this will take a piece of rod to form a perch. The bird table should be fastened in such a manner that it does not sway too violently in the wind, or birds will hesitate to use it.

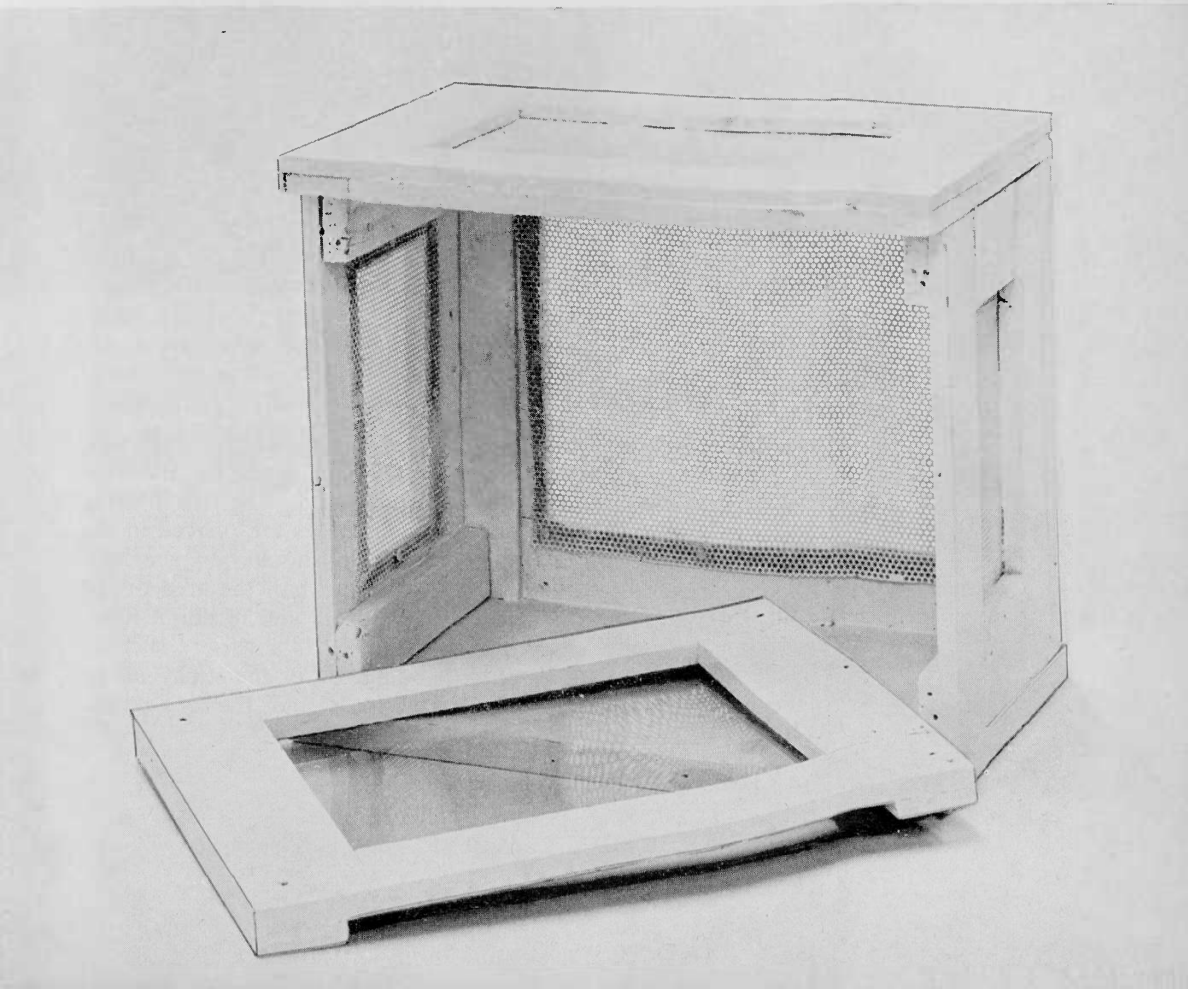
## 6. Tit box

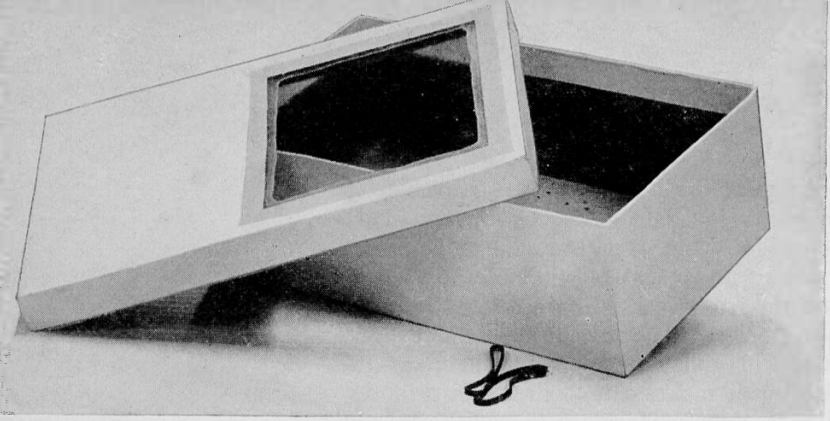
Great tits and bluetits soon occupy nest boxes if they are put out for them in sheltered places, although a south-facing aspect is not entirely acceptable to the birds as the nest gets too hot in sunny weather. The tit box illustrated here can be made from floorboarding or similar material. It should be about 6 in. high and 6 in. across at front, with a height of about 6 in. at the eaves and 7 in. at the back of both sides. The sloping roof should be hinged and fastened down with a hook and screw eye. The diameter of the entrance hole needs to be about 1¼ in. If it is made larger than this it will be found that sparrows are unwanted occupants. The perch should be inserted about ⅜ in. below the bottom edge of the hole. The general method of construction can be seen from the illustration.

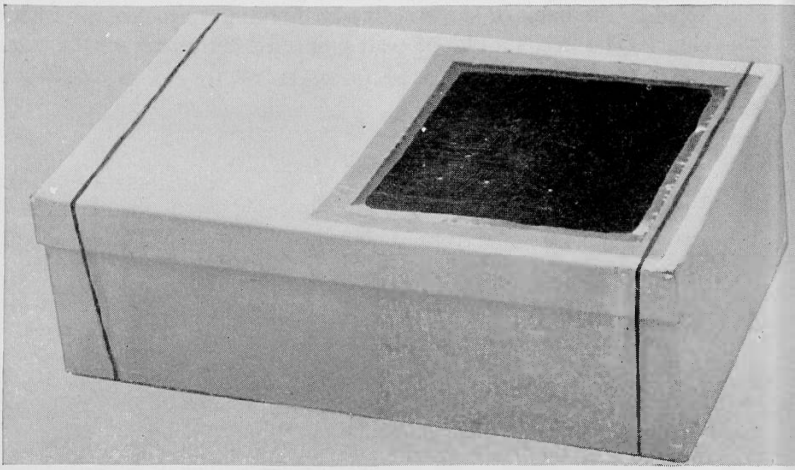


## 7. Box type cage

Temporary housing is often needed for living things. A conveniently stored type of house is shown here. This consists of a frame-type box, of about 15 × 10 × 5 in., with three sides and the back covered with perforated zinc or perforated plastic material, whichever may be available, and the front covered with a clear sheet of acetate stuck firmly to the framework with Evo-Stik. If the sections are screwed together instead of nailed it can be dismantled and stored flat when not in use. This makes a useful temporary house for all types of small animals, and furthermore, if wall plates are fitted to the back of the box, it can be hung up to leave bench space clear. The box should be well painted before use, as this makes it easier to clean.

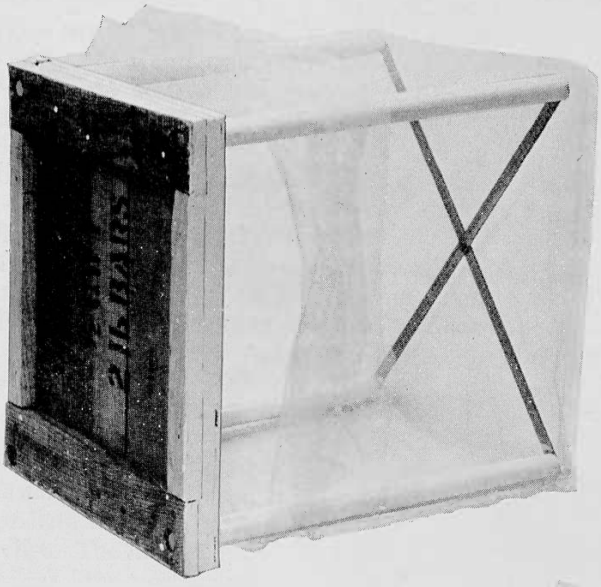


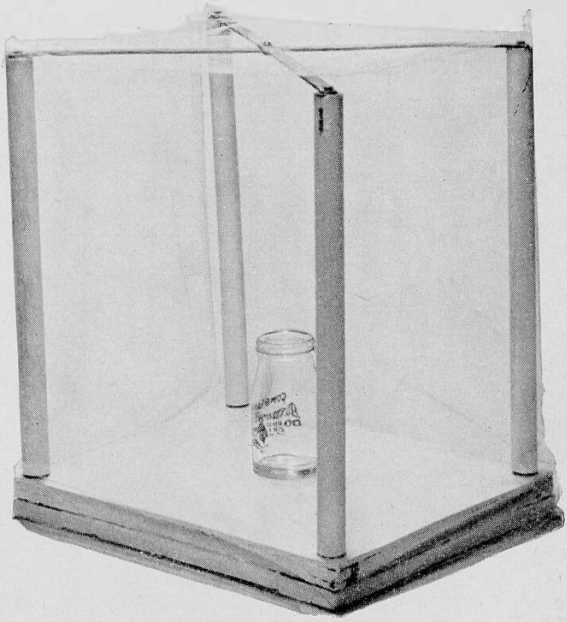




## 8. Shoe box insect cage

Sometimes temporary housing is needed for insects and small animals, when no proper preparations have been made for their reception. A cardboard box can probably be used. The two illustrations show how to adapt a shoe box. Air holes are pierced in the bottom of the box with a large needle. There should be a generous supply of holes. A window, occupying about half the area of the box lid, should be cut to facilitate observation and to admit light. This is covered with clear plastic material. If a variety such as Fablon is used, a double sheet must be put on or the sticky inside will be an embarrassment to both the user and the occupants. The lid can be held in place with elastic bands.



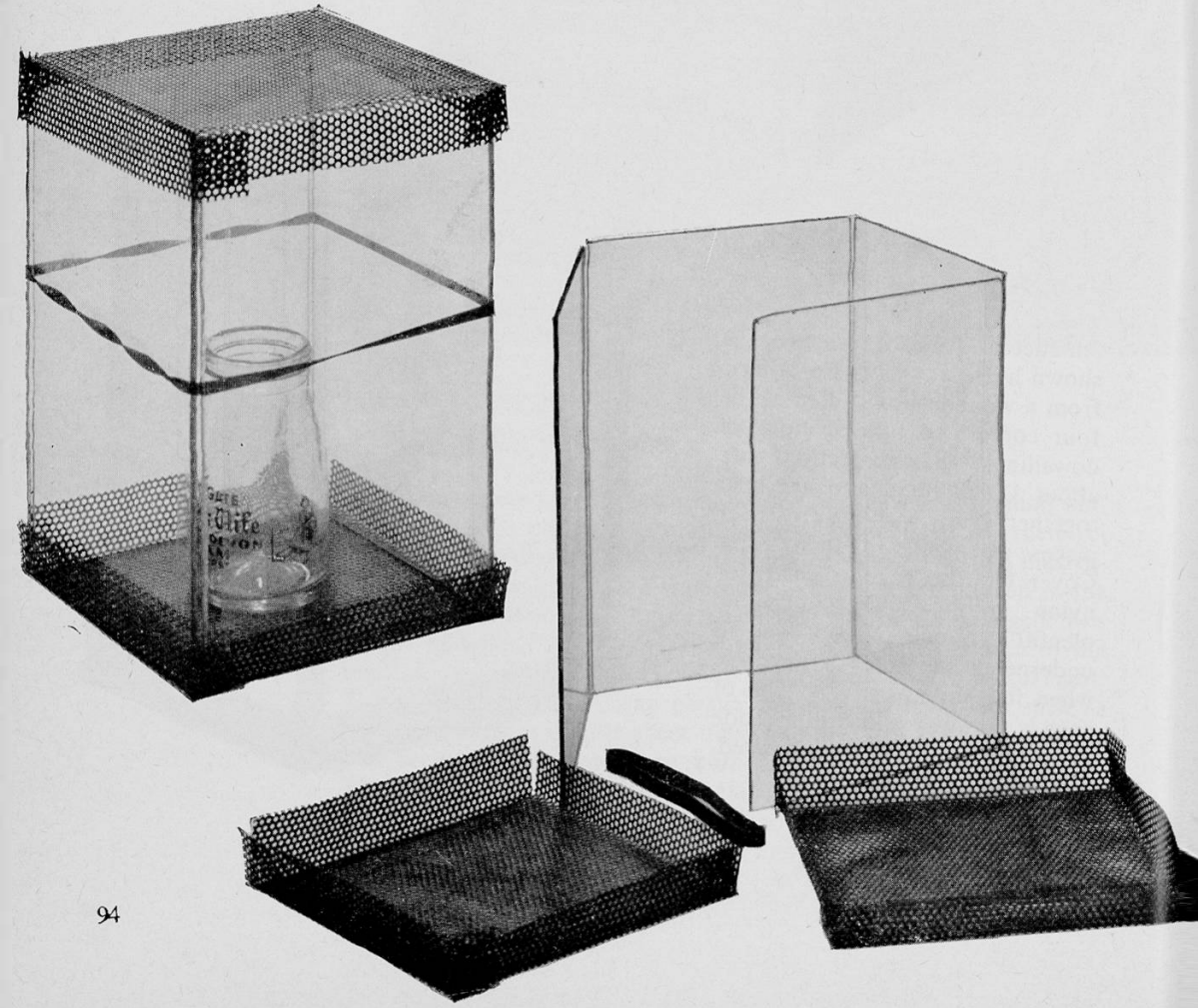


## 9. Net covered insect cage

An effective form of insect cage is shown here. It consists of a base from a wooden box drilled at the four corners to take sections of dowelling. These sections are about 15 in. high, and are held together rigidly with the crossover pieces of metal to their tops. Cover for the cage is made of nylon netting and should be plentiful enough to tuck well in underneath the base of the cage when it is in use. This type of cage is very airy and can be made as large or as small as is desired, according to the occupants.

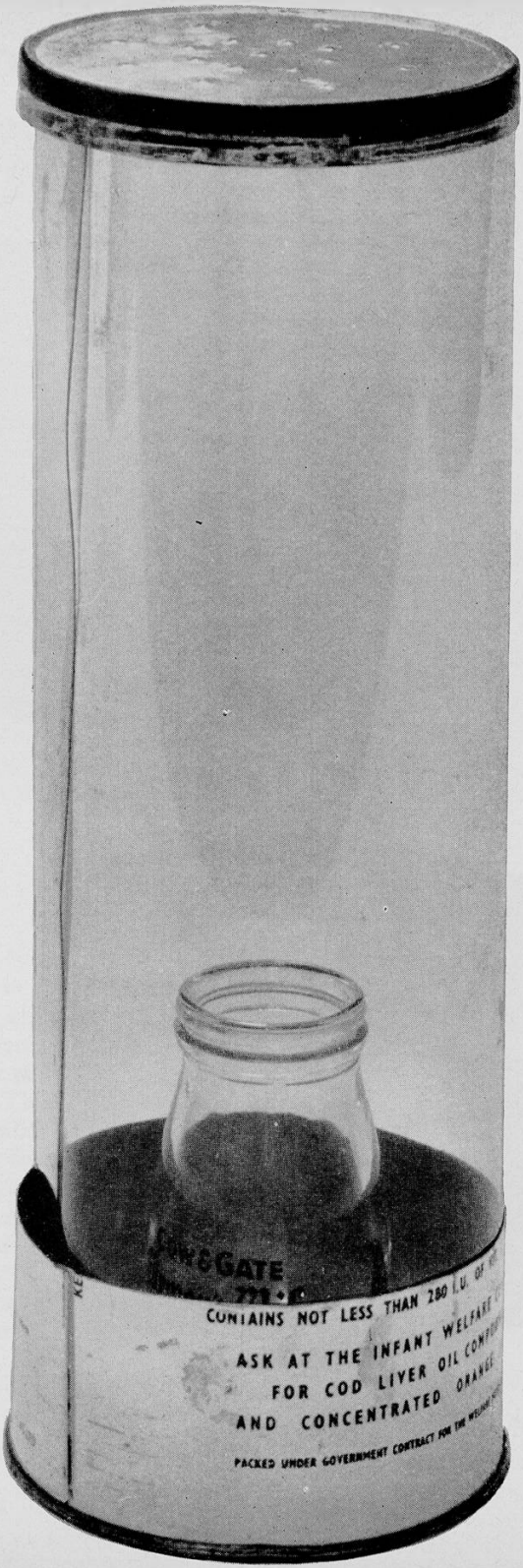
## 10. Glass plate insect cage

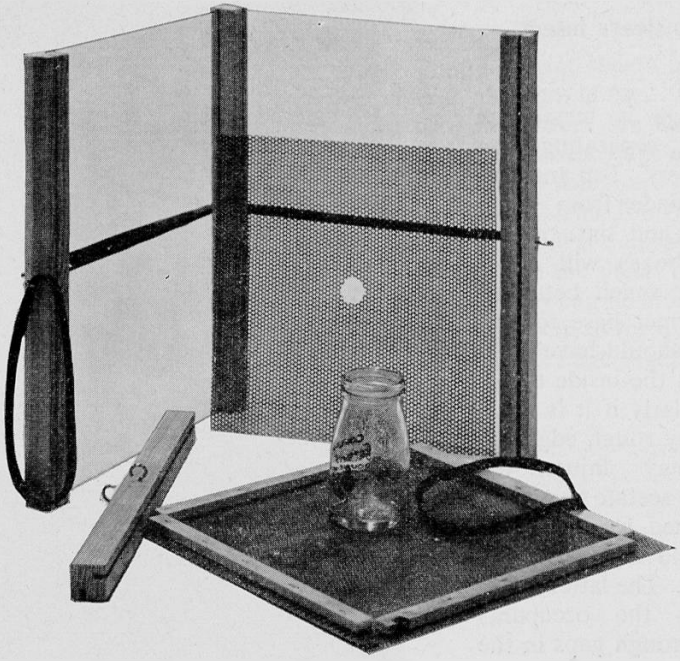
This insect cage, made from hinged glass sheets and perforated zinc, is convenient for storing flat when not in use. The perforated zinc trays which form the top and bottom are made from two squares of zinc, 8 in. by 8 in. The sides of the cage are made from four sheets of glass, 9 in. by 6 in. These sheets are joined in three places with double layers of Sellotape. The fourth edge is left free. Thus, the glass sides can be folded flat for storage when not in use. A slight gap should be left between the sheets of glass before they are stuck with Sellotape so that they can be hinged easily. On each piece of zinc, a one-inch border is bent to form the trays quite easily. A stout elastic band will hold the cage together firmly and prevent the escape of its occupants.



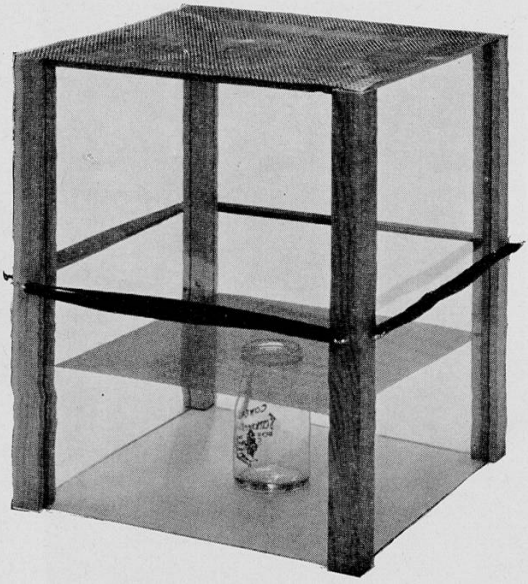
## 11. Acetate sleeve insect cage

This insect cage is merely an acetate sleeve, separating two suitable containers. Top and bottom can be made from many kinds of boxes and tins. Cardboard cheese boxes will serve, though tins are much better as they form a firmer base for the cage. The top should have holes perforated from the inside to the outside, particularly if it is made from a tin. Any rough edges on the inside may injure the occupants. The acetate sleeve can either be fastened together with Sellotape, or held together firmly with paper clips. The latter is less satisfactory, as the occupants might escape through gaps in the acetate.

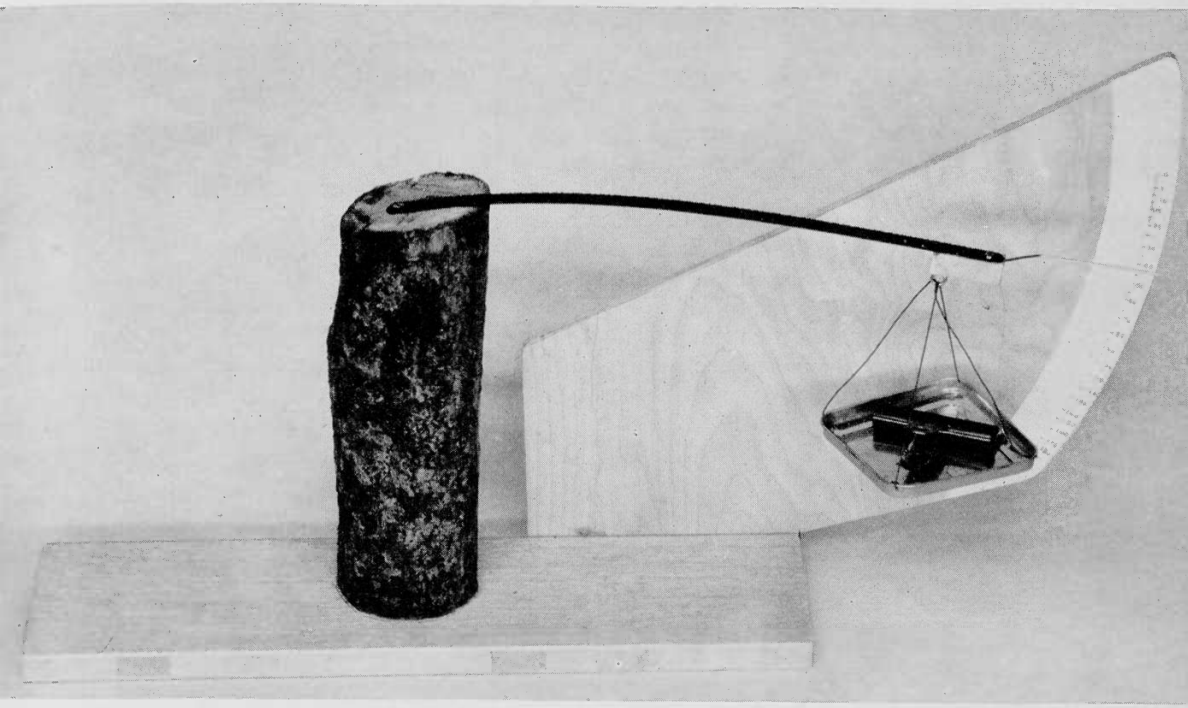




**12. Quadrant moulding insect cage**



Basically, this insect cage consists of four pieces of one-inch section quadrant moulding (grooved to take standard weight window glass), four sheets of window glass 12 in. by 9 in., and eight small screw hooks, two to be inserted on each quadrant upright. A sheet of perforated zinc 11 in. square forms the top of the cage. The cage is held firmly together with strong elastic bands attached to each of the hooks as in the illustration. Inside, a collar of perforated zinc can be put on the food vessel to prevent the occupants falling into water containing the food plant.

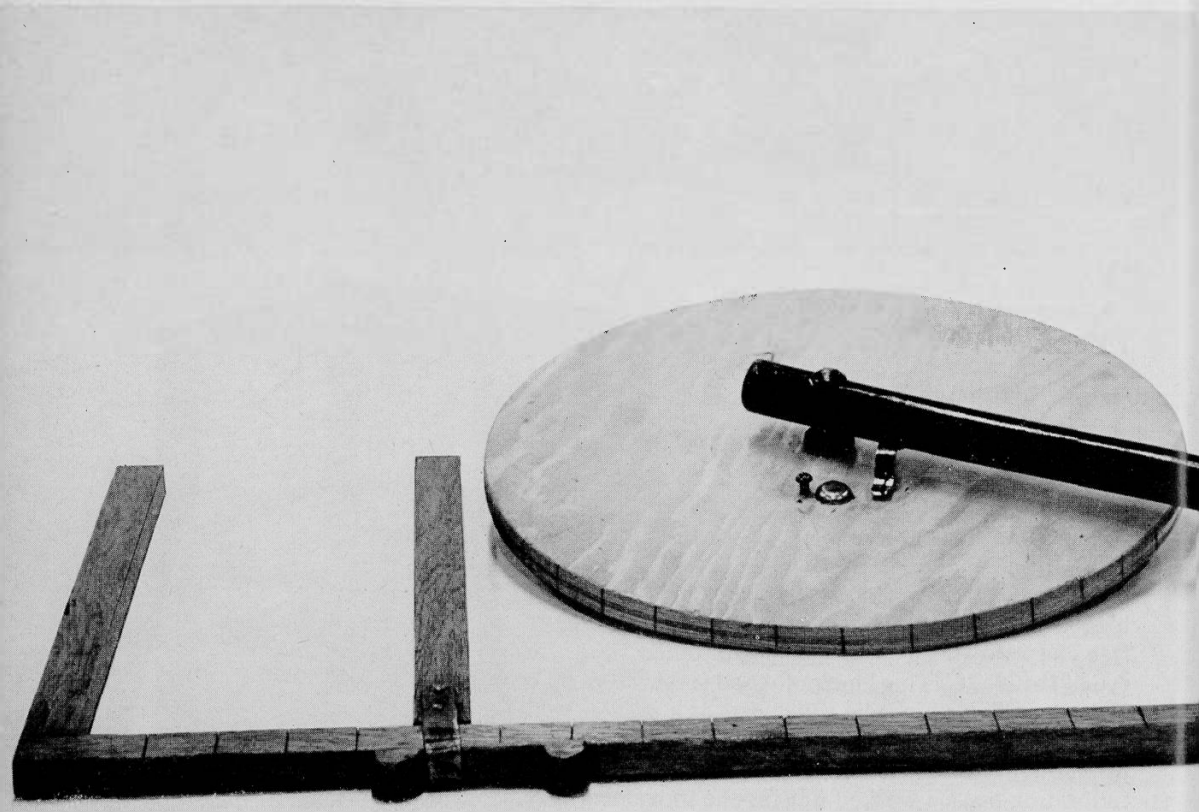


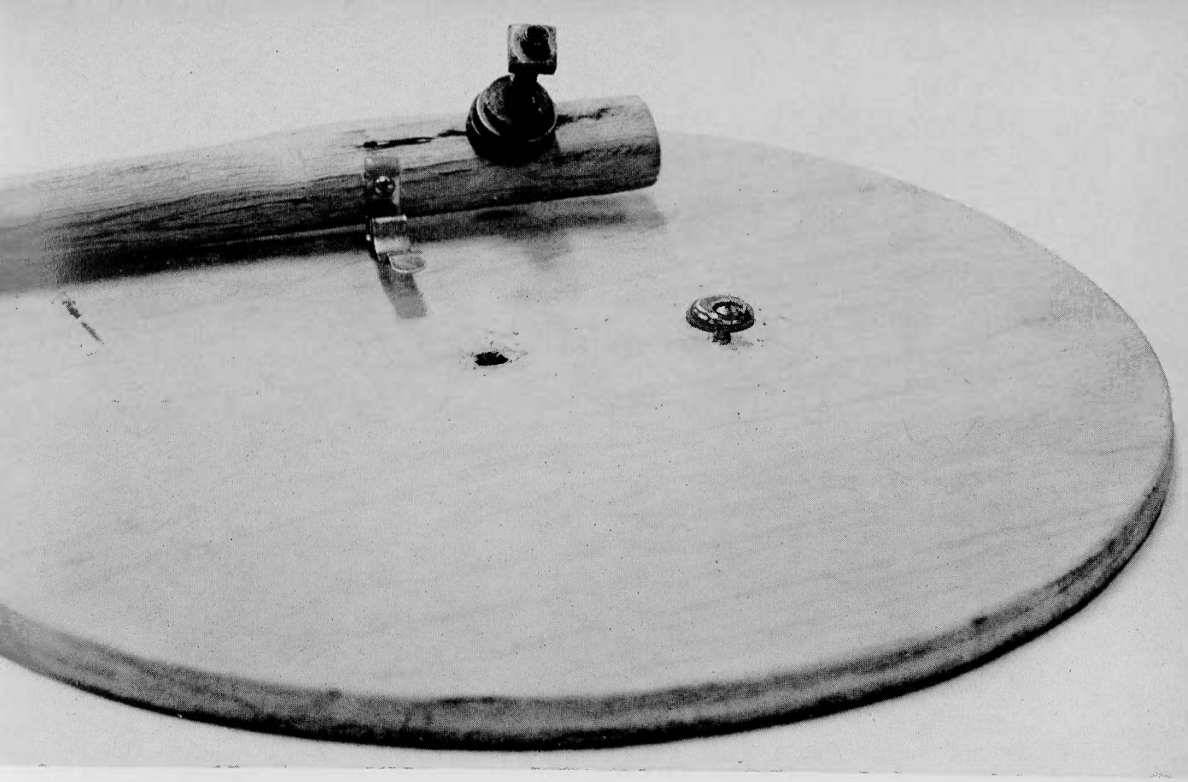
## 13. Sensitive balance

The recording of comparative gains in weight is not easy with the ordinary equipment of the normal classroom. The photograph shows one way of making a fairly sensitive balance. Basically, it consists of a heavy piece of wood for the baseboard and an equally heavy piece for the central pillar. This is important to give the apparatus stability. The arm of the balance is made from a hack-saw blade. One end of this is fixed firmly to the central pillar and at the free end a small block of wood is fastened by a screw through the eye of the blade. This block of wood serves to carry both the weighing pan and also a needle which acts as a pointer to the scale, which in this case is mounted to the back of the baseboard on a piece of plywood. If a set of small known weights is available a suitable calibration can be worked out for the movement of the arm.

## 14. Click wheel and calipers

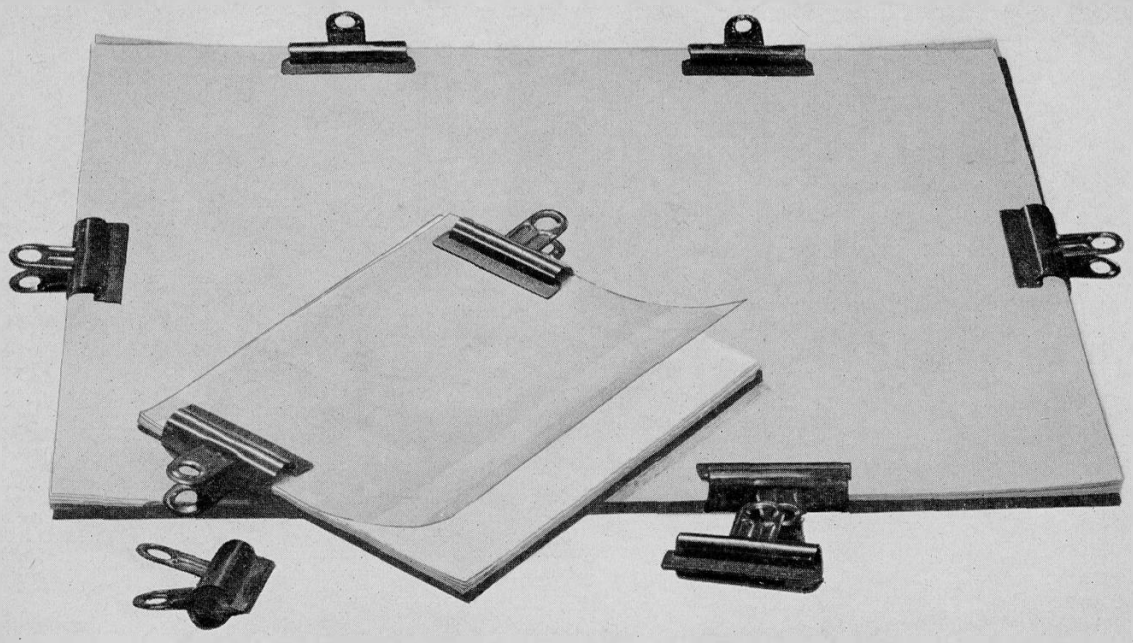
The illustration shows two pieces of apparatus for field work. One is a pair of calipers for measuring tree girths, and the other a click wheel for measuring distances. Details of this latter piece of apparatus are given in example 15. The calipers consist of pieces of oak about 1 in. by $\frac{1}{2}$ in. in size. The measuring arm is 38 in. long and the fixed limb is screwed to this measuring arm. The movable limb is held in place by a piece of bent brass of suitable size. This U-shaped piece of brass is drilled to take nuts and bolts which hold it to the moving limb. The wedge has been inserted as a device to hold the caliper firmly in place after a measurement has been taken. This is not necessary, but it is an added refinement and convenience on this piece of apparatus.





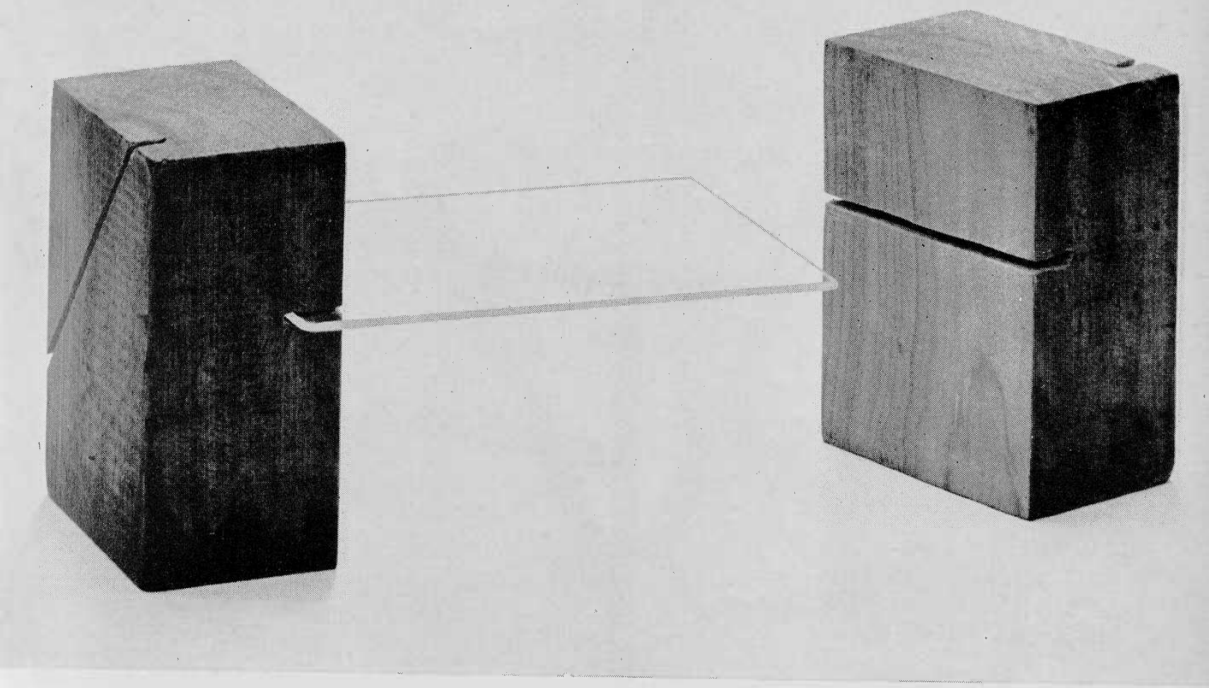
**15. Click wheel detail**

This illustration gives details of the construction of the click wheel. The wheel itself is cut from five-ply wood with a diameter of 11·46 in. This will give a circumference of one yard. The handle consists of a broomstick. This is drilled at a suitable distance from the bottom with a $\frac{1}{4}$ in. hole to take a $\frac{1}{4}$ in. by $1\frac{1}{4}$ in. coach bolt. The exact centre of the disc is also drilled with a $\frac{1}{4}$ in. hole. The clicker is made from a half Terry clip which is screwed to the broom handle, and a small metal dome of the type which is put on the bottom of chair legs. The right position for the dome should be found by experiment. Immediately beside it insert a $\frac{1}{2}$ in. wood screw to a depth of about $\frac{1}{4}$ in. This will act as a trip on the clip, which will fall onto the metal dome with a click, and so register the passage of each complete rotation of the wheel. Several washers will be needed to prevent the wheel from wobbling through too much sideplay. If the central hole becomes worn with use, it can be drilled out and a brass bush inserted to overcome this problem.



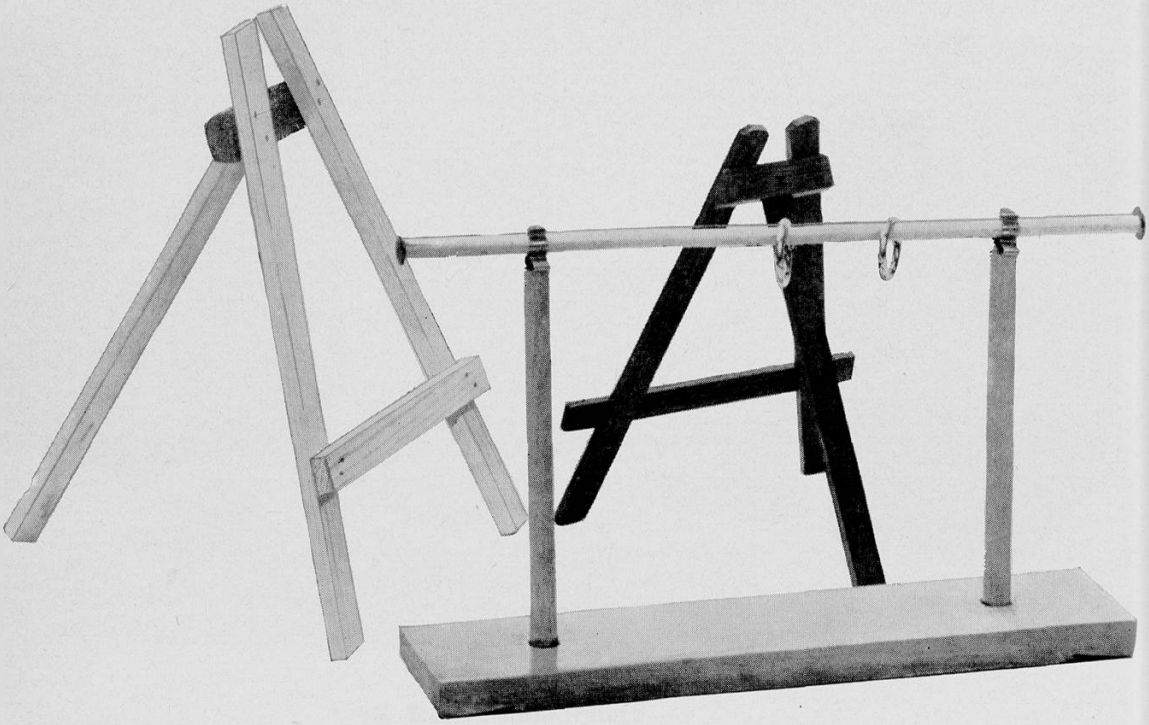
## 16. Germination frames

Growth experiments form a good field for children's investigation. A simple means of observing and controlling growth and movement in plants can be devised from the materials illustrated here. Basically, the frames consist of pieces of hardboard of a suitable size treated with several coats of varnish or clear resin lacquer. This makes the hardboard thoroughly waterproof. Alternate layers of thin absorbent cotton cloth and blotting paper form the moisture-retaining base on which to put seeds and seedlings. The whole is covered with a clear acetate sheet. This is held in place with paper clips. Tension can be adjusted by inserting thin strips of wood to act as spacers. Water, and various mixtures of plant food material can be supplied to the plants either by placing one edge of the apparatus in the solution, or by using a wick dripfeed, or by inserting plastic tubes which can carry food material at given intervals to the growing seedlings. A variety of sizes of pieces of apparatus of this kind can provide for both group and individual experiments.



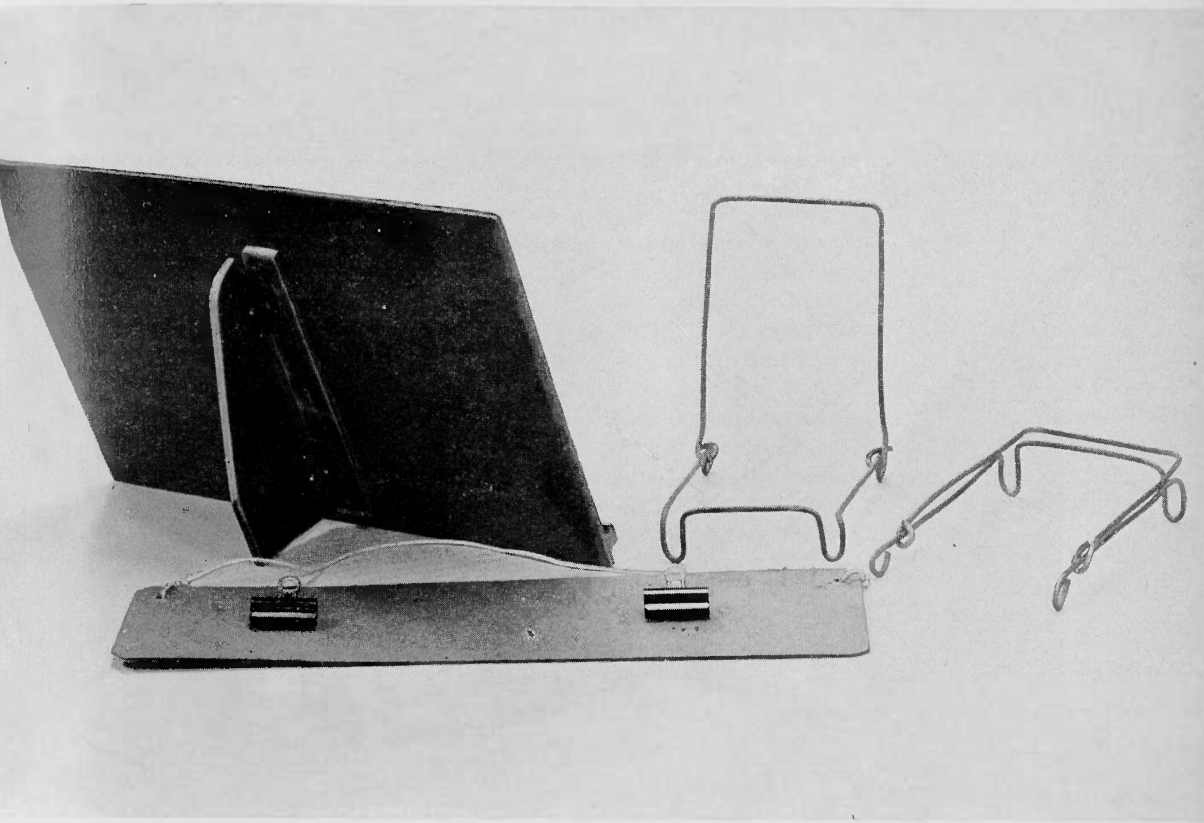
## 17. Display stage

A transparent stage for the examination and display of small pieces of material, both living and non-living, is useful. Such a simple device is shown here. Two blocks of wood, 4 in. by 4 in. by 2 in., form the side supports and a deep sawcut into the block on either side will take the glass shelf. The top of the blocks will form a hand rest when a lens is being used.



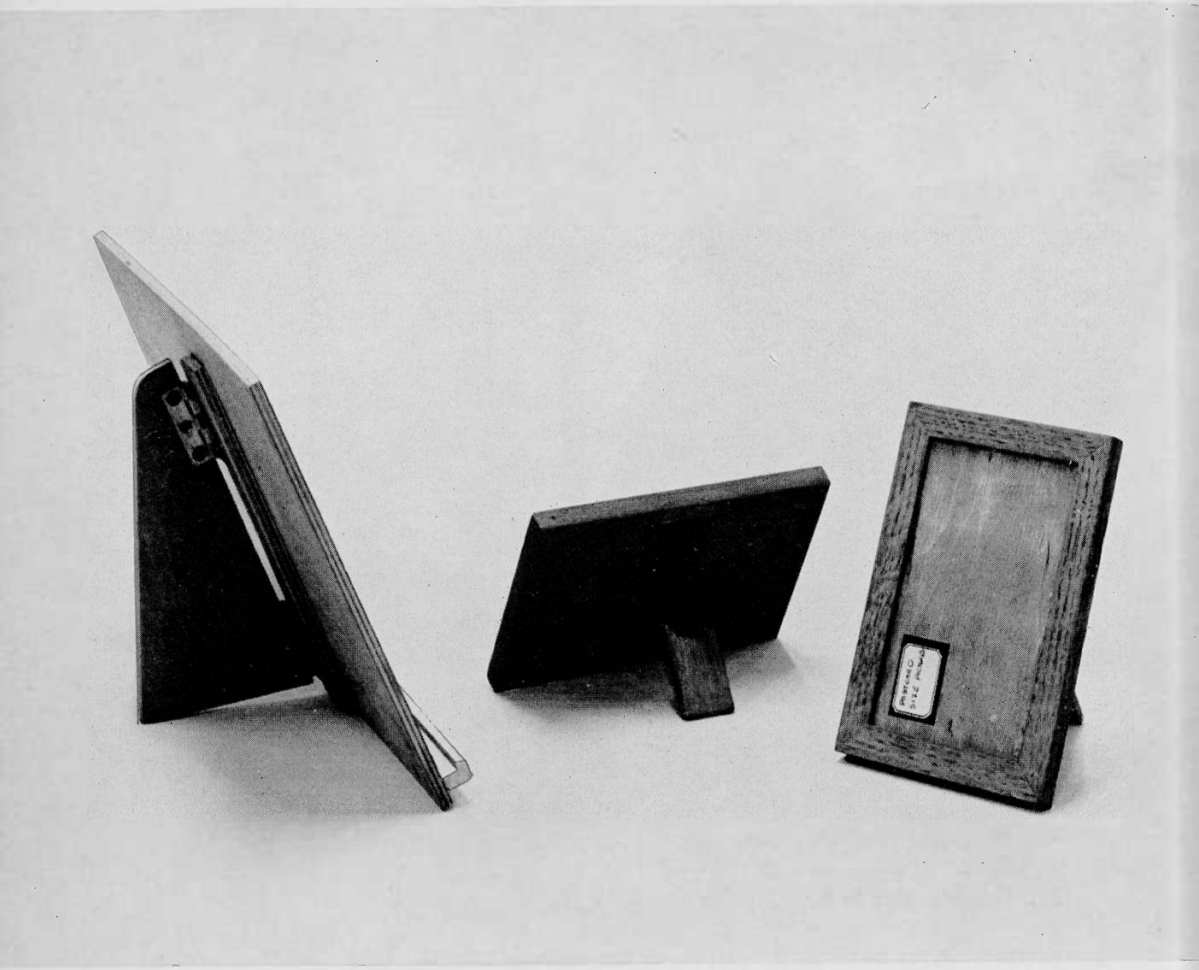
## 18. Display stands A

Displaying both illustrations and notes to support the pupil's discovery work is an essential aid both to teacher and child. This illustration shows three simple means of doing this. The holder in the foreground is completely portable, and is meant to take standard sized postcards which can bear both illustrations and instructions for procedures. The supporting pieces of dowelling at the sides end in Terry clips into which the horizontal support is placed. The small easels are easily constructed from wood $\frac{1}{4}$ in. by $\frac{1}{2}$ in. They can be made in various sizes to accommodate different kinds of material.



## 19. Display stands B

Three other forms of display holders are shown here. In the foreground the stiff piece of card, with two Waverley clips fastened to it with nuts and bolts, forms a handy chart holder which can be hung in various parts of the classroom. If the child wants to use the charts for continuous recording, it will be easy for him to remove them to make entries. On the right, the bent wire supports take book material easily. They fold flat for convenience in storage. The larger stand on the left takes large book material or small wall charts, and can conveniently hold such material at the back of a working space. It is a method, too, of making a single copy available to a group of children working at a bench or group of desks.

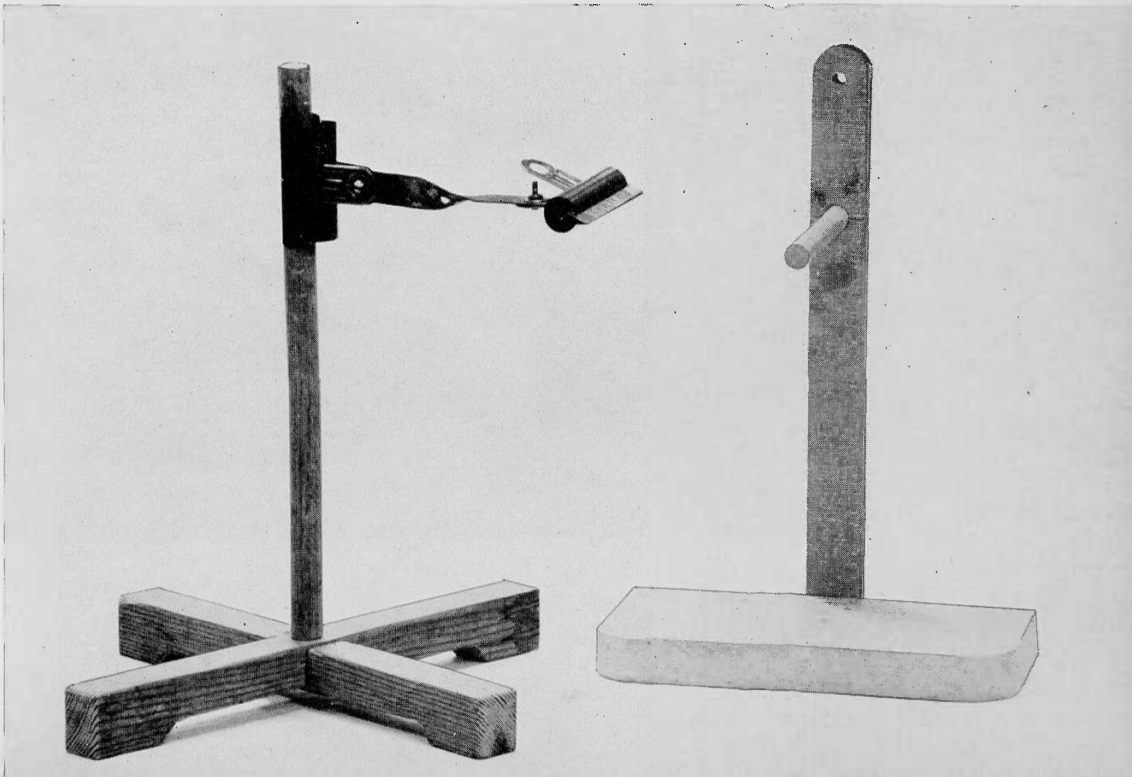


## 20. Display stands C

Old photograph frames are excellent as holders both of illustrated material and identification aids. Being portable, they are particularly valuable to the teacher, who can use them strategically to display aids to investigations.

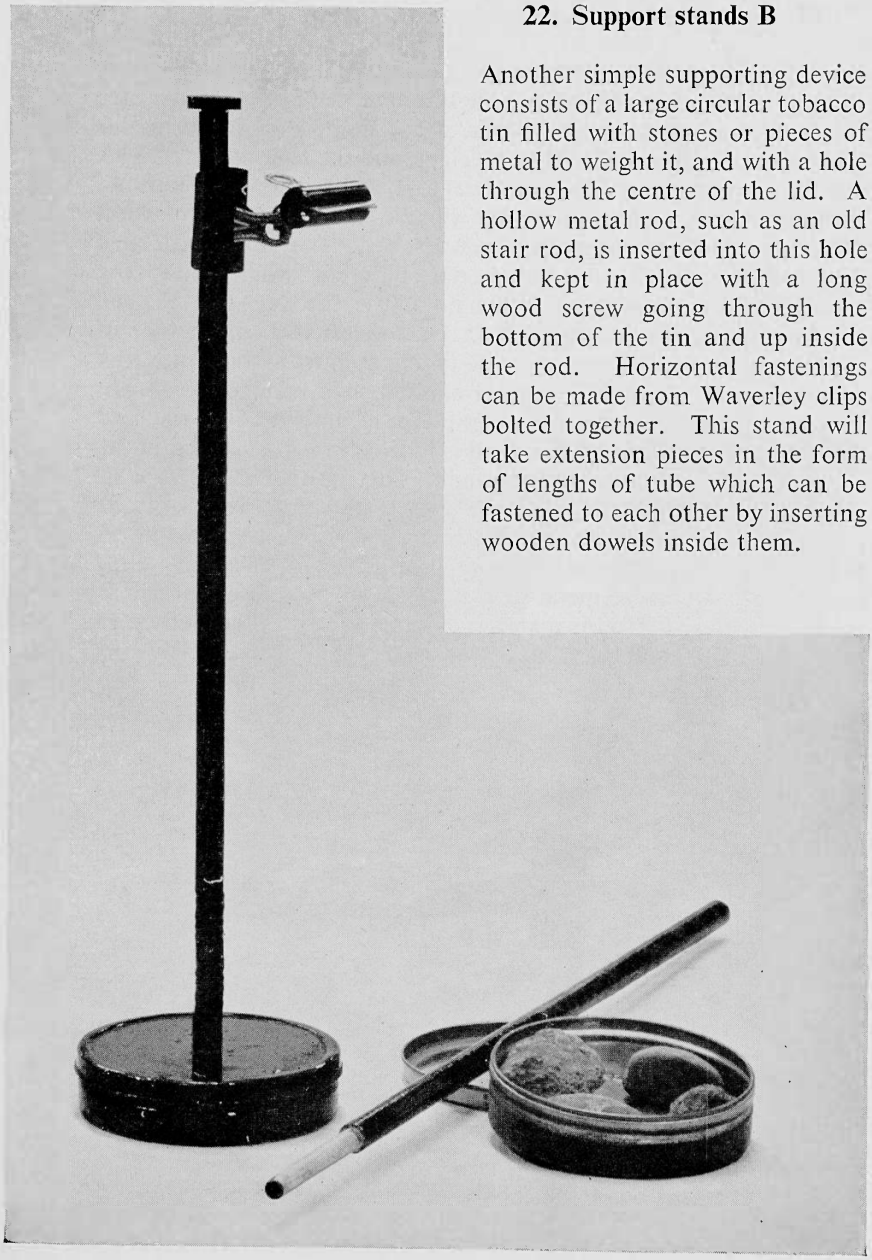
## 21. Support stands A

One of the biggest problems in practical work is that of supporting things. In the secondary school the standard piece of equipment for this is the retort stand. However, it has limitations in the junior school, both in terms of cost and weight, and the somewhat complex ancillary equipment which is essential to it. A few simple supports are illustrated here. The one on the right is merely a base of stout timber to which an upright has been screwed. Two holes have been drilled in the upright to accommodate different sizes of dowelling which complete the support. When not in use, the screws at the back can be removed for storing it flat. On the left is a robust type of supporting unit which can be made to any size, from miniature to a very large one which will support equipment over eight feet high. Basically, the stand consists of cross-pieces of timber halved one into the other. The upright of the stand is located in a hole drilled in the cross-pieces through to the ground. This upright can range in thickness from that of $\frac{1}{4}$ in. dowelling to 2 in. ash pole, with, of course, the base pieces of suitable dimensions to take it. In the model illustrated, the horizontal support consists of two Waverley clips separated by a strip of metal so that one grips the upright arm and the other is free to grip the material to be supported. The method of construction can be seen from the photograph.



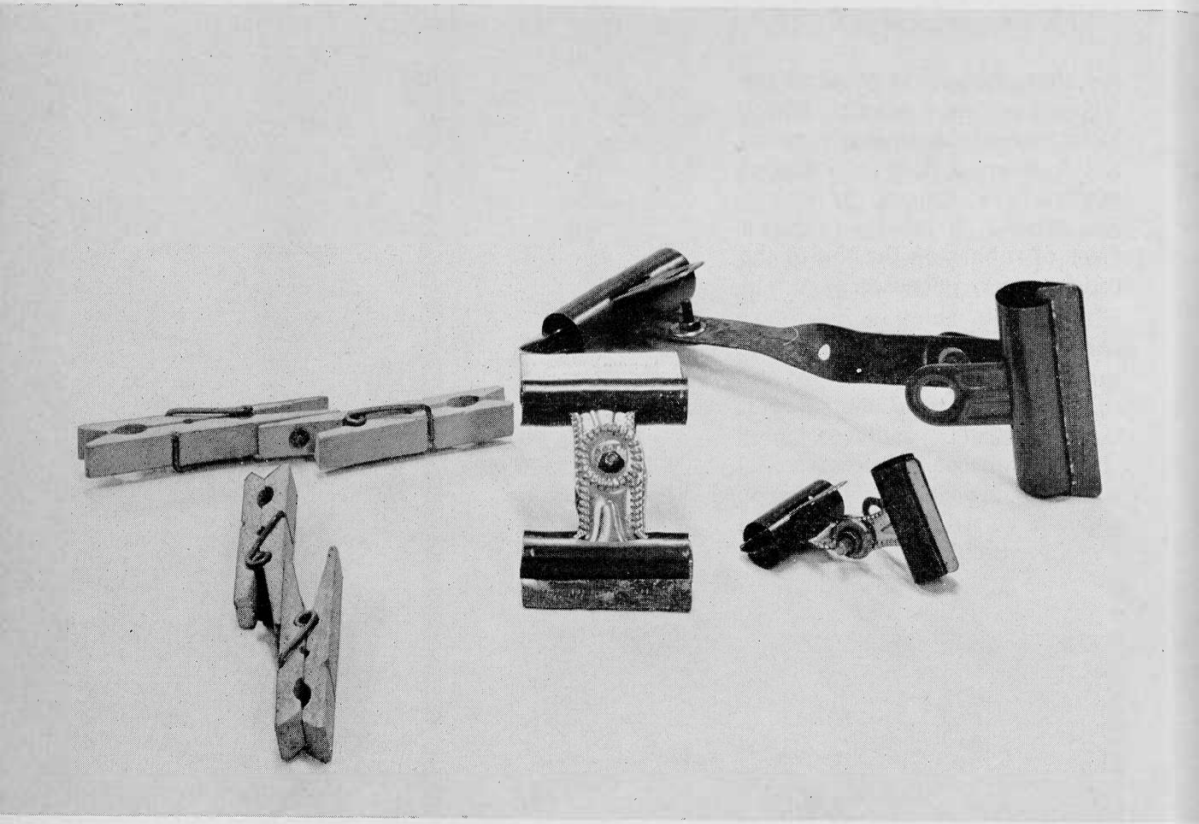
## 22. Support stands B

Another simple supporting device consists of a large circular tobacco tin filled with stones or pieces of metal to weight it, and with a hole through the centre of the lid. A hollow metal rod, such as an old stair rod, is inserted into this hole and kept in place with a long wood screw going through the bottom of the tin and up inside the rod. Horizontal fastenings can be made from Waverley clips bolted together. This stand will take extension pieces in the form of lengths of tube which can be fastened to each other by inserting wooden dowels inside them.



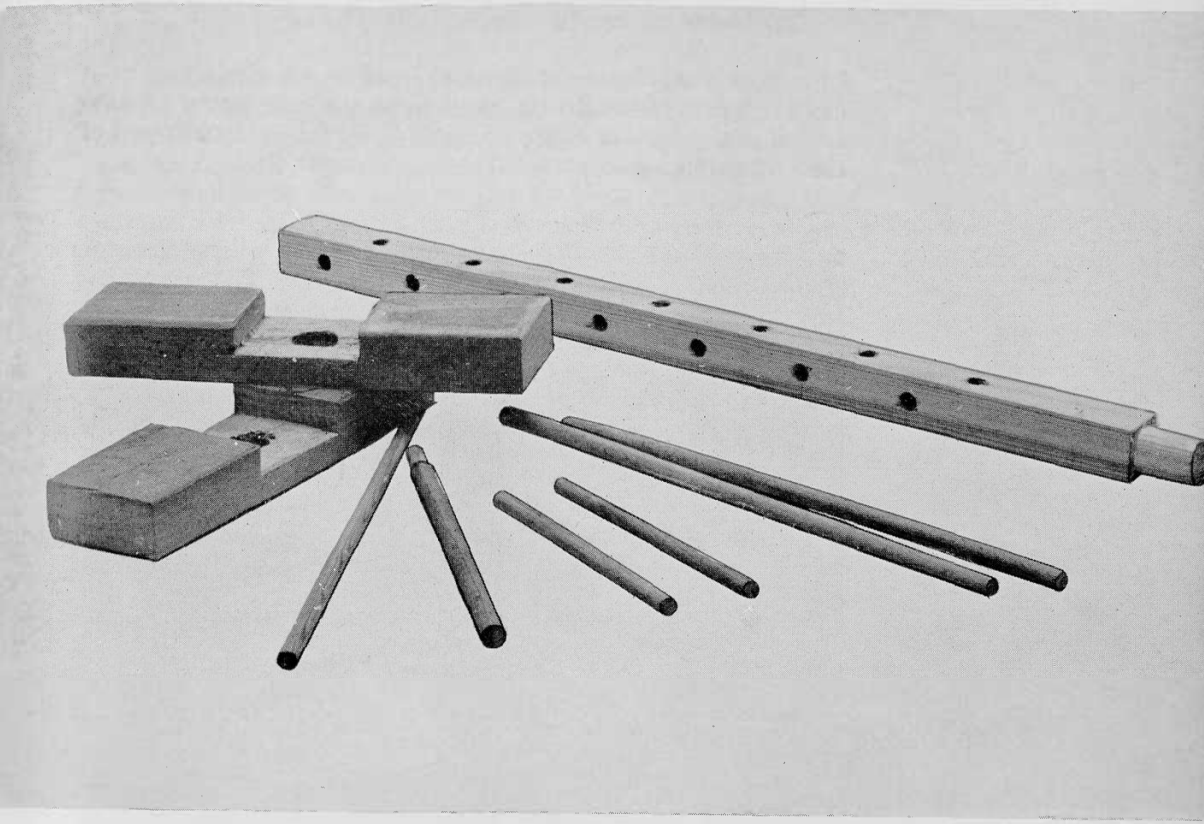
## 23. Support stands C

An alternative form of stand can be made from a wooden switch block into which a piece of metal rod is inserted firmly. This rod can carry a runner, as in the illustration. It is wise to put a piece of rubber on the top of the rod for safety purposes.



**24. Support stand clips**

This illustration shows a group of clips for upright stands. There are two large Waverley clips with a metal separator. This separator can be twisted to give either horizontal or vertical fastenings according to requirements. Miniature size Waverley clips in the right foreground have been fastened directly with nuts and bolts. Another two are similarly fastened in the middle of the photograph, but this time they are both facing in the same plane. On the left spring clothes pegs are used in a similar manner. These are not wholly satisfactory as one arm of the peg needs to be shortened to give sufficient clearance when the fastening is made between the two pegs.

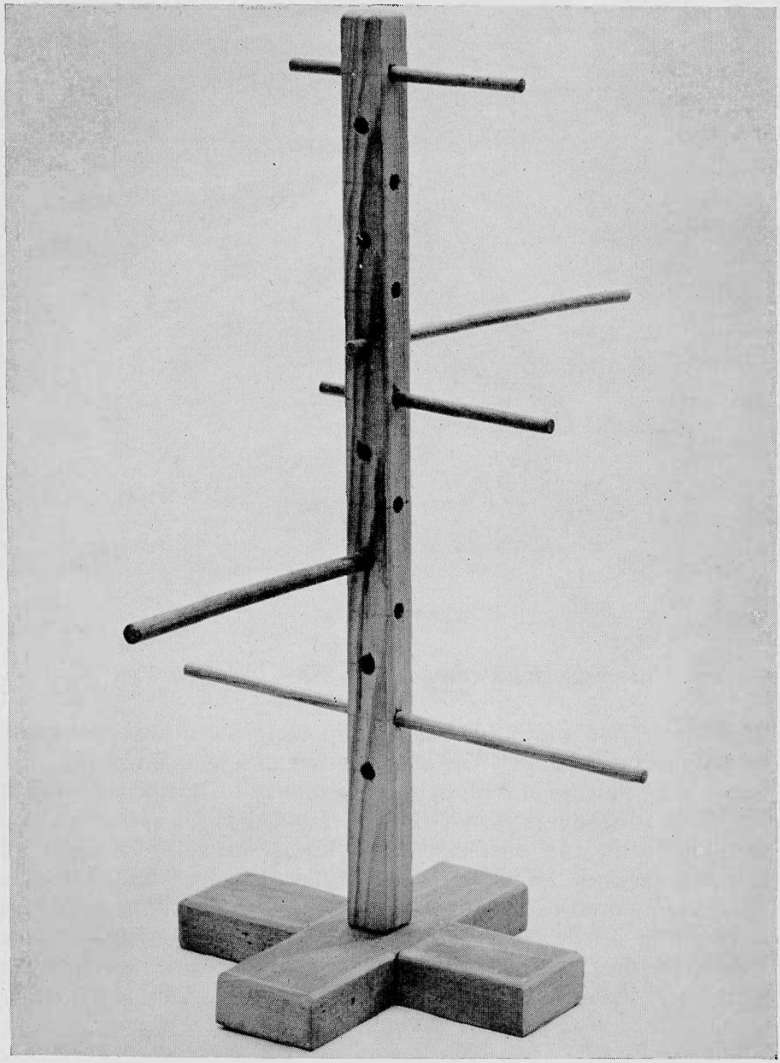


**25. Universal stand components**

This illustration shows the basic components for a universal stand of simple construction. The base consists of a simple halving joint between two pieces of 2 in. by $\frac{3}{4}$ in. battening. The upright is a 2 ft length of 1 in. square wood. This is rounded at the end to go into the hole in the two base pieces. Holes are drilled 1 in. apart on alternate faces of the upright. This means, in effect, that there is a fastening-point at each $\frac{1}{2}$ in. interval. Pieces of dowelling of various sizes can be fitted into these holes to give supports along the whole length of the material. Obviously, this same principle can be adapted to various sizes and shapes of wood according to the need.

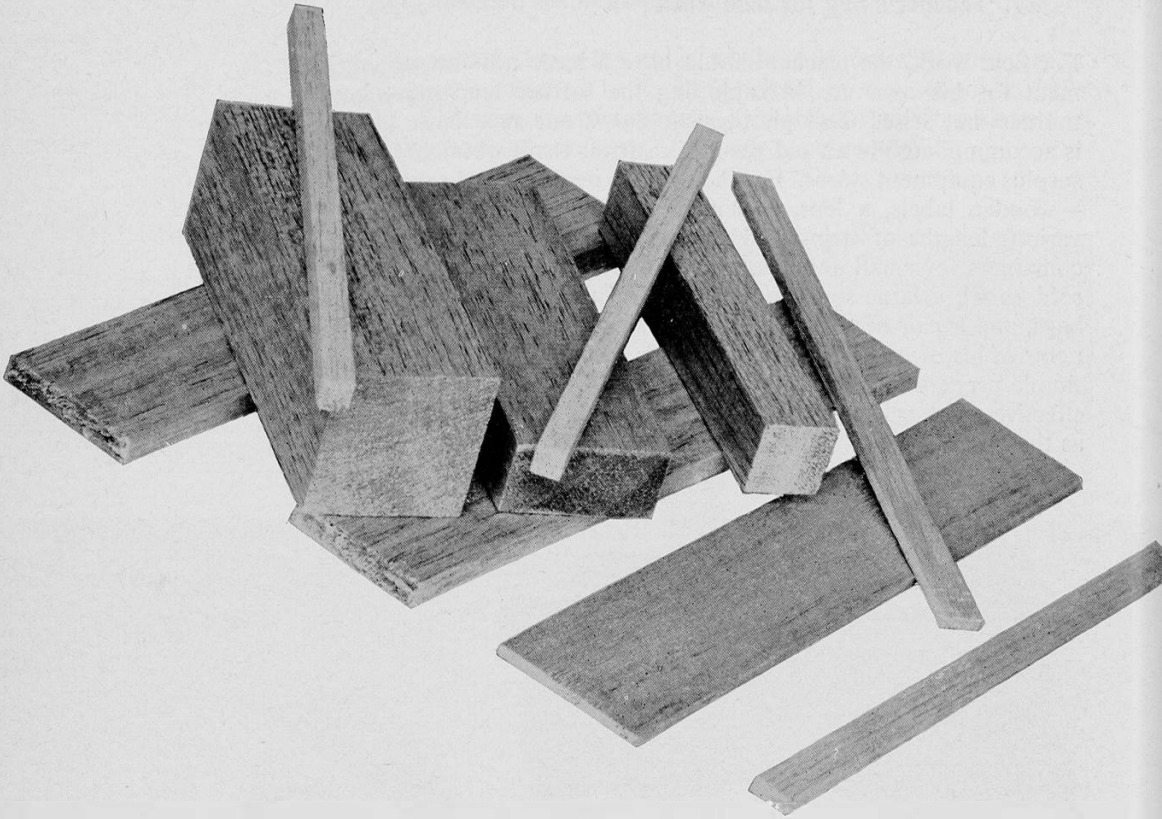
## 26. Universal stand assembled

This illustration shows the universal stand in use with a variety of cross-supports fastened to it. It is helpful in any school to have several of these pieces of apparatus available for children as part of their own working equipment for their experiments.



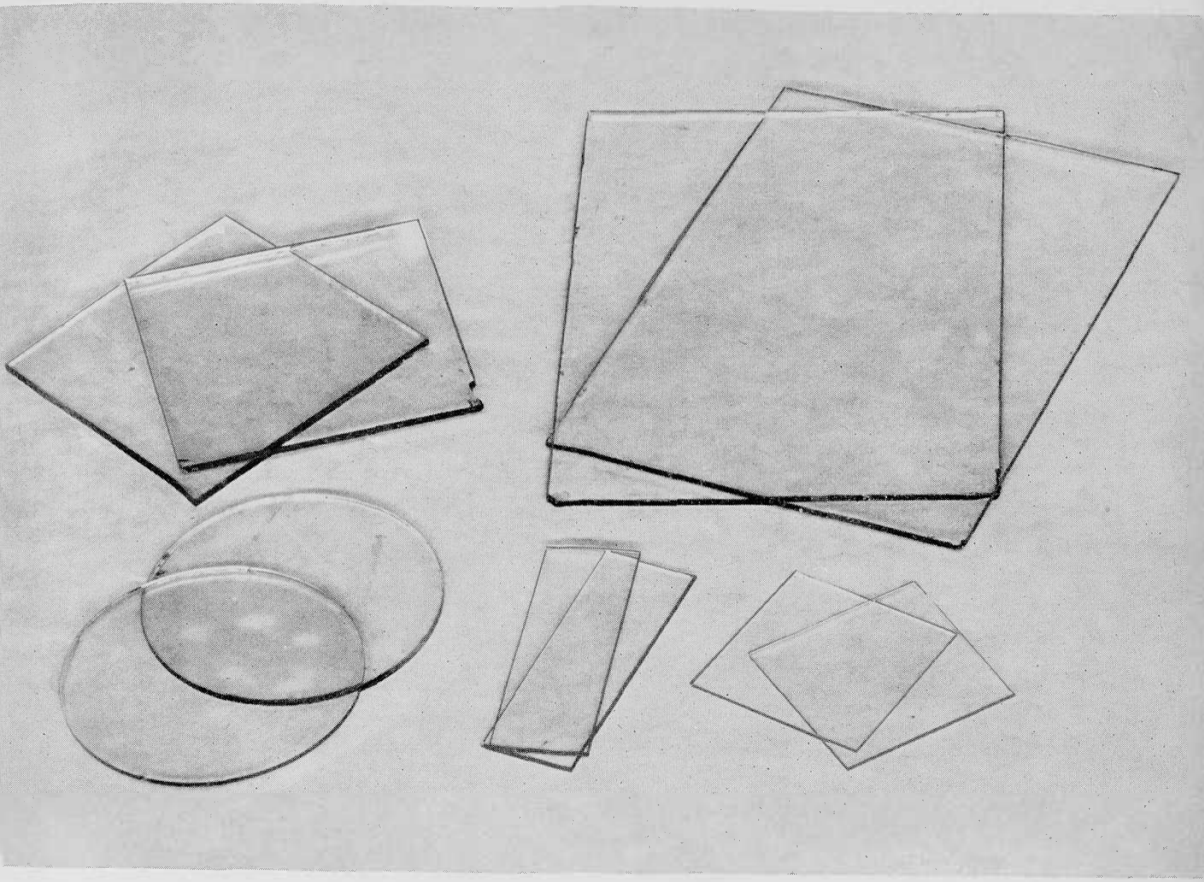
## 27. Teacher's bag for field work

For field work, the teacher should have a basic amount of equipment for his own use in exploiting the further teaching opportunities that arise. This photograph shows one such basic kit. It is accommodated in an old gas mask carrier easily obtainable from surplus equipment stores. For the rest, the items are self-explanatory —wooden labels, a lens, a pencil, a small stainless steel digger, various lengths of string and nylon cord, a pair of trouser clips, containers for small animals, a penknife, a steel scratcher, a small cold chisel, a large soup spoon, a steel measuring tape, Polythene bags, and a pair of secateurs. Obviously, a teacher will have other items of his own choosing to add to his own collection. With these simple preparations, work in the field can be made so much more effective and teachers will be in a position to seize new opportunities as they occur.



**28. Balsa wood material**

A wide range of sizes of balsa wood is a most valuable asset among the materials placed at the children's disposal. This illustration is a reminder of some of the common sizes and shapes which teachers would find helpful.

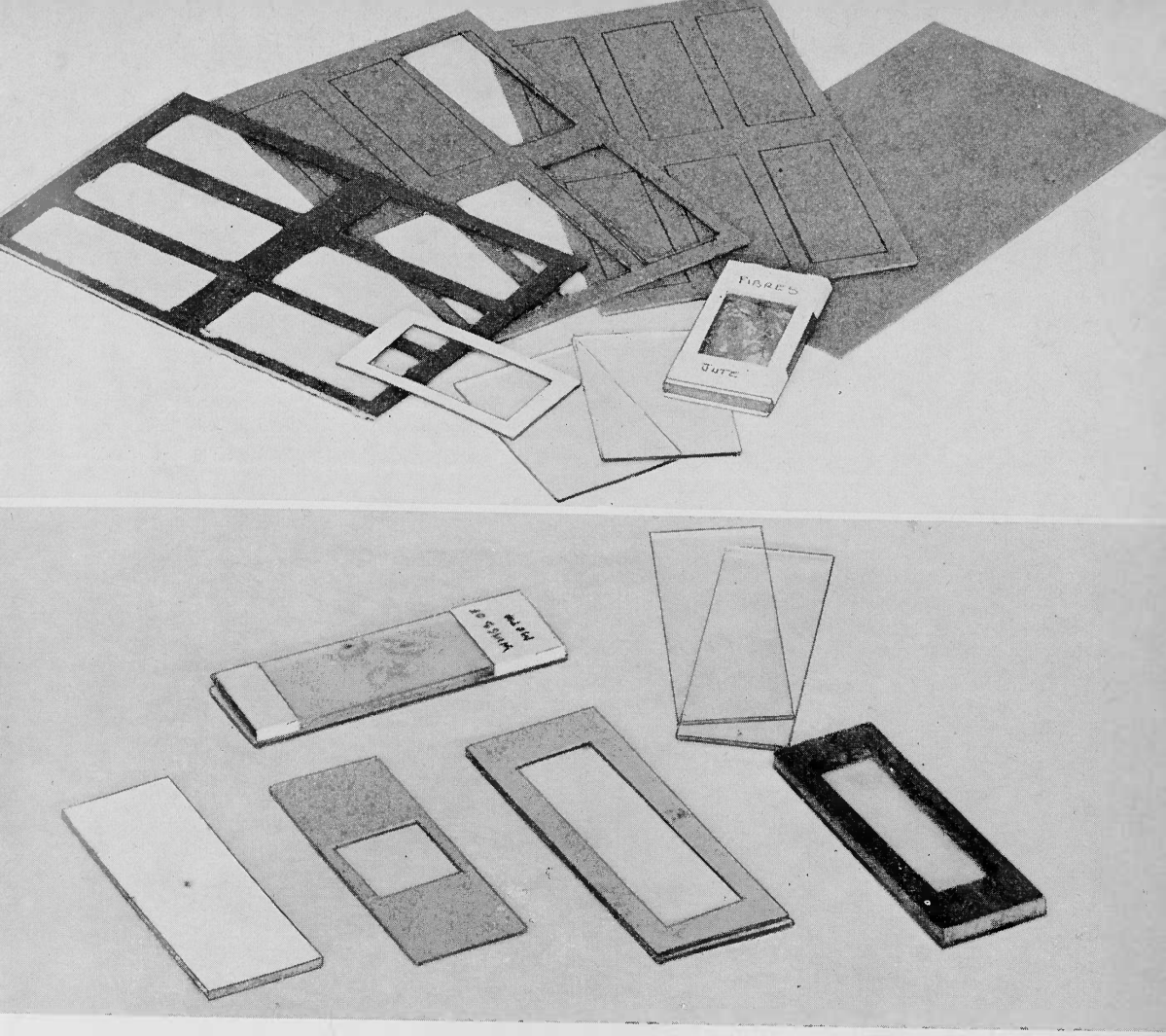


**29. Glass material**

It is also important to have a wide range of sizes of pieces of glass to form cover-plates to the various mounts which the children may want to make. This illustration shows 2 in. square glass plates, standard sized microscope glass slides, 3 in. circular glass covers as used in the laboratory for gas jars, 4 in. square glass pieces supplied by the local glazier as offcuts, and pieces of miscellaneous sizes again bought as glazier's offcuts at a very cheap rate. Make the edges of the glass safe by rubbing them with a fine sharpening stone or binding them with Sellotape.

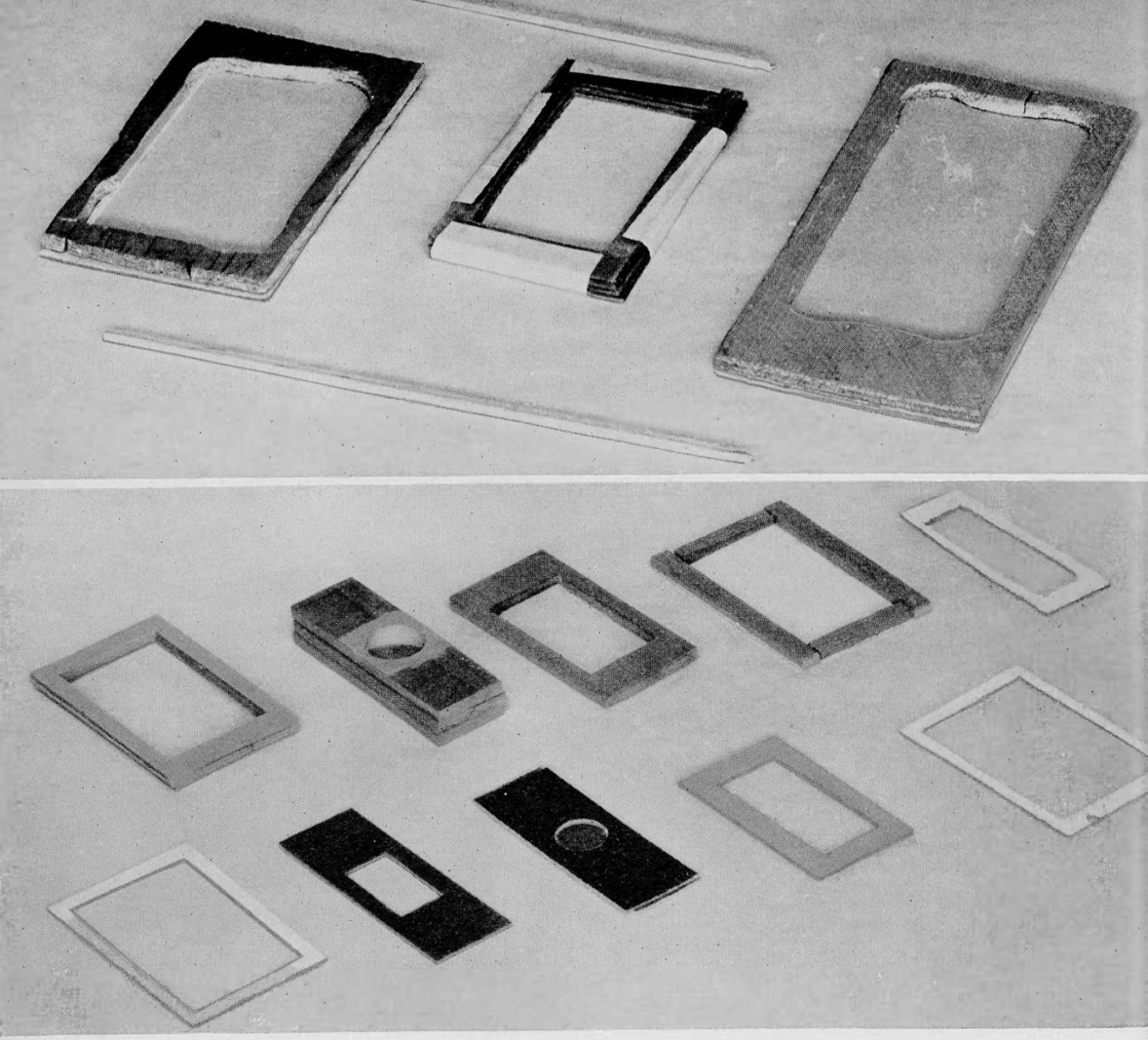

## 30. Storage and display material

These are materials which it is helpful to keep for the child to use when he wants to display specimens collected during outdoor work. Empty tins are useful as combined storage and display containers when work is interrupted. It is important to help the child deal with specimens without constantly handling them and so running the risk of damaging them and acquiring poor techniques and habits early on.




## 31. Mounts A

These illustrations show simple techniques for mounting and handling small objects, or for preserving them for future use and observation. Small seeds can be sandwiched between two clear glass plates, both backed with a strip of cardboard. Mounts can be made by hollowing out the centre of thin wood or cardboard and covering this with glass. Cardboard separators are shown marked out and cut out in the upper of the two pictures.



**32. Mounts B**

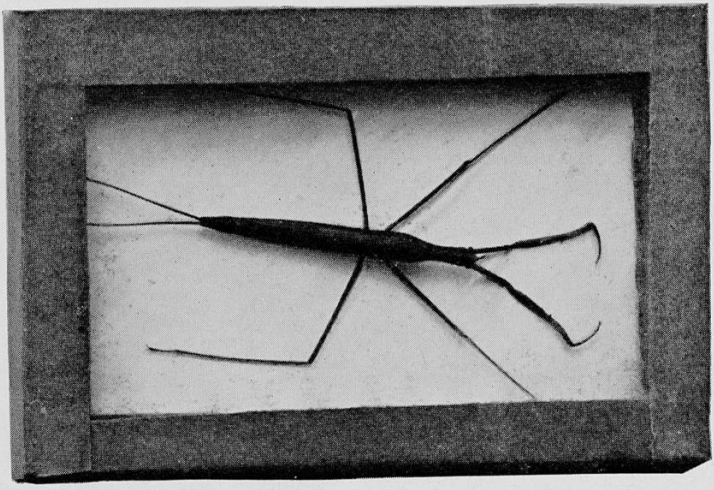
Shown here are various types of mount which are easily made for specimens of different sizes and types. If balsa wood is used this is easily cut with a penknife. Children, especially in the primary school range, very often identify their specimens by carefully matching them against others, and it is valuable to have a series of mounts which can be individually displayed. As well as preserving the specimens, the mere fact of mounting them shows the pupil the need to treat his materials with care and respect.

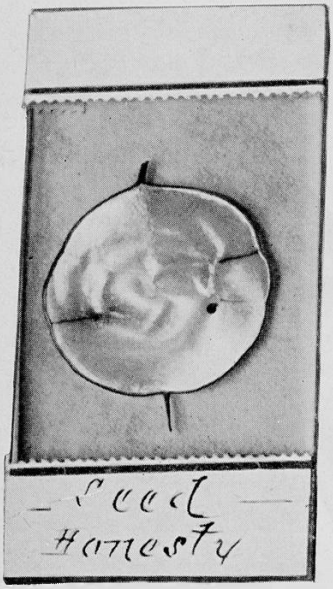
## 33. Mounts C

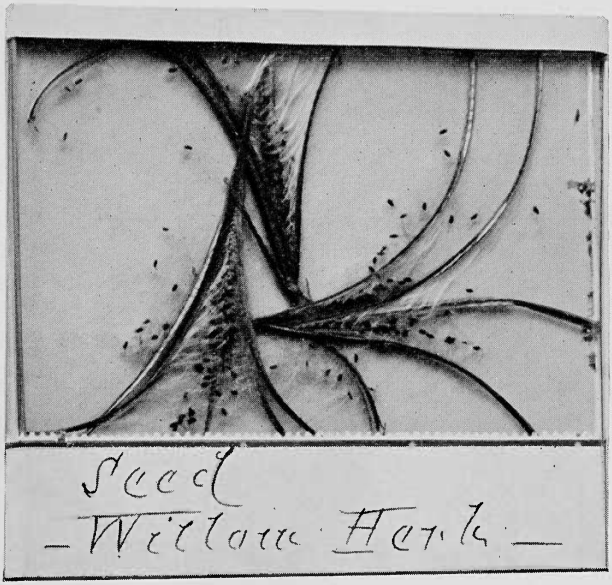
These illustrations show a typical range of specimens which have been mounted by and for children during the course of their work in science. This material has been used specially to bring out the need for conservation. If there is one specimen at the school which will serve for identification purposes, there is little need to bring back much more from the field. When living things are brought back, they can be identified and studied and then liberated. It is right that many teachers should be concerned about this side of the work, and indeed, it may well be one of the major responsibilities of the schools to teach an interest not only in living things, but also in preserving them alive in their natural surroundings.

## 34. Mounts D

Here are some more illustrations of typical subjects mounted by children using the equipment already described. A collection of seeds and fruiting bodies can be much better preserved in glass mounts with suitable spacers, than by many other methods. Comparatively large and small subjects benefit from display in a mount against a contrasting background. This can be seen demonstrated in these photographs quite well.

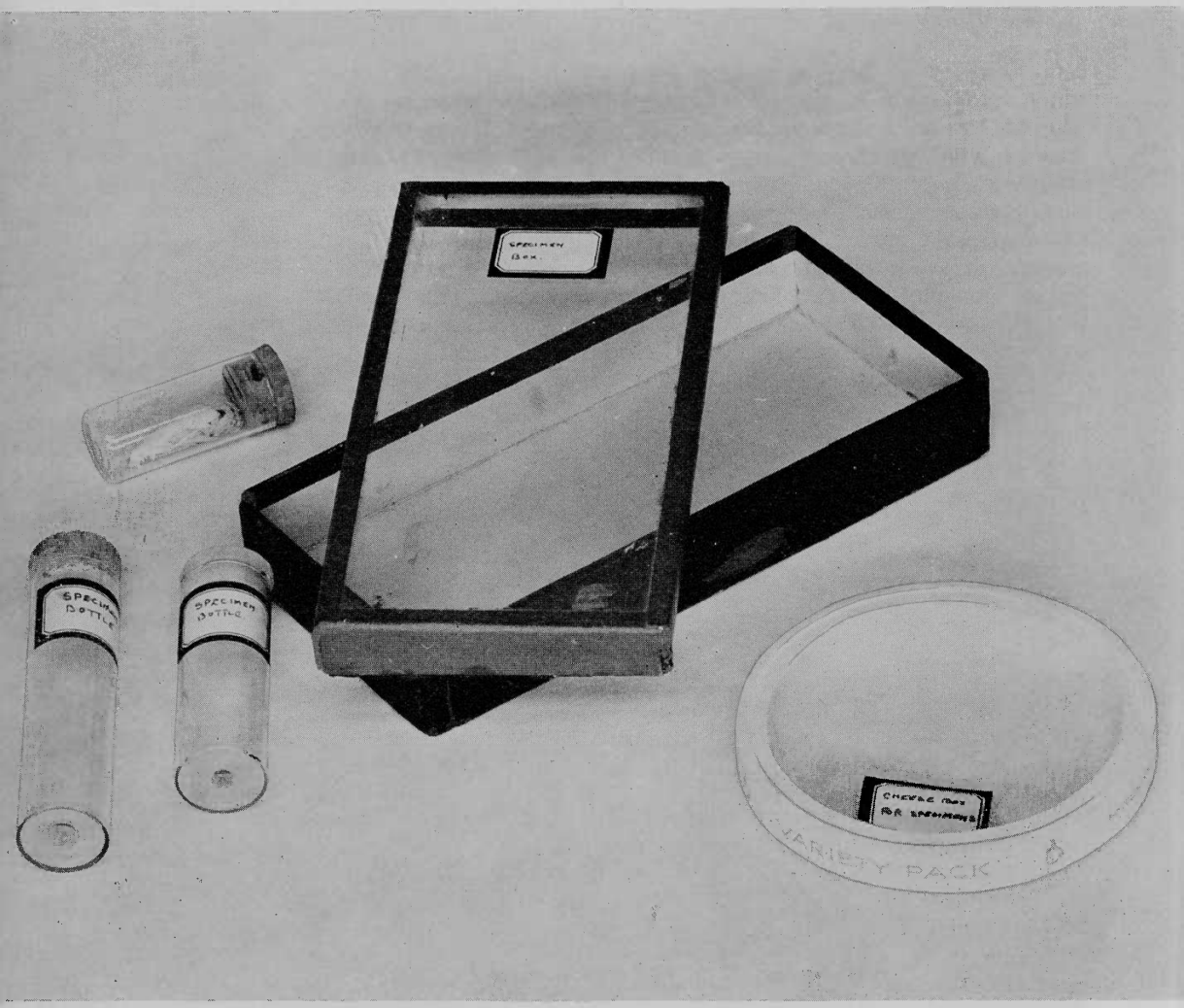




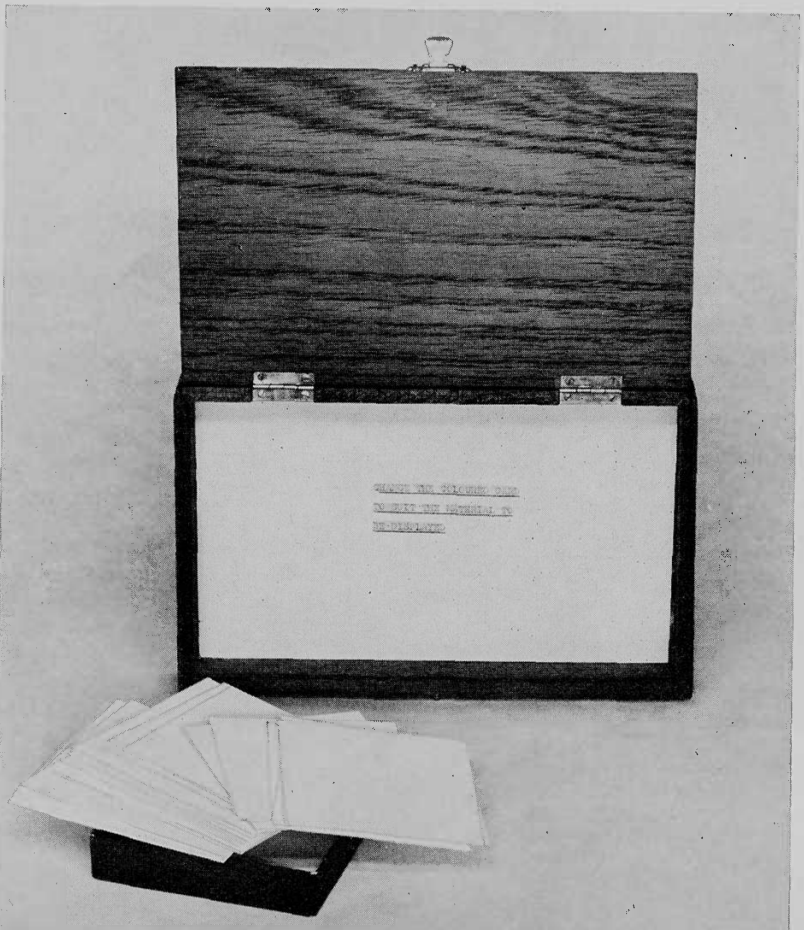
## 35. Mounts storage

The storage of mounted material is not really difficult, and is very important as glass mounts are liable to break unless care is taken. This illustration shows a suitable method of storage. It is designed round the box which contains the trays of mounted material. The trays are quite simply made by placing a group of slides on a sheet of cardboard, leaving sufficient space between each for a separator, and drawing round them. This sheet of card is then cut so that the marked spaces for the slides are removed. The cut-out sheet is then placed upon another sheet of cardboard and stuck to it, so that both form a tray to store the material, with each storage space the right size for the glass specimen holder. Several such trays can be stored in the one box. No doubt more elaborate devices can be designed, but the type that is illustrated can easily be made by the children themselves.


SPECIMEN BOX
SPECIMEN BOTTLE
SPECIMEN BOTTLE
VARIETY PACK

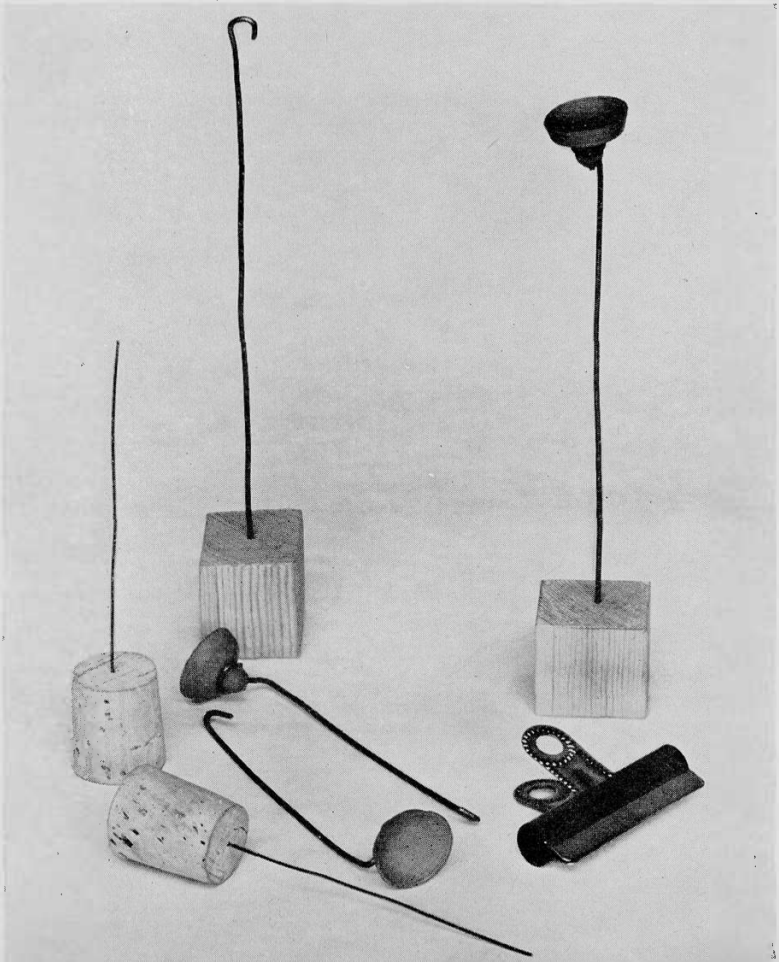
## 36. Storage containers

Much of the material that children collect for purposes of identification and study will be short-term in use. This sort of work does not warrant expenditure upon elaborate containers. These illustrations suggest some methods of providing containers for displaying such materials. On the left is shown an ordinary cardboard box with the lid cut away and an acetate sheet stuck in firmly in place of the cardboard. This makes a box which will hold a considerable amount of the larger material. A cheese box can be similarly treated, as shown in the bottom righthand corner of the picture. Empty bottles of all kinds are useful, but transparent plastic containers are far better. Empty cigar boxes such as the one illustrated in the photograph below can be particularly useful when a range of specimens needs to be displayed against a coloured background. It is helpful to have a range of coloured papers ready for this kind of work. These can be seen in the foreground of the picture.



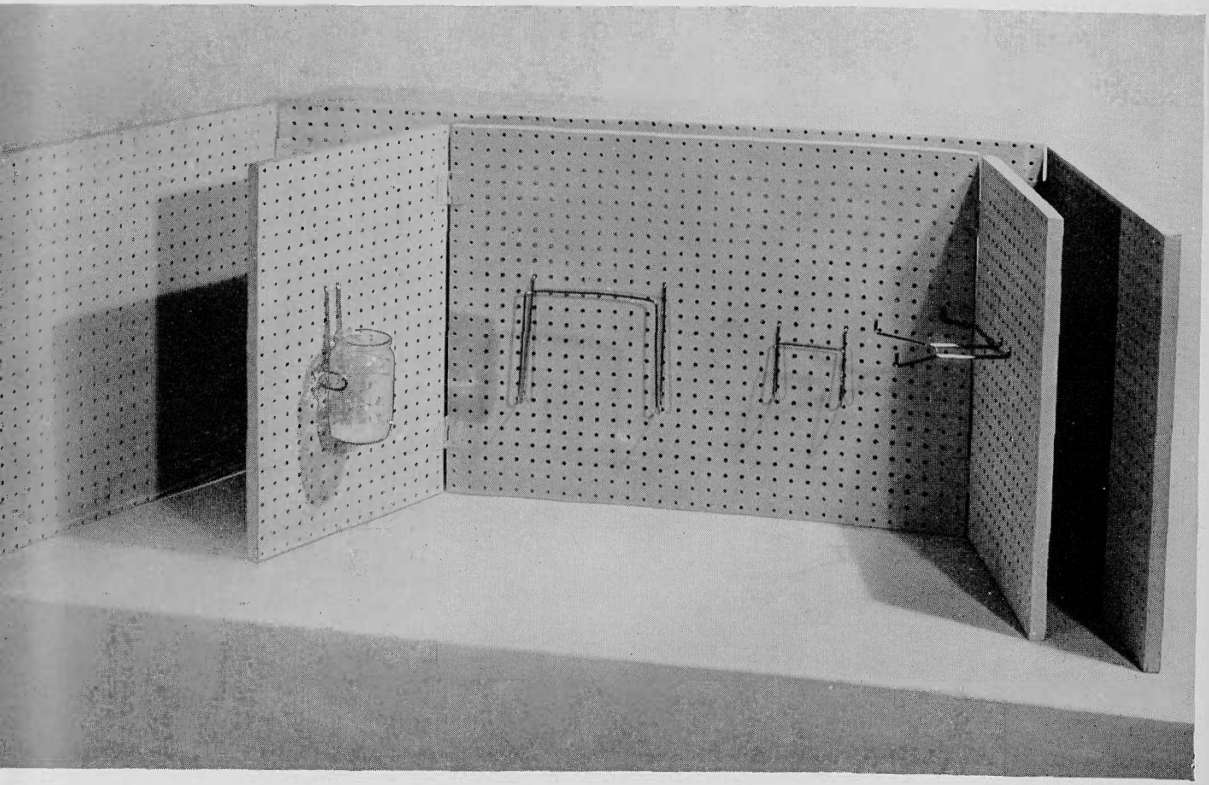
## 37. Display stands D

Supporting specimens both so that they will be visible in a display, and so that they can be better studied, is always a problem. The photograph here shows some methods of overcoming this. Hardwood blocks into which wires of different lengths are stuck, are useful. The wire can terminate in a rubber sucker, and this again will hold a glass plate which takes a specimen. Rubber suckers with wires bent into hook form and attached, allow specimens to be hung up at the back of a display, whilst corks with long thin wires will support light specimens in suitable places on a display table. Waverley clips are useful to grip bent pieces of wire which will in turn support light objects and specimens. In this way, materials can be arranged not only in a pleasing manner, but also in a telling one, which will enable children to study them better.



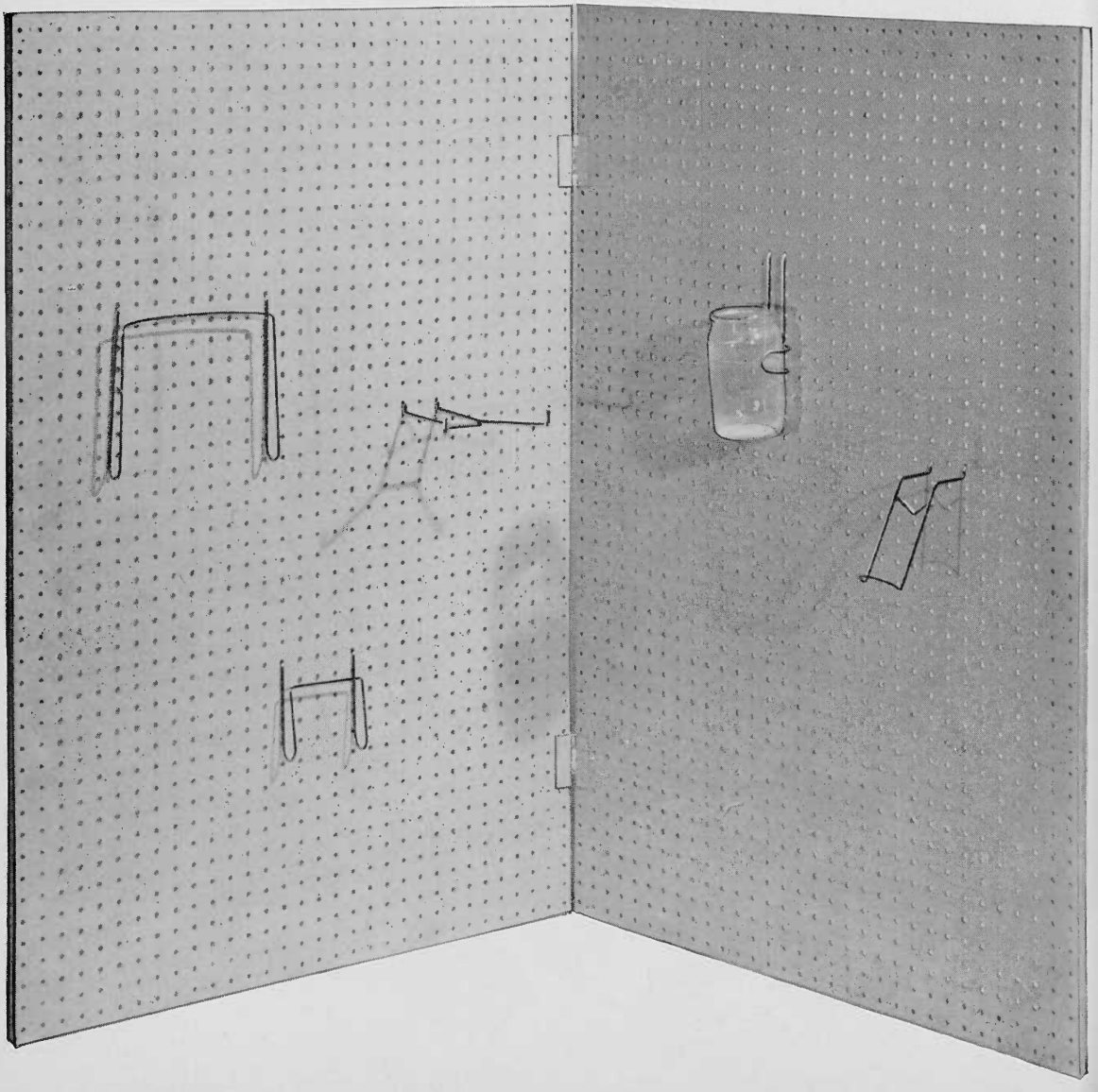
## 38. Display background screens A

This illustration shows two models of pegboard display screens for use in school. Their construction is obvious. The smaller, which is suitable to go on a standard pupil's table or desk, consists of a 2 ft wide background with two sidearms each 1 ft wide. The height can be varied to suit the needs of the particular situation. The larger model in the background is designed to go on a standard sized school dining-hall table. Sometimes surplus tables are available for classroom use, and the provision of a background support makes these much more effective. Dimensions of these larger screens are 3 ft wide at the back, with the two arms each of 1 ft 6 in. wide. The height in the particular model illustrated is 1 ft 6 in. Standard pegboard fittings can be attached to these display screens, as well as many other devices.



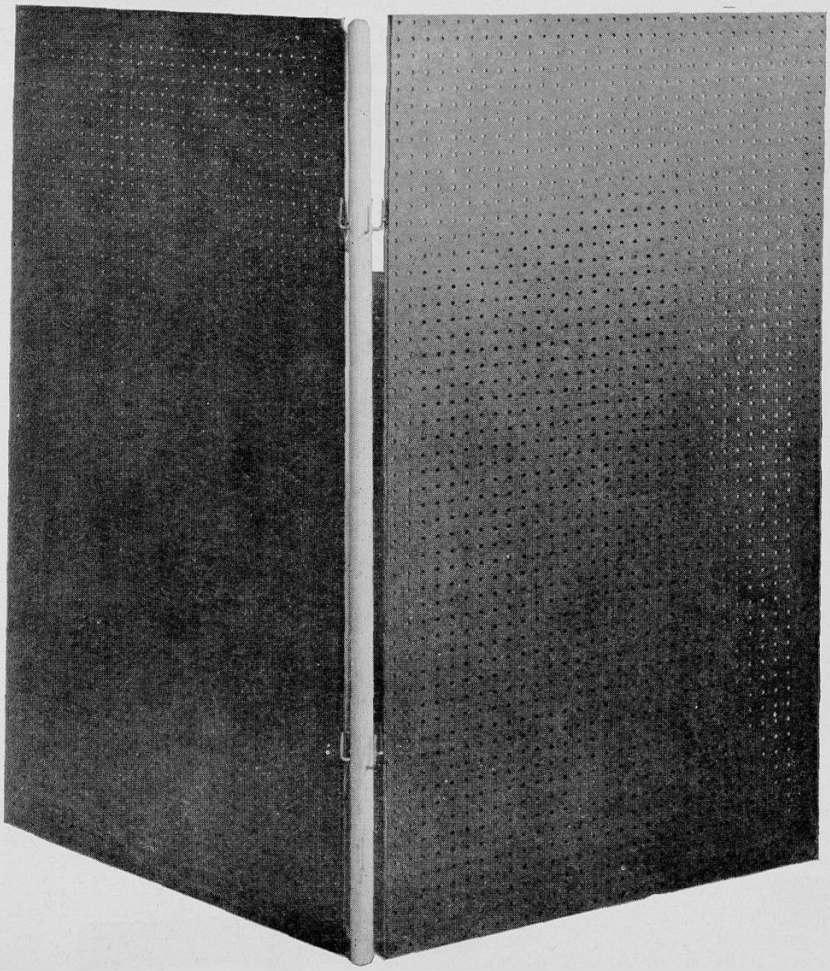
## 39. Display background screens B

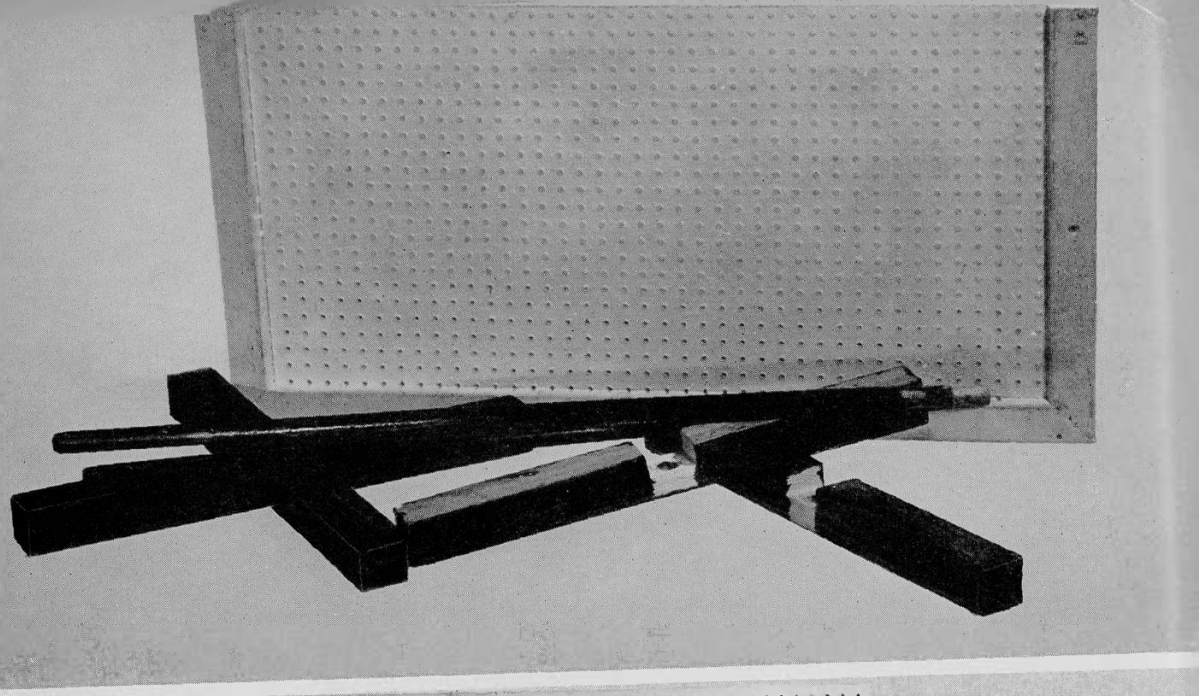
In classrooms where conditions are cramped, vertical display space is the most important of all. The display screen illustrated here consists of two 4 ft by 2 ft sheets of hardboard, stiffened at the back with battening and hinged in the middle. This can be a free-standing or a table-mounted display screen, or even a working point for some children. It can also be used to screen off a small working area from the rest of a rather cramped classroom.

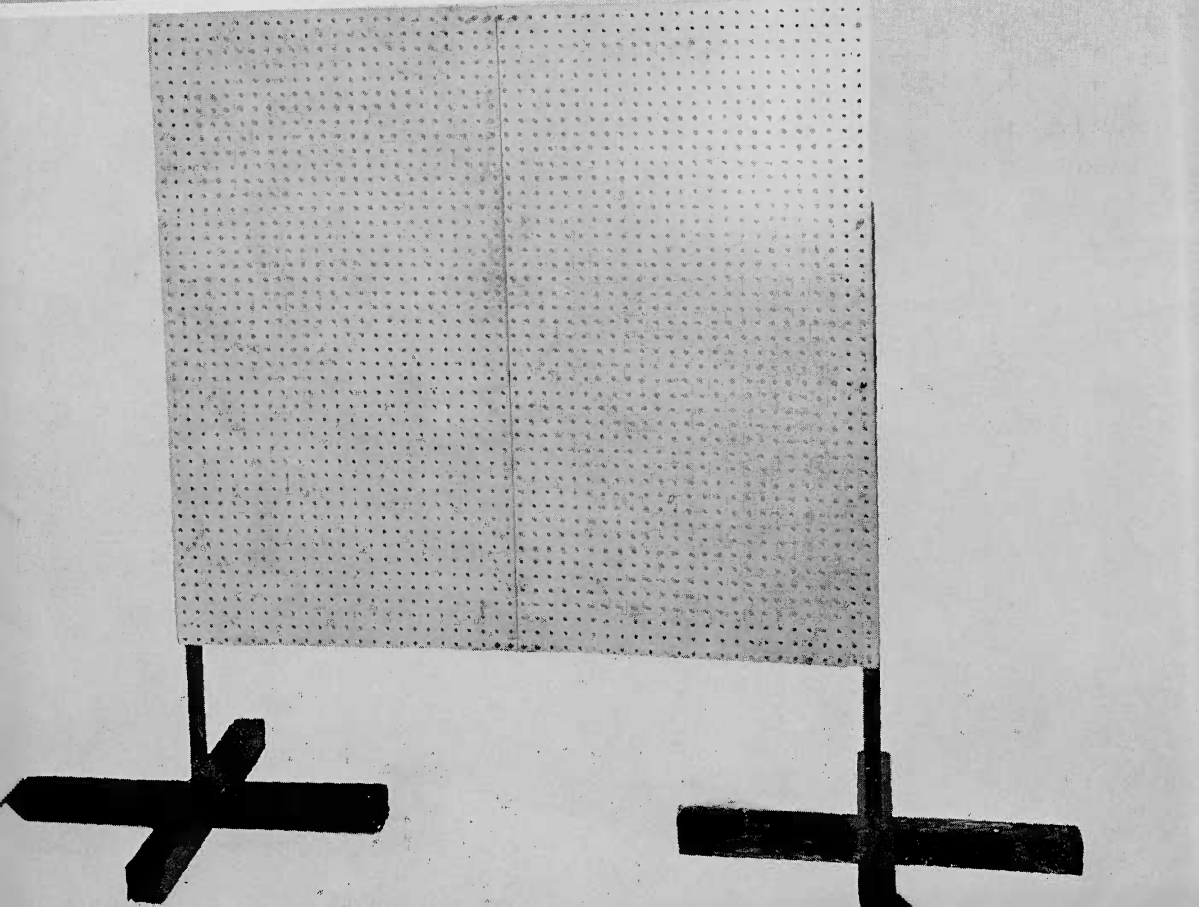


## 40. Room divider

In large classrooms it is sometimes desirable to have an easily erected form of room divider. This suggestion of physical division sometimes makes group work easier to organize, and easier for the children to sustain. This threefold or fourfold divider consists essentially of 4 ft by 2 ft units of pegboard each stiffened at the back with battening round the edges, and with 'eyes' placed at suitable positions on the inside edge. A stout beech broomstick is drilled at corresponding points and wire put through the holes. This wire is cut and bent to a right-angled hook. The pegboard can then be hooked on through the eyes and thus form a free-standing unit. To store the unit you only need to lift the sections off the metal fixings and put the broomstick and the flat pieces aside until they are next required. (In order to display the hooks we have shown only two units attached, but this divider takes three.)



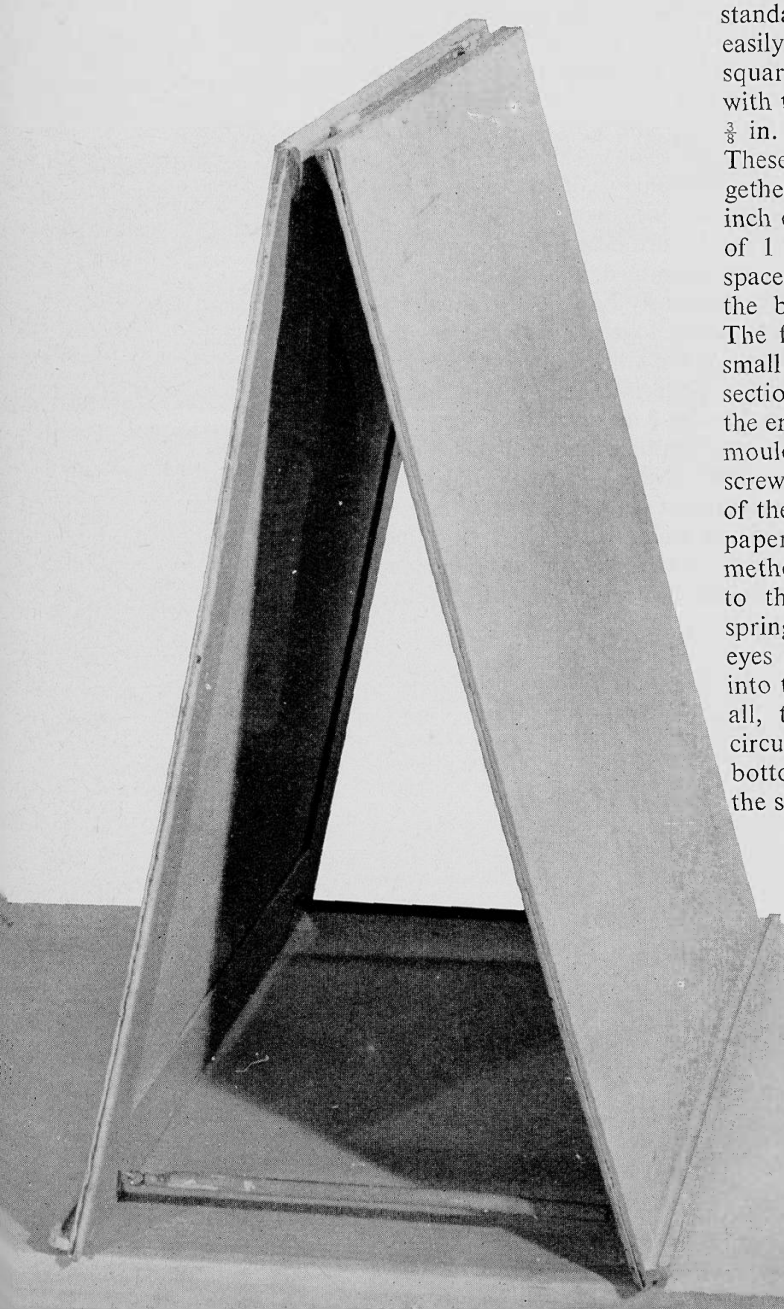




## 41. Display screen A

A display screen which is free-standing is illustrated here. Thus, it can be located anywhere in the classroom or in an entrance or a corridor space which is used for group work. It is also constructed in a manner which will allow it to be taken apart easily for storage. The same method of construction can be applied to designs of many sizes. The upper photograph shows the main methods of construction. Each foot is made from two stout pieces of 2 ft × 2 in. × 2 in. timber halved together in the centre and with a 1 in. hole drilled in the joint to accommodate an upright. The uprights are made from beech broomsticks. The screen itself consists of two pieces of pegboard stiffened at the edges with battening and drilled on the vertical edges to correspond with holes drilled into the broomsticks. The lower picture shows the screen assembled. The method of bolting the screens to the uprights can clearly be seen. Then the two assembled halves of the unit are joined together with two strips of metal, or oak, bolted to the back of the stiffening bars, across the joint in the two sections. A metal plate is best for this joint as it gives strength without bulk, but $\frac{3}{8}$ in. by $\frac{3}{4}$ in. oak battens have been used equally successfully. The only limiting factor in this piece of equipment is the spread of the feet. Naturally, these have to be avoided by children who are working at the apparatus so it is not convenient to make it on a very large scale. However, it does mean that otherwise difficult areas of a school can be converted into learning spaces, thus freeing room in the classroom for really rich exploitation as a teaching space.

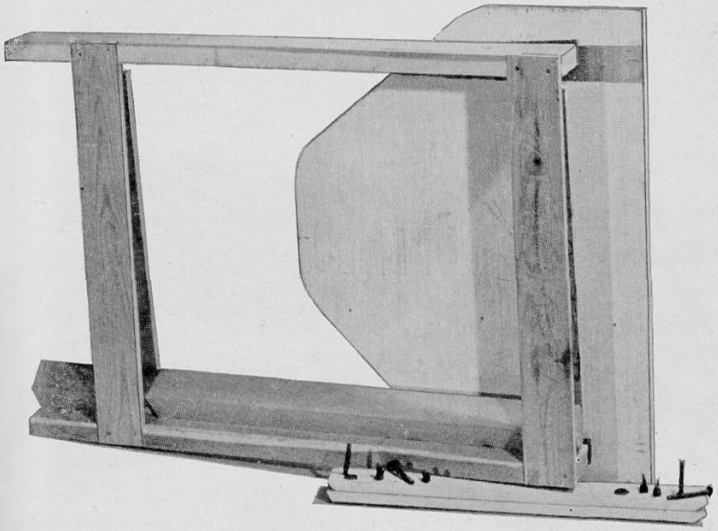
## 42. Display screen B

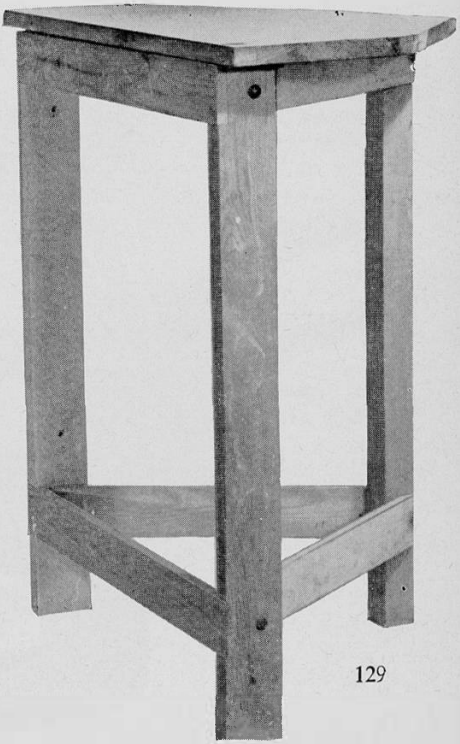


An easel type display and working unit is illustrated here. This is of dimensions such that it occupies a standard pupil's table or desk easily. It consists of two 2 ft square pieces of hardboard edged with thin battening for stiffening; $\frac{3}{8}$ in. by $1\frac{1}{2}$ in. material is ideal. These sections are hinged together at the top. Pieces of half-inch dowelling are cut to a width of 1 ft 3 in., and these act as spacers when they are fastened to the bottom edges of each side. The fastening is made from two small hooks placed in the flat sections, and 'eyes' screwed into the ends of the dowelling. Picture moulding of a suitable size can be screwed along the bottom edge of the flat sections to hold books, papers, etc. An alternative method of holding material flat to the display space is to use springy curtain wire. The fixing eyes for this can easily be put into the side battening, or best of all, the curtain wire used as a circular band slipped round the bottom of the whole unit before the spacers are clipped into place.

## 43. Portable work bench

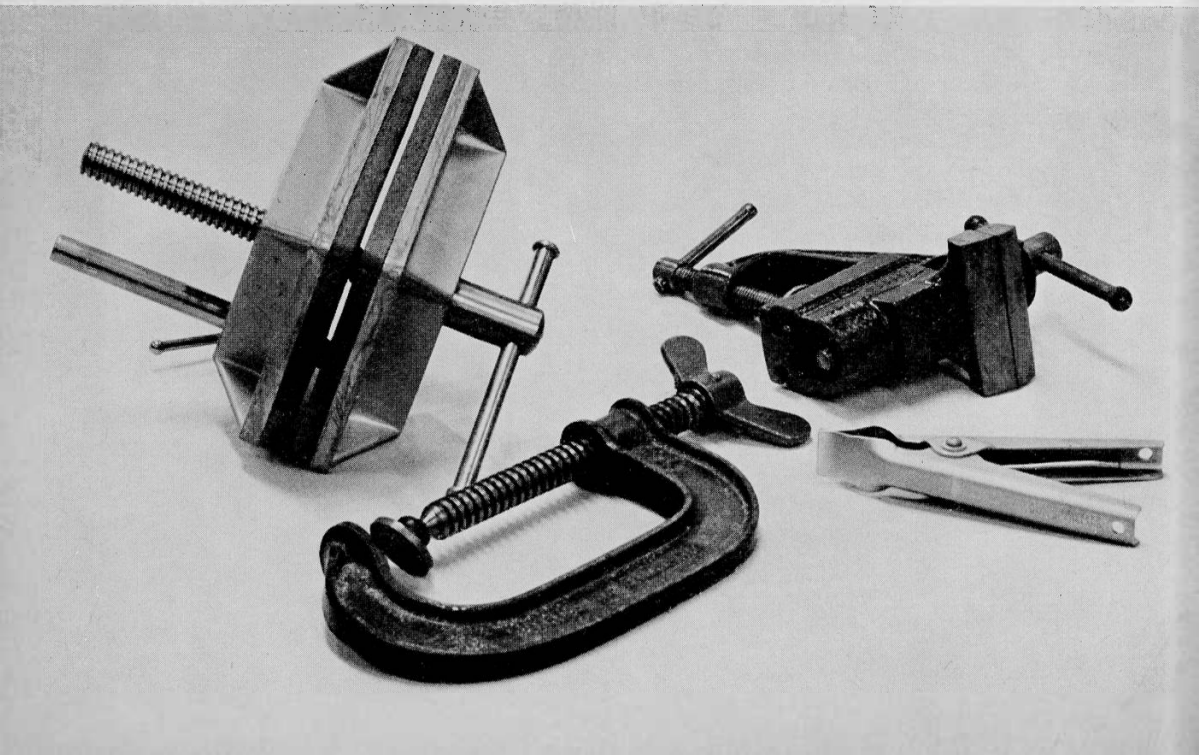
In classrooms where space is severely restricted it is not always possible to accommodate a bench or stout table for light handicraft activities. The illustrations show an attempt to solve this problem. This is a completely portable work bench. The triangulated base and leg section are constructed from $\frac{3}{4}$ in. by 2 in. battening and, for its one stout leg, 2 in. square material. The sections are so hinged that they will fold together and let the unit be stored flat. The top is made from 1 in. thick material, hinged at the back and with the apex located over the leg 2 in. square. It is at this point that really heavy hammering should take place. Though the other legs will undoubtedly stand this sort of treatment, the one that is 2 square in. thick is designed for it. In addition, the top extends beyond this strong support far enough to allow a small vice to be fastened there securely. The whole unit is held together with $\frac{1}{4}$ in. nuts and bolts. Butterfly nuts are used, so that it is easy to assemble. When all the nuts and bolts are tightly in place, this makes a really rigid working unit capable of withstanding the sort of strains that children will put upon it. It should be stressed, however, that it is not designed for heavy work by adults but really to allow practical work to take place in a classroom where space is so restricted that it might otherwise be impossible.





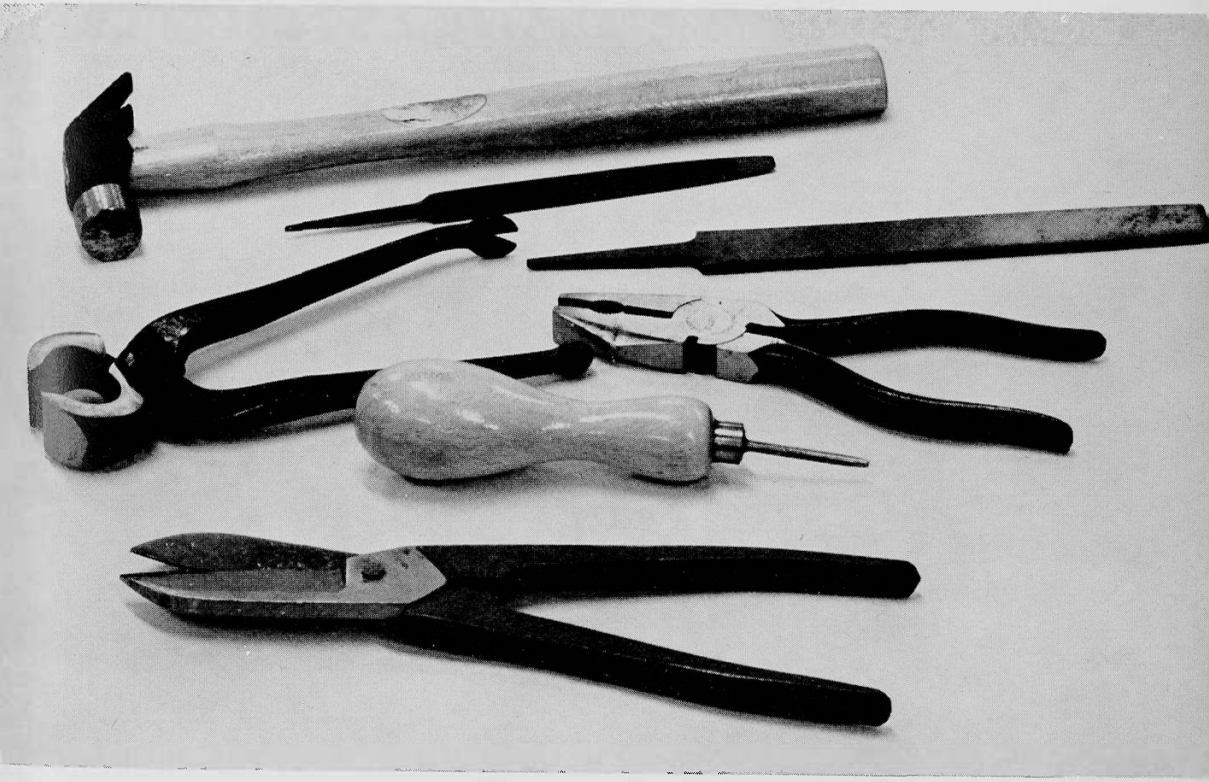
## 44. Vices and clamps

The first essentials for practical work in the classroom are not the cutting and shaping tools, as might be imagined, but essentially vices or clamps to hold the material firmly, so that it can be safely and successfully worked upon. The illustration shows the four commonest types of device which children have used most successfully. In the background, there is a Stanley vice which clamps onto a table or bench of the kind already illustrated. This allows material to be held in two planes quite easily, and is probably the best general purpose device of this kind for work in the classroom. Immediately in the foreground from it is a conventional G-clamp. A clamp 3 or 4 inches in size will do all that is necessary by way of fastening materials that children will commonly use. Also in the foreground is a clamping device which is very useful for holding thin materials such as hardboard or pegboard. This spring-loaded clamp may be rather difficult for small children to open and close, though the simplicity of its action commends it strongly. In the background there is a small table-fitting engineer's vice. This can be accommodated on a table or a bench of the type already described. When metal objects are to be cut, a vice of this sort is certainly most useful. None of these pieces of equipment is expensive. If accidents are to be avoided, it is most strongly urged that some form of vice be used when practical work is done by children.



## 45. Tools A

Some tools essential to the classroom work section are illustrated here. They consist of a small sized hammer with a claw end, triangular file of second cut, a flat file 6 inches in length of second cut, medium sized pincers, medium sized pliers with sidecutters for wire, a 1½ in. bradawl, and in the foreground a pair of tinsmith's snips. (Teachers should take care that the pattern of the snips is as illustrated and not the sort where the ends are turned inwards.)



## 46. Tools B

A further selection of tools is illustrated here. The sheet saw in the foreground is supplied with two blades made from steel which will cut almost any material. This makes the saw particularly useful for children, as damage will not arise to the blade if wood containing nails is used for their work. Both the finer blade and the one shown will cut metal speedily and safely. The junior hack-saw is also a most useful tool. This will cut most materials and is of a size which children can handle easily and skilfully. To the right of the group of saws is a small dovetail cutting saw. This is useful to younger children for working soft woods and smaller pieces of material. On the left is a cutting knife for use with balsa wood. It has a detachable blade so that the dangers of the blunt blade can be avoided. This knife should be used in conjunction with a steel safety rule. A small ratchet screwdriver is a useful addition to the classroom tool kit. Children soon master the working of a ratchet, and it makes the insertion of screws in awkward places much easier. A light hand drill taking bits up to $\frac{1}{4}$ in. is essential to complete the first purchases of tools for the classroom work bay.

## 47. Tools C

The teacher will find a brace and a set of centre bits a most useful addition to the classroom tools. The illustration here shows one of their uses in providing mounts of various sizes in various materials. However, the brace is not restricted to this kind of work, and whenever large holes are needed in material this is the type for the job. Adjustable cutters can be bought in place of the bits. On the whole, however, teachers will find a $\frac{1}{2}$ in., a $\frac{3}{4}$ in., and a 1 in. bit will do almost all the jobs that are necessary in junior science work.