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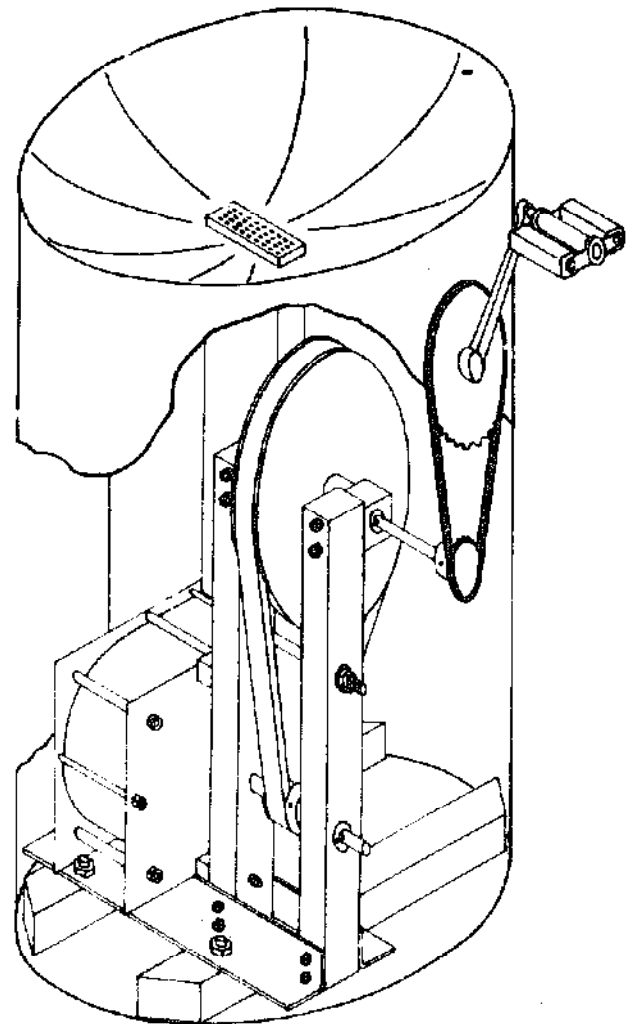
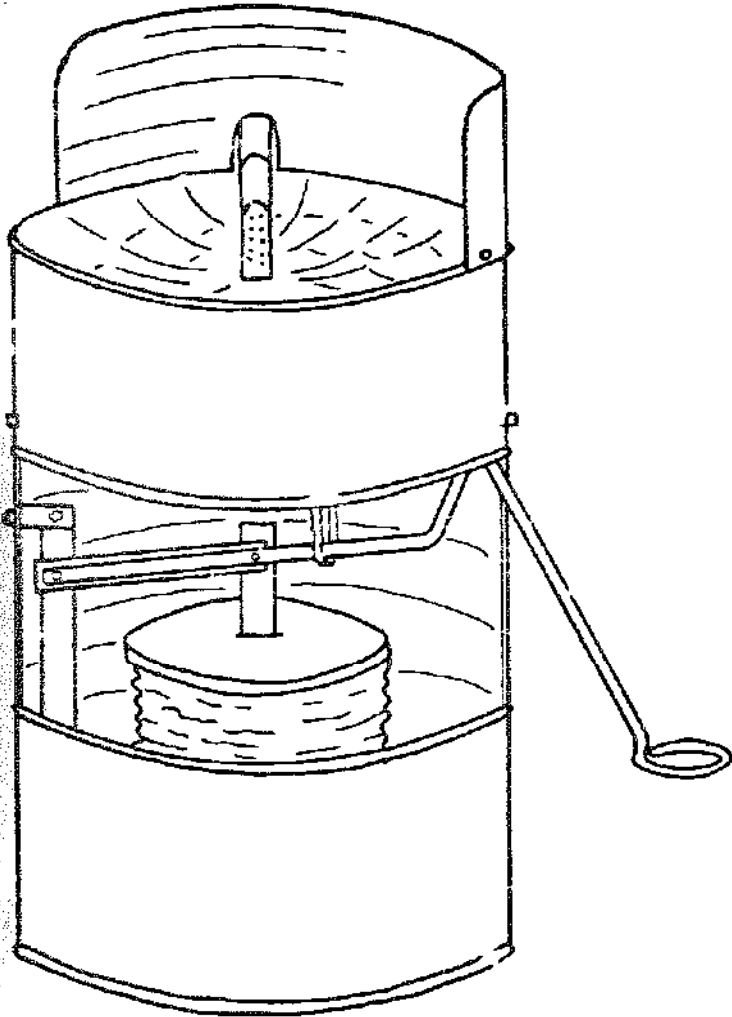
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OIL DRUM FORGES

Belows operated

Fan operated



THE BELLOWS OPERATED OIL DRUM FORGE

Developed by the Intermediate Technology Development Group
Project, Zambia

Introduction:

The Rural Oil Drum Forge is designed so that it can be made by a farmer for use in his own workshop or by a blacksmith as a step in the upgrading of his tools. The blacksmith could then manufacture and sell the forges. The construction of the forge does not depend on welding or brazing facilities being available. All the components can be obtained in the rural areas. As parts wear, replacement will not cause trouble to the owner. The forge can be used by one man, as it is foot operated, leaving the operator's hands free to tend the work and the fire.

The Forge will serve to show the local artisan that he need not depend on imported items of this sort. As an engineering exercise, the forge is suitable for any training programme, with particular reference to small scale industrial development. It is hoped that the techniques used will stimulate the inventiveness of local craftsmen. The forge will give good service, and, perhaps most important, make its owner money.

Project Leader R M Coombs Project Engineer H S Pearson
Designed by the Project Engineer
Farm Machinery Research Unit, Regional Research Station,
Magoye, Zambia.

THE RURAL OIL DRUM FORGE

Tools and Materials Required for Construction of Forge

Tools

Hammer - over 1 $\frac{1}{4}$ kg (2.75 lbs)
Two shifting spanners 20 cm - (8")
File
Steel tape rule 183 cm - (6 ft.)
Screw driver 20 cm - (8")
Centre punch
Punch 6.3 mm - ($\frac{1}{4}$ ") Diameter
Punch 12.5 mm - ($\frac{1}{2}$ ") Diameter
Drill 6.3 mm - ($\frac{1}{4}$ ") Diameter
Drill 5 mm - (3/16") Diameter
Pipe die 25 mm - (1") Diameter
Hacksaw
Wood saw
Chisel made from old Land Rover spring
Hand drill (if available if not, holes can be punched)

Materials:

Wood

109 cm X 51 mm X 75 mm (43" X 2" X 3")
25.4 cm X 51 mm X 32 mm (10" X 2" X 1 $\frac{1}{4}$ ")
76 cm X 38 cm X 19 mm (30" X 15" X $\frac{3}{4}$ ")
18 mm X 25 mm X 6.3 mm (7" X 1" X $\frac{1}{4}$ ")

Steel

One oil drum 194.5 litres (45 galls)
Mild steel rod 170 cm X 12.5 mm diameter (67" X $\frac{1}{2}$ ")
Mild steel flat 102 cm X 38 mm X 6.3 mm (40" X 1 $\frac{1}{2}$ " X $\frac{3}{4}$ ")
21.5 cm X 25.5 cm X 1 mm (8 $\frac{1}{2}$ " X 10" X 0.394")
Two pieces of very thin metal (e.g. sack labels)
6.3 cm X 10.1 cm (2 $\frac{1}{2}$ " X 4")

Pipes & Fittings

Gas pipe, 114 cm X 12.5 mm nominal bore (45" X $\frac{1}{2}$ ")
Four 90° elbows 12.5 mm ($\frac{1}{2}$ ") nominal bore
One socket reducing 25 mm (1") to 12.5 mm ($\frac{1}{2}$ ")
One female X female elbow, 25 mm (1") nominal bore
One male X female elbow, 25 mm (1") nominal bore
Two nuts 25 mm (1") internal bore
Two nipples 25 mm (1") internal bore
Two nipples 12.5 mm ($\frac{1}{2}$ ") internal bore
One socket 12.5 mm ($\frac{1}{2}$ ") internal bore

Bellows Material

Canvas 109.2 cm X 30.5 cm (43" X 12")

Plastic Sheet (old fertilizer bag) 109.2 cm X 30.5 cm
(43" X 12")

Steel banding (e.g. old packing case banding)
228.5 cm X 12.5 mm (90" X ½")

Nuts/Bolts

0.45 kg (1 lb) of 38 mm X 6.3 mm (1½" X ¼") nuts and bol

Screws

20 51 mm (2") wood screws

10 9.5 mm (¾") wood screws

Nails

One box of large head tacks

Drawing Pins

One box of drawing pins

Other Materials

Old car or cycle tyre inner tube

20 kg (44 lbs) of ant-hill soil

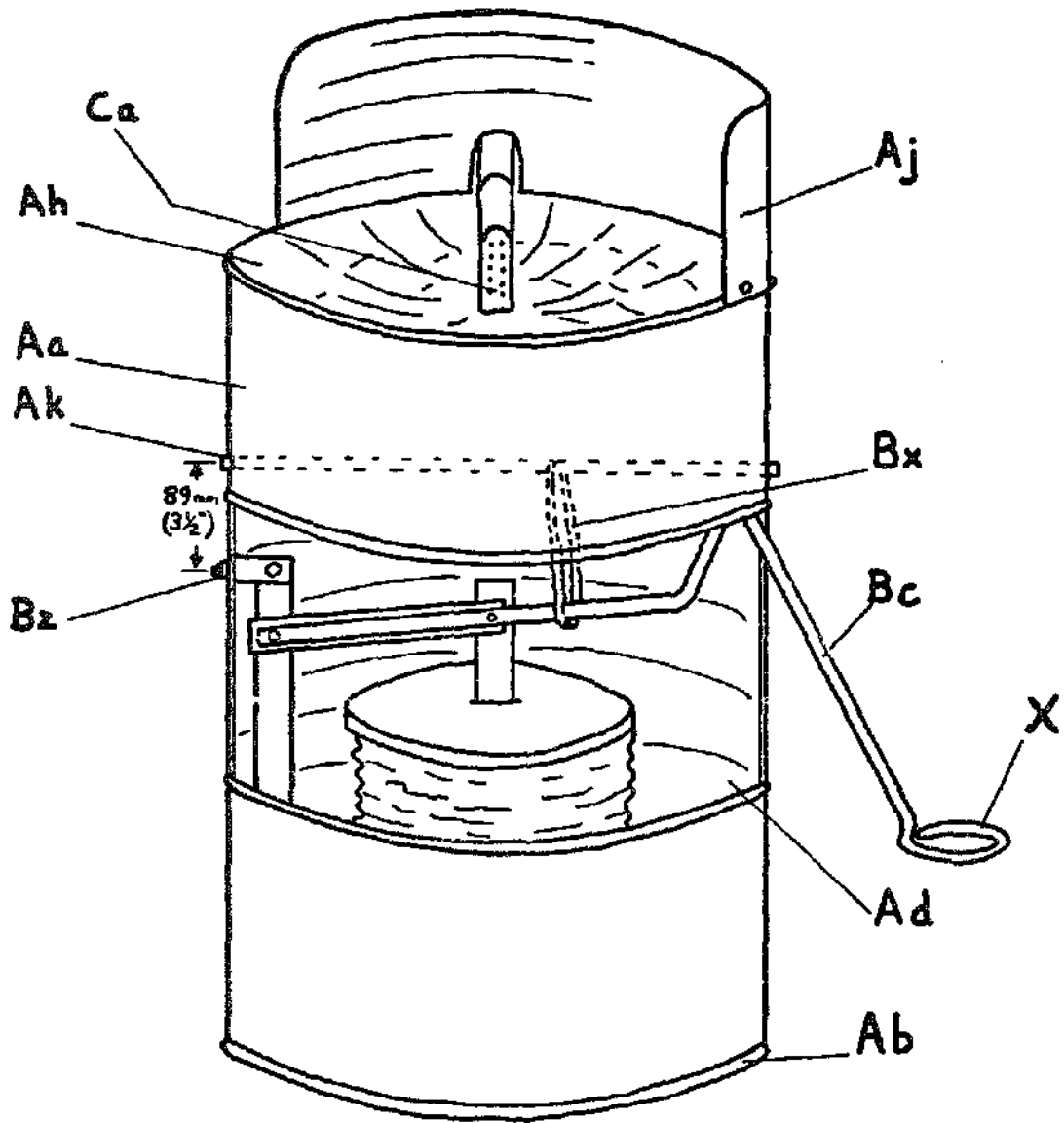
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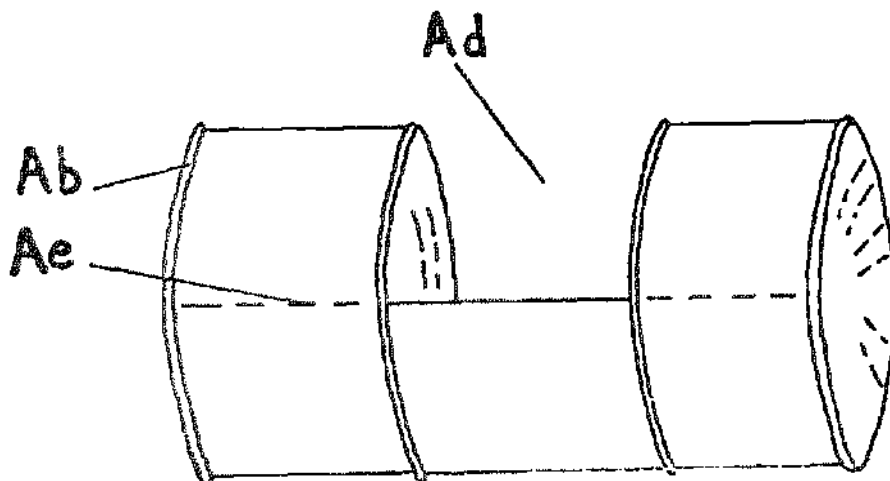
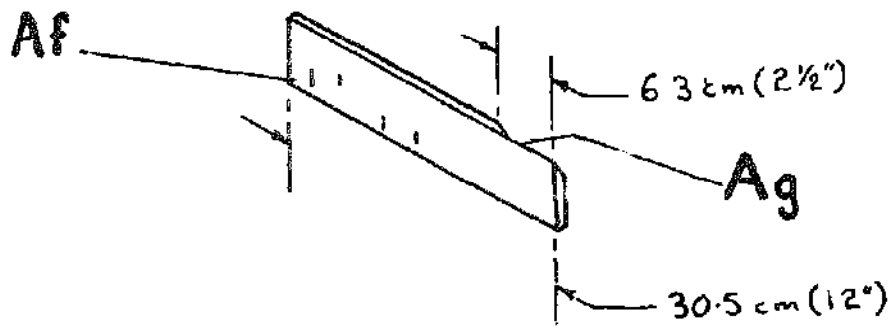
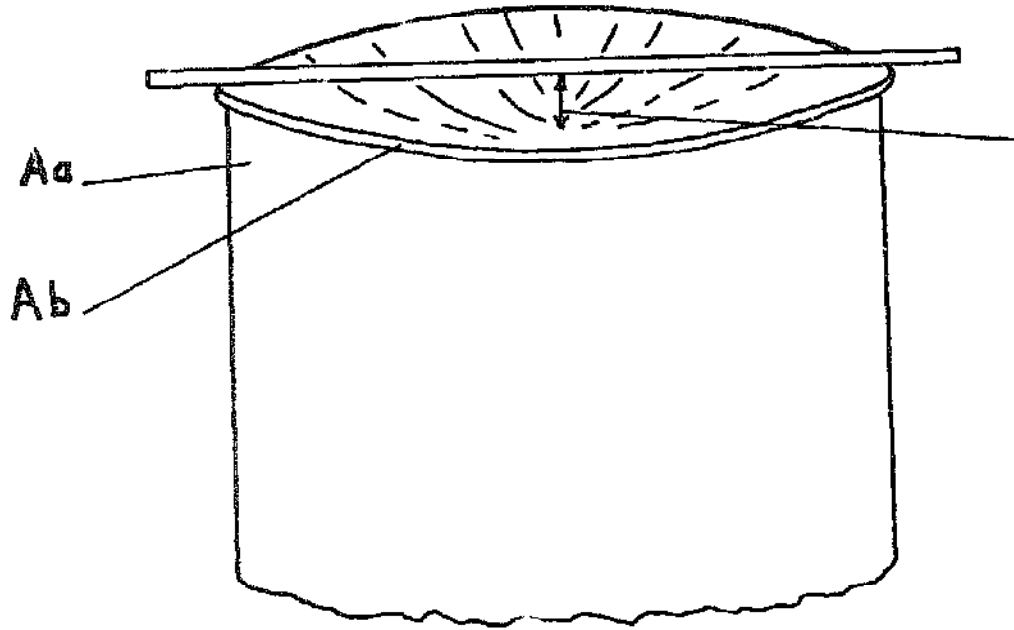
<u>ITEM</u>	<u>DESCRIPTION</u>
Aa	Oil drum. Steel. 194.5 litres (45 galls)
Ab	Rim of drum.
Ac	Top of drum made concave to a depth of 12.7 cm (5")
Ad	Half of centre section of drum is cut away
Ae	Seam of drum
Af	Home-made cutting tool (old car spring)
Ag	Sharpened edge of cutting tool
Ah	Fire bricks (made from crushed ant-hill soil)
Aj	Shield made from cut-away centre section (Ad)
Ak	Piece of 12.5 mm ($\frac{1}{2}$ ") diameter steel bar to support return spring (Bx) of pedal arm (Bc)
Ba	38 mm X 6.3 mm diameter ($1\frac{1}{2}$ " X $\frac{1}{4}$ ") nuts & bolts.
Bb	Pedal arm support plate. Mild steel
Bc	Pedal arm. Mild steel
Bd	Pedal arm pivot bracket. Mild steel
Be	Bellows top. Wood 19 mm ($\frac{3}{4}$ ") thick
Bf	Banding. Thin steel 12.5 mm ($\frac{1}{2}$ ") wide
Bg	Pivot stand side support bracket. Mild steel
Bh	Pivot stand. Mild steel. <u>Note</u> attach this part before fitting air outlet elbow (Ce)
Bj	Mounting beam. Wood
Bk	Air outlet box. Sheet metal 1 mm (0.0394") thick
Bl	Valve holding strips. Hard wood. 2 off
Bm	Valve flaps. Very thin metal, must be flat. 2 off
Bn	Bellows base. Wood 19 mm ($\frac{3}{4}$ ") thick
Bo	Bellows fabric. Leather/canvas/polythene 109 cm X 30.5 cm (43" X 12")
Bp	Bellows base support. Wood. 53 cm X 5 cm X 7.6 cm (21" X 2" X 3") 2 off. <u>Note</u> length of these pieces can be varied to suit size of oil drum
Bq	Screws to attach bellows base (Bn) to bellows base support (Bp)
Br	Bellows air inlet/outlet holes
Bs	Hole for attachment of bolt for pivot bracket (Bd)
Bt	4 holes for screws (Bq)
Bu	90° twist (metal hot) in pivot stand (Bh)
Bv	Air outlet hole in outlet box (Bk)
Bw	Template for wire former for bellows pedal arm (Bc)
Bx	Return spring or rubber inner tube for pedal arm (Bc)
By	Bend air outlet box (Bk) along dotted lines and make up as shown

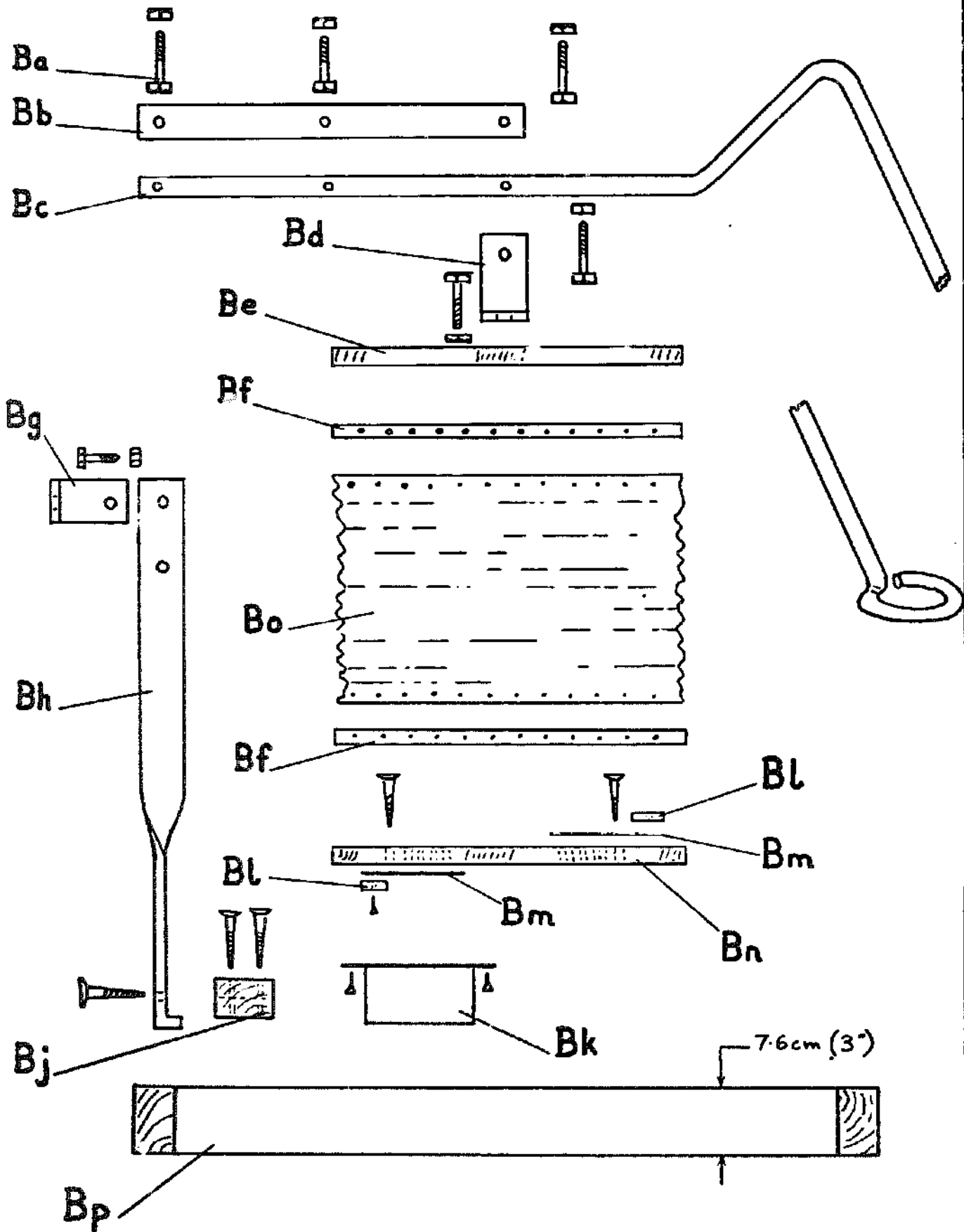
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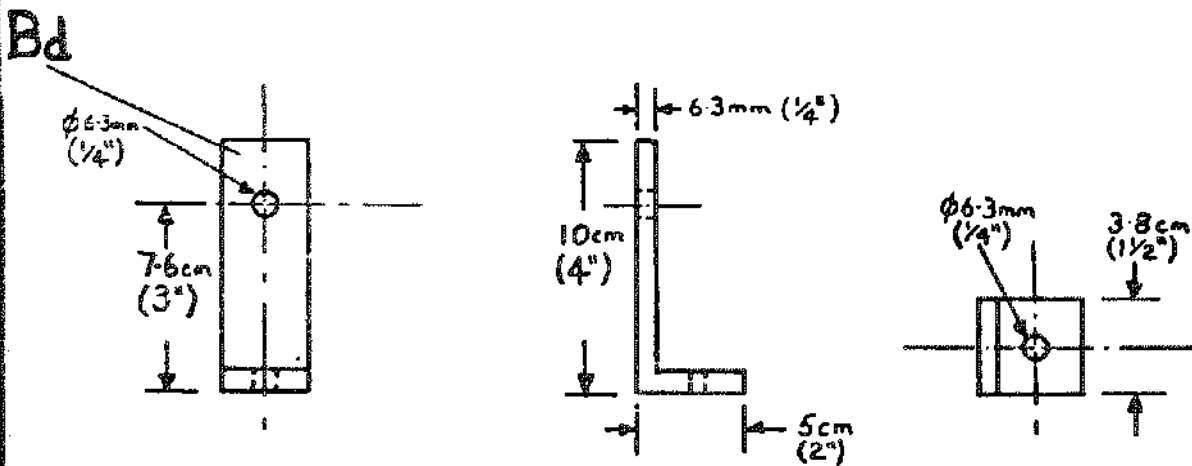
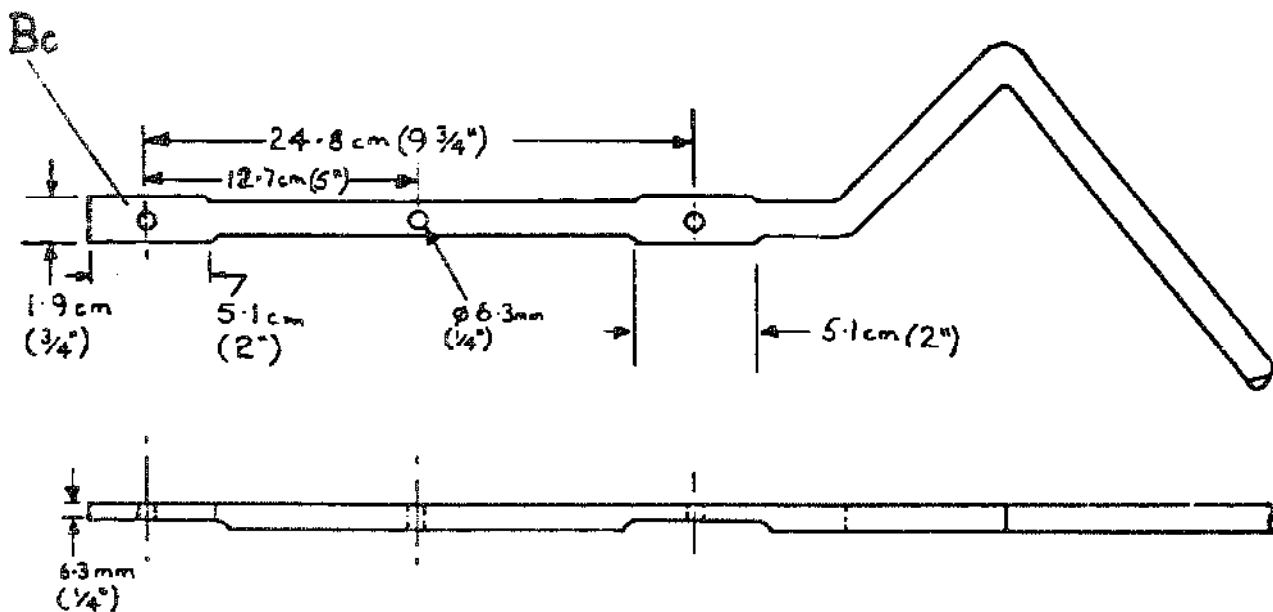
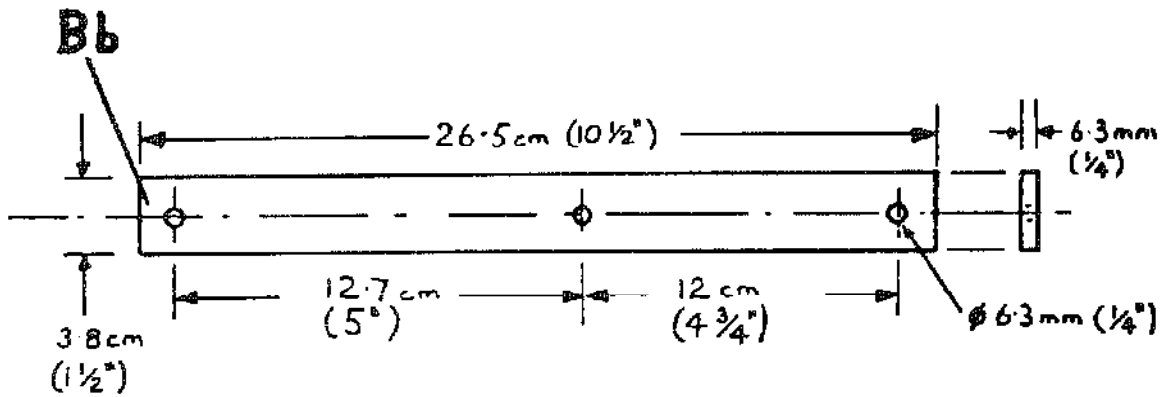
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Aj	Shield made from cut-away centre section (Ad)
Ak	Piece of 12.5 mm ($\frac{1}{2}$ ") diameter steel bar to support return spring (Bx) of pedal arm (Bc)
Ba	38 mm X 6.3 mm diameter ($1\frac{1}{2}$ " X $\frac{1}{4}$ ") nuts & bolts.
Bb	Pedal arm support plate. Mild steel
Bc	Pedal arm. Mild steel
Bd	Pedal arm pivot bracket. Mild steel
Be	Bellows top. Wood 19 mm ($\frac{3}{4}$ ") thick
Bf	Banding. Thin steel 12.5 mm ($\frac{1}{2}$ ") wide
Bg	Pivot stand side support bracket. Mild steel
Bh	Pivot stand. Mild steel. <u>Note</u> attach this part before fitting air outlet elbow (Ce)
Bj	Mounting beam. Wood
Bk	Air outlet box. Sheet metal 1 mm (0.0394") thick
Bl	Valve holding strips. Hard wood. 2 off
Bm	Valve flaps. Very thin metal, must be flat. 2 off
Bn	Bellows base. Wood 19 mm ($\frac{3}{4}$ ") thick
Bo	Bellows fabric. Leather/canvas/polythene 109 cm X 30.5 cm (43" X 12")
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Bq	Screws to attach bellows base (Bn) to bellows base support (Bp)
Br	Bellows air inlet/outlet holes
Bs	Hole for attachment of bolt for pivot bracket (Bd)
Bt	4 holes for screws (Bq)
Bu	90° twist (metal hot) in pivot stand (Bh)
Bv	Air outlet hole in outlet box (Bk)
Bw	Template for wire former for bellows pedal arm (Bc)
Bx	Return spring or rubber inner tube for pedal arm (Bc)
By	Bend air outlet box (Bk) along dotted lines and make up as shown

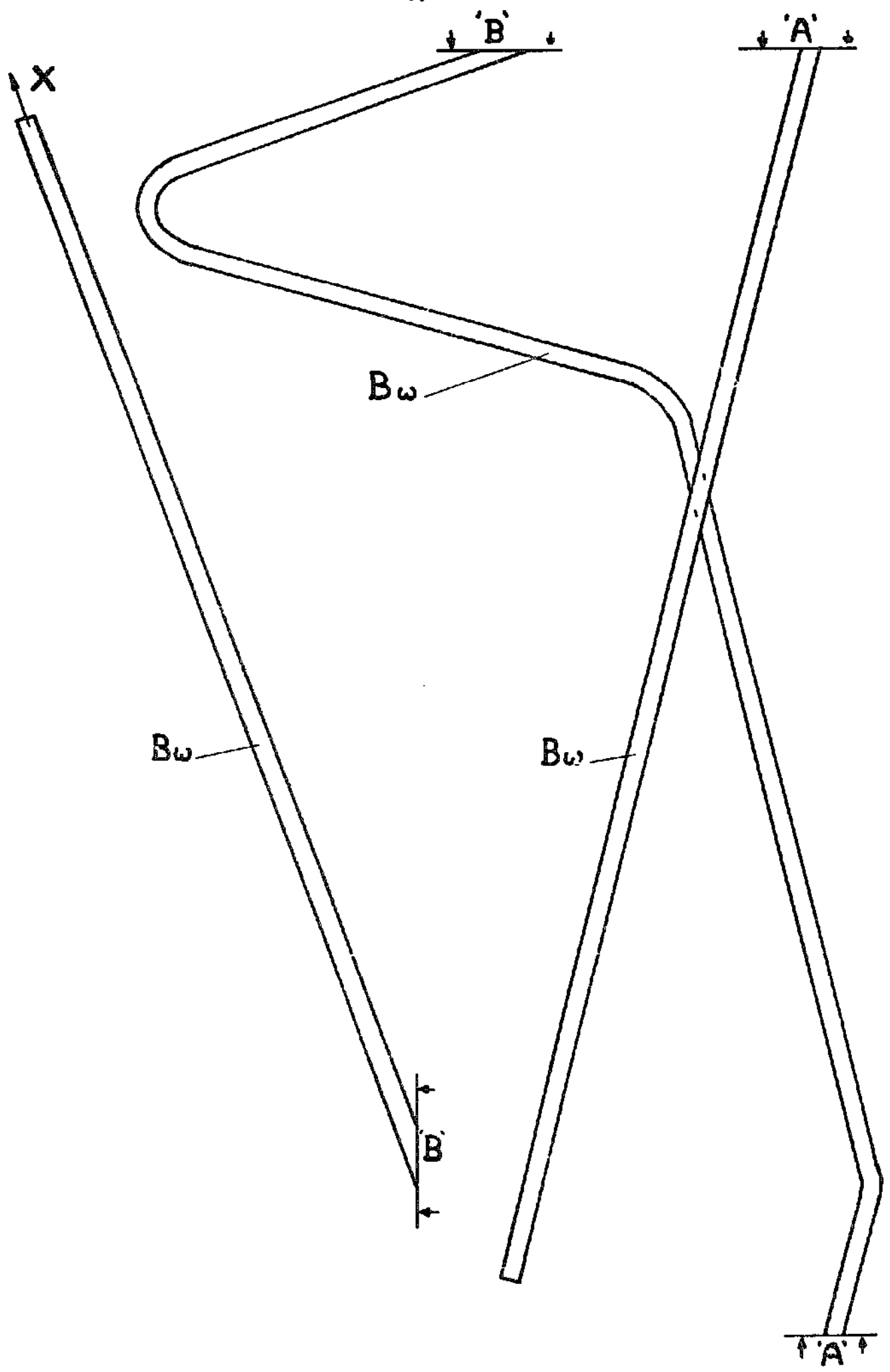
Bz	Position of bolt which attaches pivot stand side support bracket (Bg) to side of drum
Ca	Blower nozzle made from 12.5 mm ($\frac{1}{2}$ ") bore pipe 102 mm (4") long
Cb	Fire hearth. (top of drum hammered concave)
Cc	Fit bellows assembly to drum as shown
Cd	4 screws through the side of drum to attach the bellows base support pieces (Bp)
Ce	25 mm (1") bore F.F. pipe elbow
Cf	Air outlet pipe nipple
Cg	Holding nuts for outlet pipe nipple
Ch	25 mm (1") diameter hole in drum for pipe to pass through
Cj	25 mm (1") bore pipe elbow
Ck	25 mm (1") bore pipe nipple
Cl	25 mm to 12.5 mm (1" to $\frac{1}{2}$ ") reducing socket
Cm	12.5 mm ($\frac{1}{2}$ ") bore pipe
Cn	12.5 mm ($\frac{1}{2}$ ") bore pipe elbow
Co	12.5 mm ($\frac{1}{2}$ ") bore pipe
Cp	12.5 mm ($\frac{1}{2}$ ") bore pipe elbow
Cq	12.5 mm ($\frac{1}{2}$ ") bore pipe nipple
Cr	12.5 mm ($\frac{1}{2}$ ") bore pipe elbow
Cs	12.5 mm ($\frac{1}{2}$ ") bore pipe nipple
Ct	12.5 mm ($\frac{1}{2}$ ") bore pipe elbow
Cu	12.5 mm ($\frac{1}{2}$ ") bore pipe
Cv	12.5 mm ($\frac{1}{2}$ ") bore pipe socket
X	Pedal loop

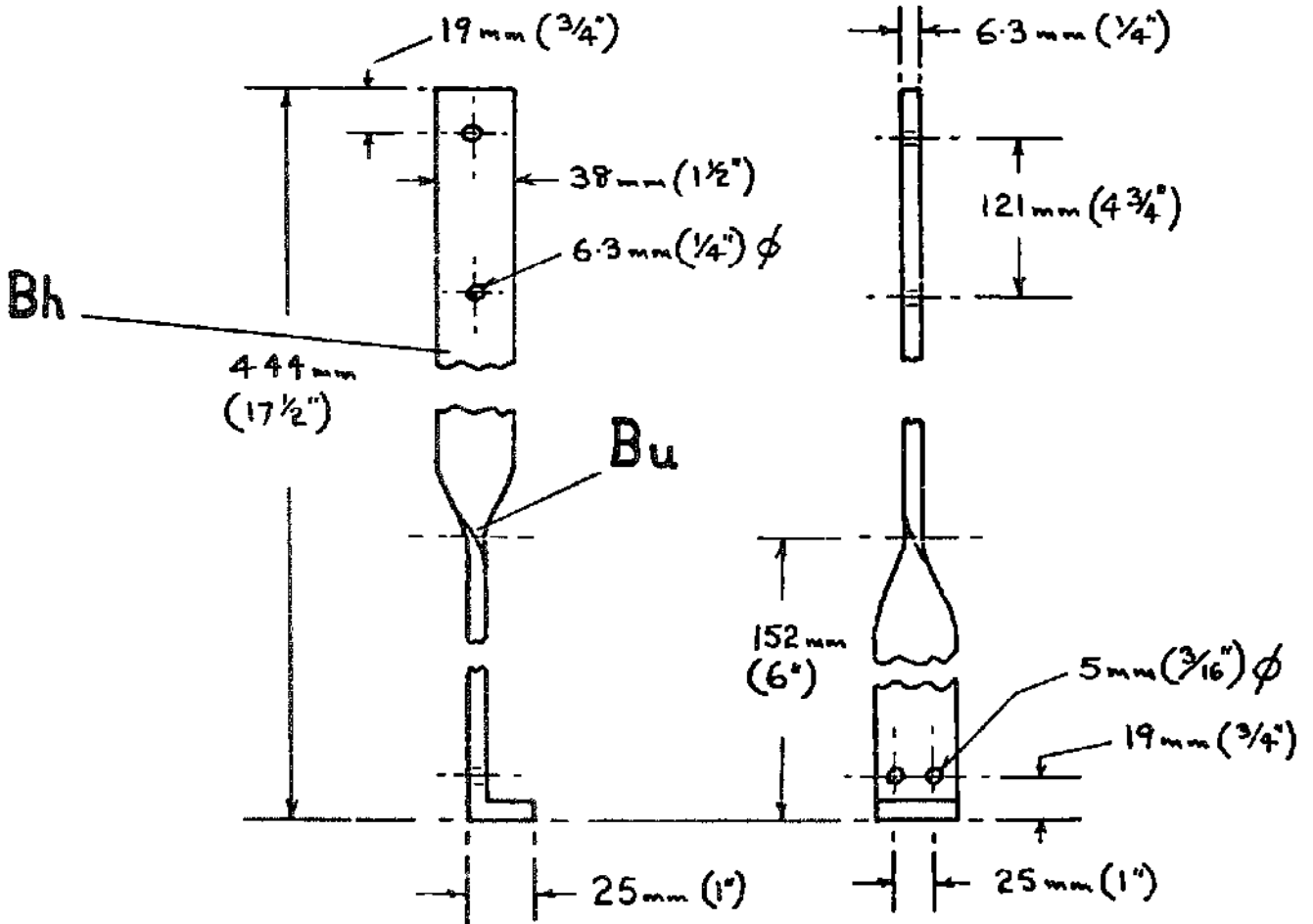
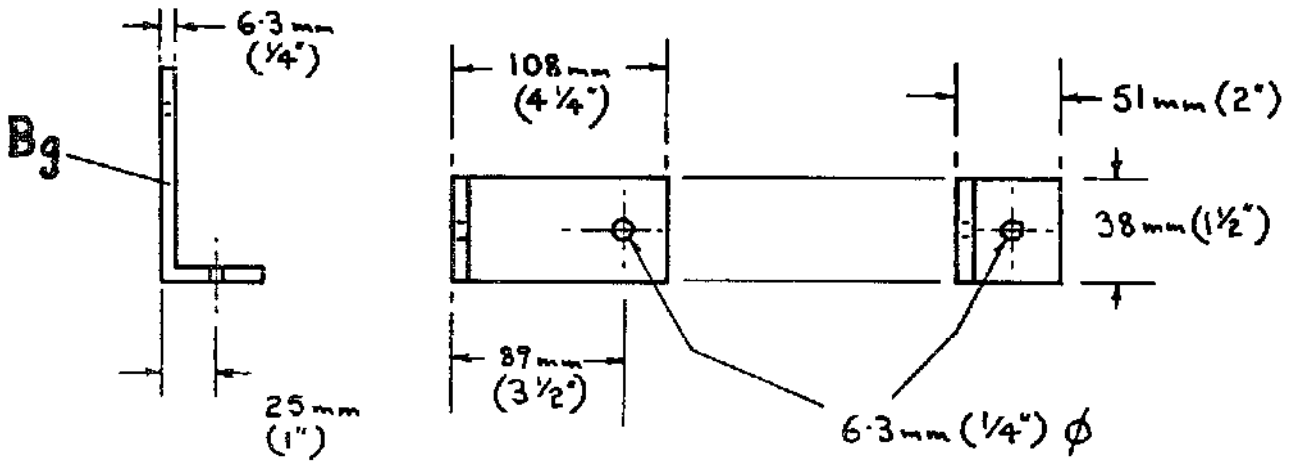


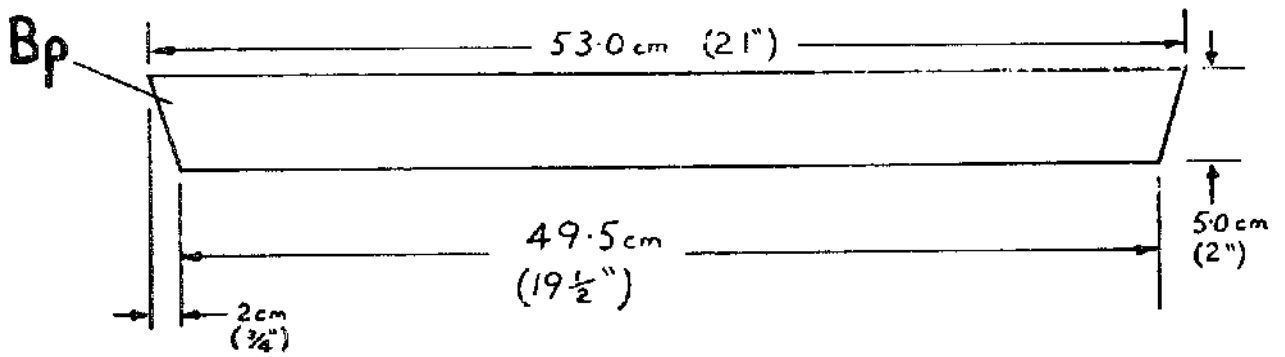
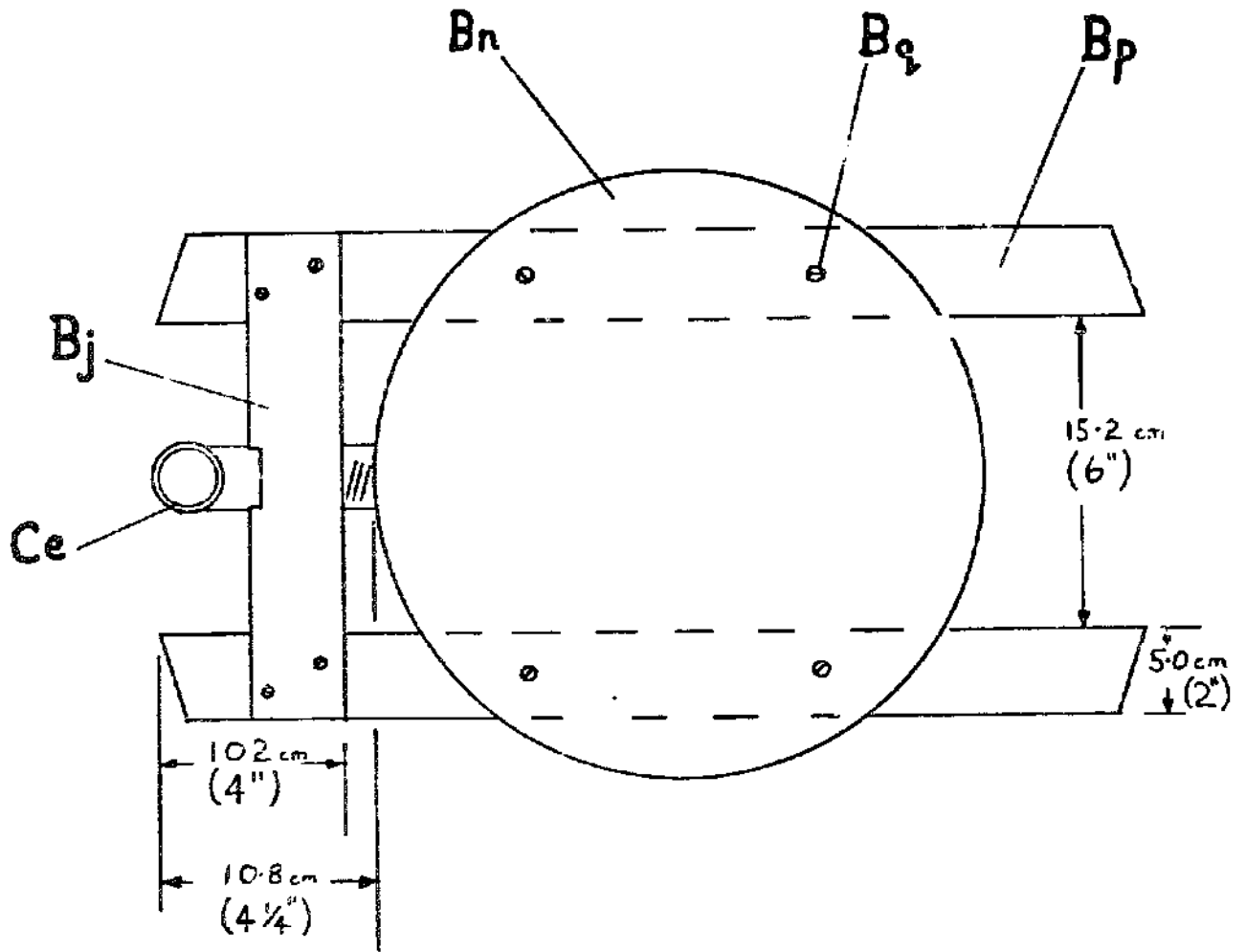


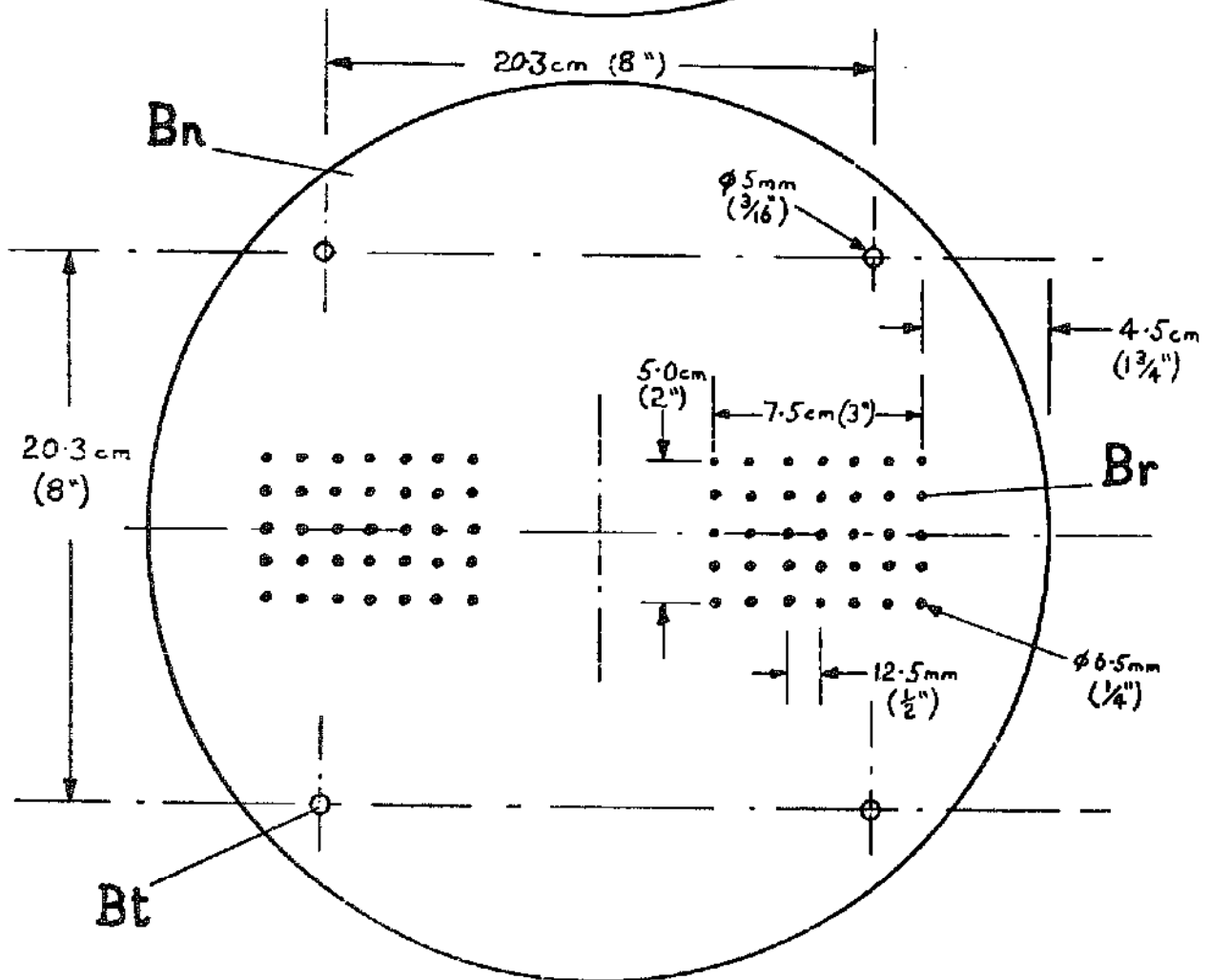
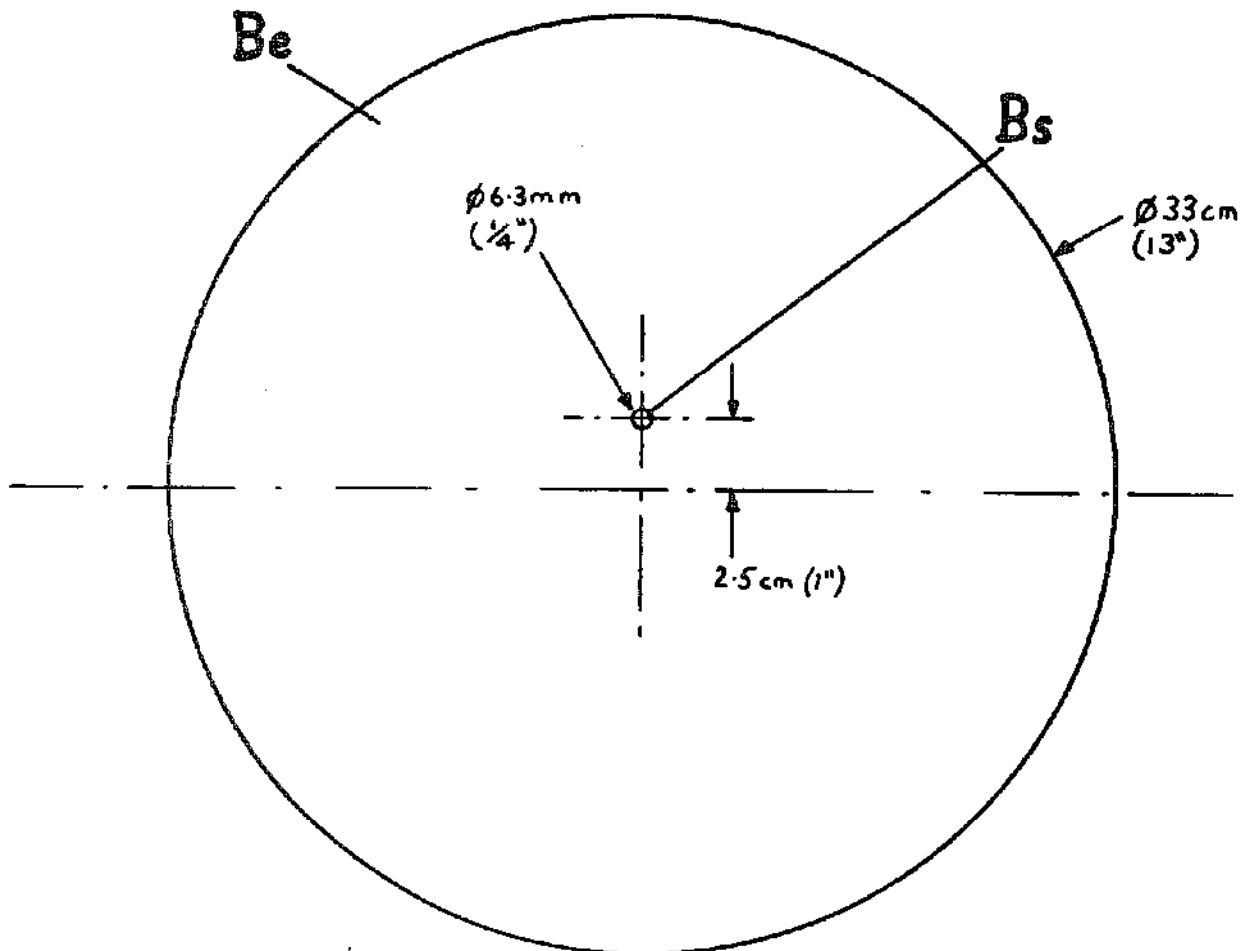


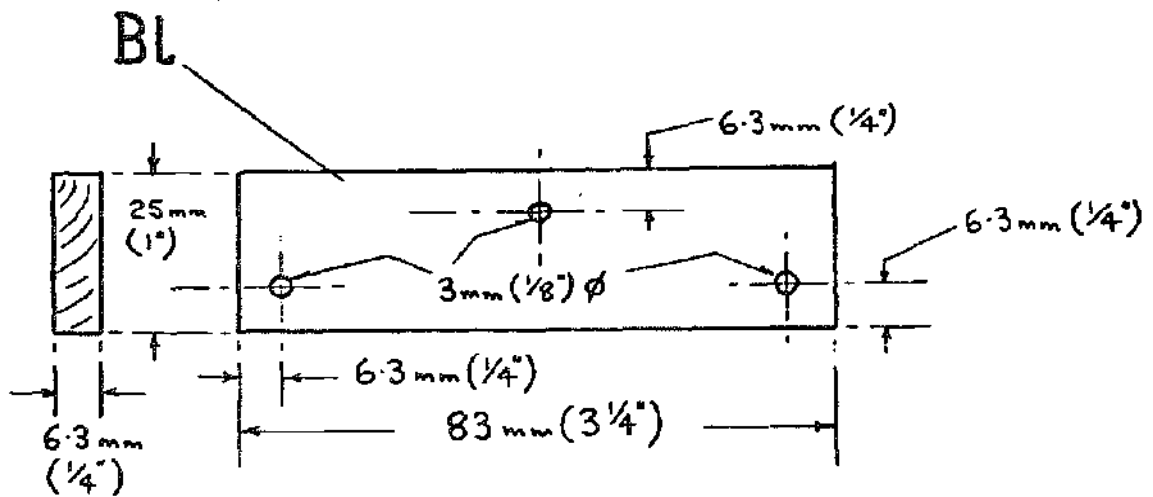
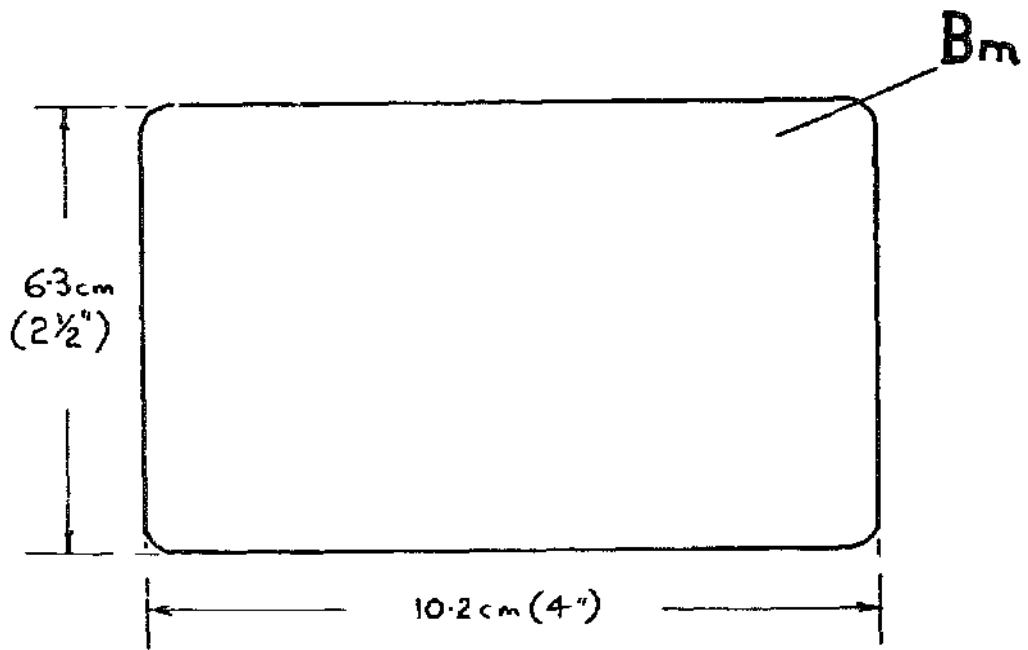
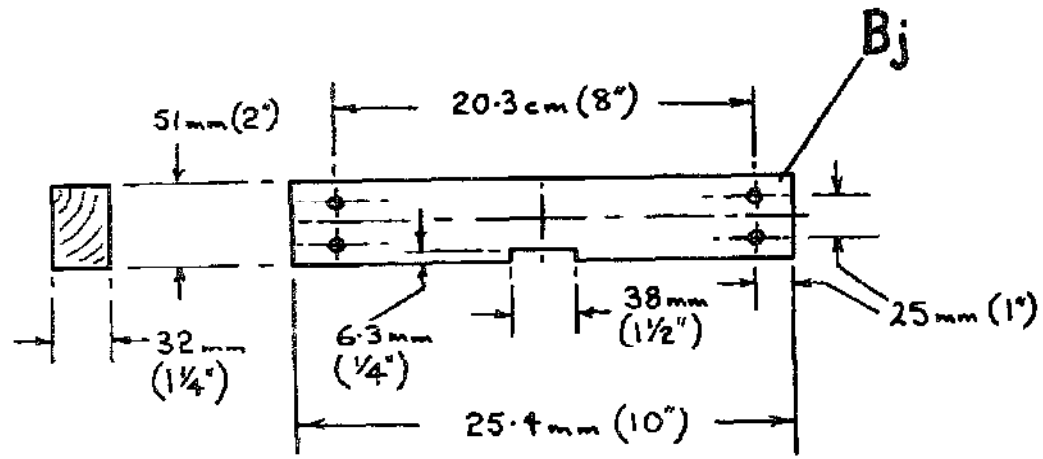


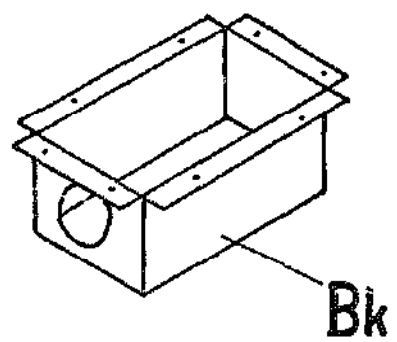
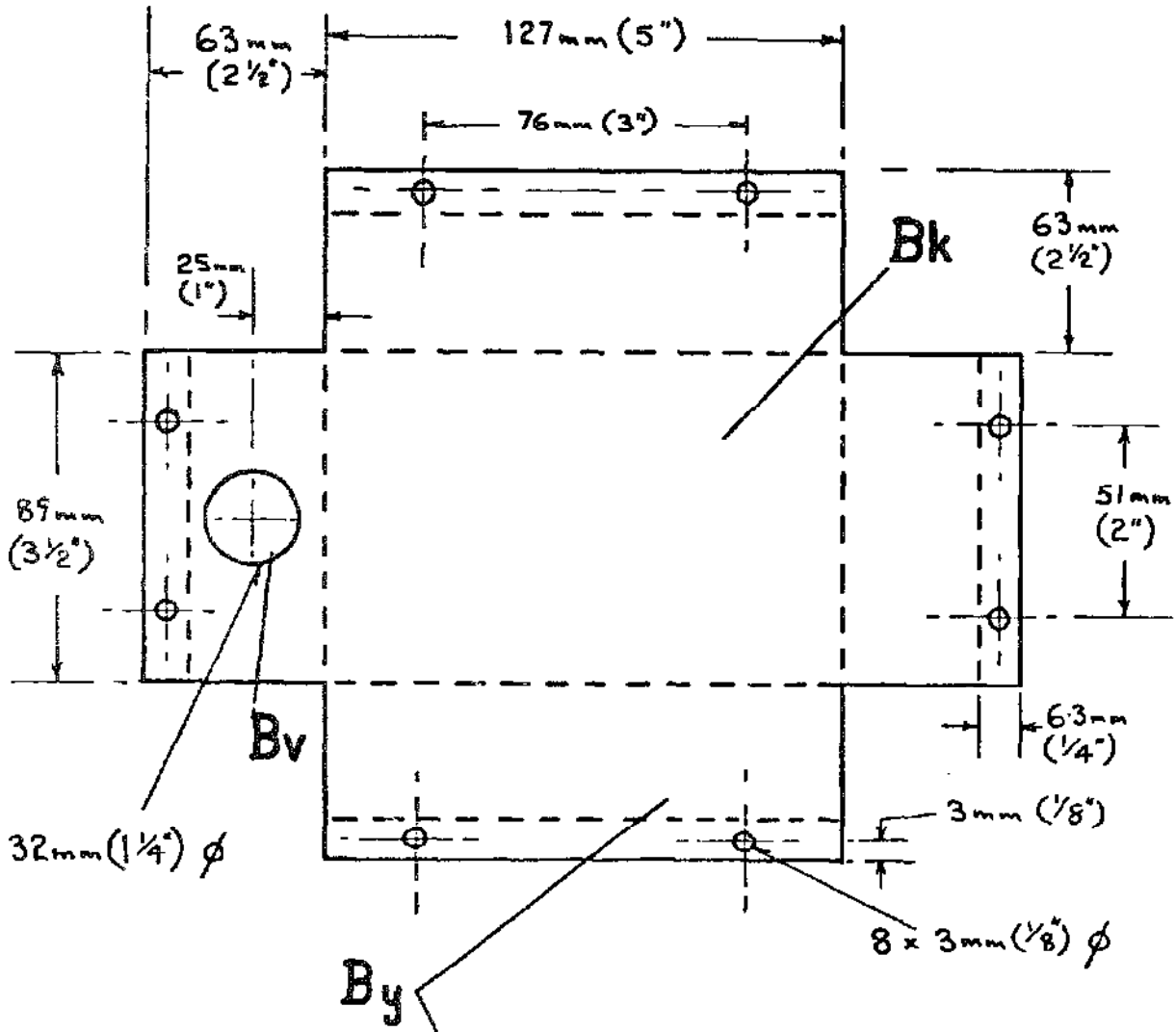


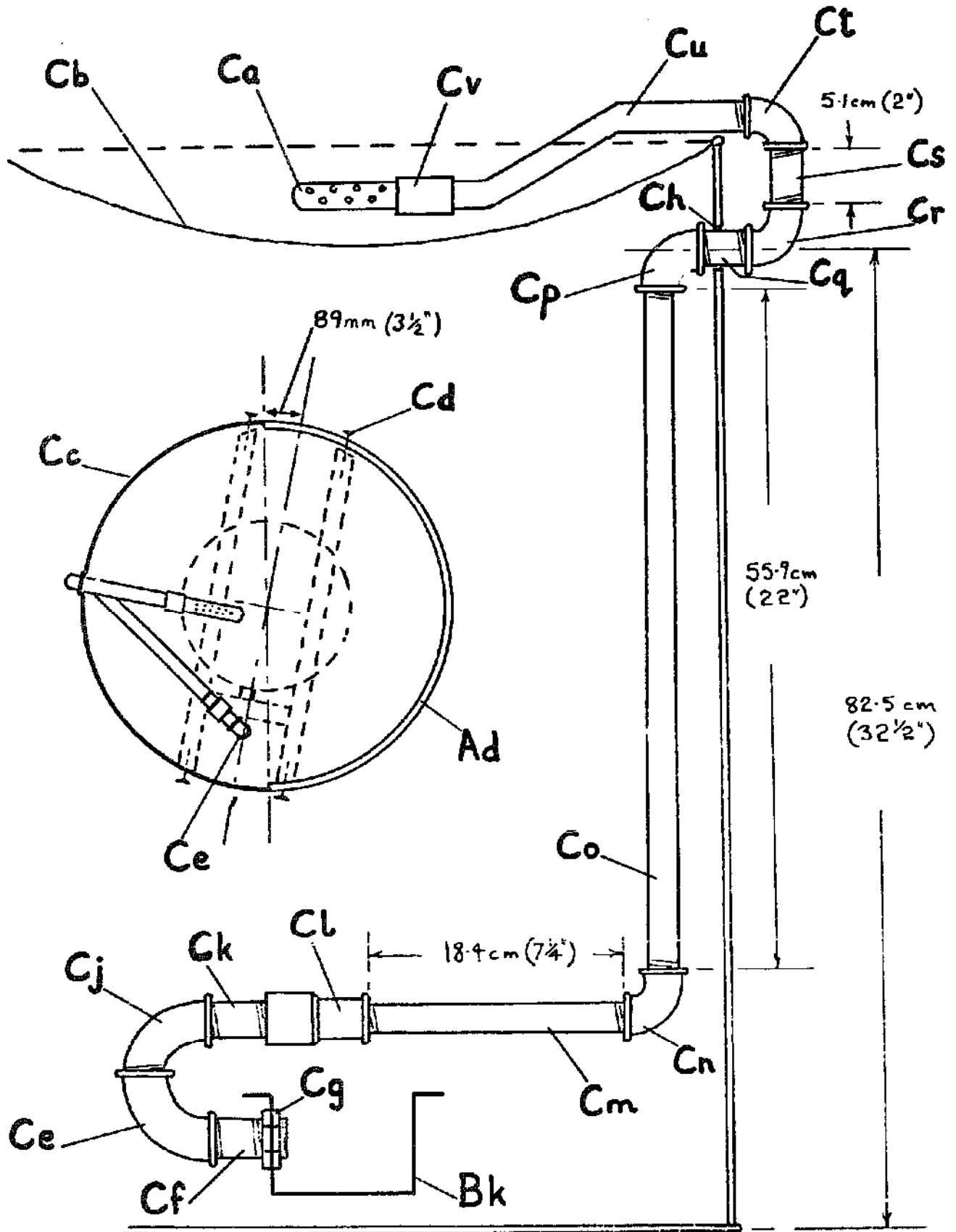












THE RURAL OIL DRUM FORGE

CONSTRUCTION DETAILS

Note: The Key letters in brackets refer to the items indicated in the drawings attached.

FORGE TOP AND CUT-AWAY

The oil drum (Aa) should be stood upright with the filler hole at the bottom. If the rims (Ab) are badly bent they should be hammered straight so that the drum stands firmly with the top even and circular in shape.

To form the curved fire hearth in the drum top a ball pein hammer of 1¼ kilos (2.75 lbs) is required, using the hammer face and not the ball end. Starting at the centre and working outwards in circles, the drum top is hammered in to a depth of 12.7 cm (5") at the centre as shown at (Ac). Heavy hammer blows in one spot must be avoided as this can lead to splitting of the metal. This operation can be done, with care, without having to anneal the metal. However, if difficulty is experienced a fire can be made in the drum top to bring the metal to 'red' heat; the fire is then left to go out and the metal must be allowed to cool down slowly on it's own (do not pour water on the hot metal). After the above described heating treatment, the metal will be soft enough for hammer work to form the required bowl-shaped fire hearth.

The next step is to cut away the mid-section (Ad) of the drum to make room for fitting the bellows unit. To determine half of the circumference use the seam (Ae) of the drum as a starting point, and with a piece of string or a flexible tape wrapped around the drum, mark the half-way point by two chalk marks, one on each of the two intermediate ribs. The drum is laid on its side and the removal of the drum mid-section carried out using the home-made cutting tool (Af). With the tool held at 90° to the drum seam, hammer the sharpened edge (Ag) through the metal, proceeding along the rib lines until the chalk mark is reached on each of the ribs. The metal is then cut between the ribs, one cut along the drum seam line and the other cut in a straight line connecting the chalk marks. The mid-section (Ad) can now be removed, and is put aside for use later on in the forge construction. The sharp edges left by cutting are dangerous and should be turned inwards using a small hammer.

THE BELLOWS UNIT

Follow the attached drawings in the construction of the bellows components. The bellows top (Be) and bellows base (Bn) are cut from 19 mm ($\frac{3}{4}$ ") thick timber. Both the air-inlet and air-outlet holes (Br) must be drilled with care so that the wood does not split between adjacent holes. The valve flaps (Bm) can be made of any thin sheet metal, but must be sufficiently flexible to lift out and allow the full 'bellows-volume' of air to be drawn in and out during operation. The thin metal label tags used on crop sacks are suitable for the valve flaps. The inlet valve is fixed on the upper side of the bellows base (Bn) and the outlet valve on the underside, care being taken to ensure that the valve flaps are positioned to cover completely their respective set of holes (Bt). The valve flaps are secured in place by holding-down strips (Bl), the screws of which must not go through the flaps as this would tend to buckle the sheet metal.

Fix the pedal arm pivot bracket (Bd) to the bellows top (Be).

Make up the air outlet box (Bk) of 1 mm (0.394") thick sheet metal. Fit the air outlet 25 mm (1") pipe nipple (Cf) into the box outlet aperture (Ch) using securing nuts (Cg), one nut on the inside and the other on the outside of the box side. Screw the 25 mm (1") bore pipe elbow (Ce) onto the pipe nipple (Cf) so that the elbow end points upwards. When fitting the outlet box (Bk) to the bellows base (Bn), ensure that the outlet flap valve (Bm) is central within the outlet box. The edges of the outlet box can be made airtight using soft solder or putty.

Fix the bellows base (Bn) to the wooden bellows base supports (Bp) with four screws (Bq) as shown on Page 19.

The material used for the bellows must be airtight. If supple leather is available this is the best material to use. Certain types of canvas can also be used, but if too thin they will allow air to escape when the bellows are compressed. A satisfactory compromise was found by using canvas on the outside, for support and strength, with an inner lining of strong plastic (in this case an old fertilizer bag) to make the bellows airtight.

Cut a strip of canvas (Bo), 109.2 cm X 30.5 cm (43" X 12") in size, and a piece of plastic sheet for the inner lining of the same dimensions.

Attach the bellows plastic inner liner to the outer edges of

both the bellows top (Be) and the bellows base (Bn) with drawing pins spaced approximately 25 mm (1") apart, ensuring that the pedal arm pivot bracket (Bd) is parallel to the centre lines of the bellows base supports (Bp). Make several folds of the two edges of the plastic liner at the point where they meet together (smear glue on the edges being folded together) and secure the seam joint by stitching. The bellows outer canvas (Bo) is fitted over the inner liner to the edges of the bellows top and bellows base, strips of steel banding (Bf) 12.5 mm ($\frac{1}{2}$ ") in width, with small holes made by a nail at 25 mm (1") spacing, being used, and the steel bands held in place with broad-head tacks. It should be arranged that the canvas joint seam does not coincide with that of the inner plastic liner to help reduce air leakage to a minimum.

Note: The bellows are intended to provide a steady air-stream flow and are not built to give high pressure. Therefore no attempt should be made to block the outlet to see how much pressure is available as this may result in damage to the bellows.

Fit the bellows unit into the drum, as indicated by the dotted outline in the section-plan view on Page 19. The bellows base supports (Bp) rest on the drum bottom, and the ends of the base supports are secured in position by four screws (Cd) through the side of the drum. When fitting the bellows unit it should be positioned 89 mm ($3\frac{1}{2}$ ") off-centre from the centre line of the drum cut-away, this measurement being made at the drum circumference.

AIR PIPES

Join up the air pipes as shown on Page 27. When measuring the length of 12.5 mm ($\frac{1}{2}$ ") bore pipe required, 12.5 mm ($\frac{1}{2}$ ") extra length should be allowed for at each end for the threads.

To the elbow (Ce) is connected a 25 mm (1") bore pipe elbow (Cj), followed by a 25 mm (1") bore pipe nipple (Ck), then a 25 mm to 12.5 mm (1" to $\frac{1}{2}$ ") reducing socket (Cl), a 12.5 mm ($\frac{1}{2}$ ") bore pipe (Cm), 12.5 mm ($\frac{1}{2}$ ") bore pipe elbow (Cn), 12.5 mm ($\frac{1}{2}$ ") bore pipe (Co), 12.5 mm ($\frac{1}{2}$ ") bore pipe elbow (Cp), 12.5 mm ($\frac{1}{2}$ ") bore pipe nipple (Cq) passing through the hole (Ch) in the drum side, 12.5 mm ($\frac{1}{2}$ ") bore pipe elbow (Ct), 12.5 mm ($\frac{1}{2}$ ") bore pipe nipple (Cs), 12.5 mm ($\frac{1}{2}$ ") bore pipe elbow (Ct), 12.5 mm ($\frac{1}{2}$ ") bore pipe (Cu), and a 12.5 mm ($\frac{1}{2}$ ") bore pipe socket (Cv) to blower nozzle (Ca). The blower nozzle (Ca) should be made about 102 mm (4") long with outer end closed and the other end threaded to fit the

12.5 mm ($\frac{1}{2}$ ") bore pipe socket (Cv). The nozzle should be drilled with about 20 holes each 5 mm ($\frac{3}{16}$ ") in diameter along the top and sides in order to spread the air blast. The blower nozzle (Cu) is easily replaced when it becomes burnt out through use.

BELLOWS PUMPING PARTS

The pivot stand (Bh) is made to the dimensions as shown on Page 11, a 90° twist being made following heating of the metal at the point (Bu) as indicated on the drawing.

The pivot stand (Bh) is secured by a screw to the mounting beam (Bj) which is then screwed down in position on the bellows base supports as shown in plan view on Page 19.

The pivot stand support bracket (Bg) is bolted to the side of the drum as indicated at (Bz) on Page 7.

The pedal arm support plate (Bb) is made to the dimensions given on Page 13.

To facilitate construction of the pedal arm (Bc), first make a wire template (Bw) to the full-size scale as given on Page 15, allowing an extra 254 mm (10") from the point indicated by the arrow X for the pedal loop (X). The pedal arm (Bc) is then made of 12.5 mm ($\frac{1}{2}$ ") diameter mild steel bar, matched to the wire template, to the dimensions as given on Pages 13 and 15. The pedal arm (Bc) is bolted with its support plate (Bb) to the pivot stand (Bh) and the pivot bracket (Bd).

At a point 89 mm ($3\frac{1}{2}$ ") above the support bracket (Bg) and in line with the pedal arm, a 12.5 mm ($\frac{1}{2}$ ") diameter hole is drilled through the drum-side and a similar hole made on the opposite side of the drum to take the pedal arm spring support rod (AK).

If available, a metal spring can be used as the return spring for the pedal arm. Alternatively a suitable length of old car rubber inner tube can be used. The pedal return spring (Bx) is positioned as shown on Page 7.

THE FIRE HEARTH

Bricks (A1) for the fire hearth (Cb) can be made from crushed ant-hill soil. The bricks of 50 mm X 50 mm X 19 mm (2" X 2" X $\frac{3}{4}$ ") should be laid in the hearth while they are still moist and allowed to dry slowly, the drum standing in the shade. The bricks should

be dampened to avoid cracking if they appear to be drying out too quickly.

The pipe (Cu) should be protected from the forge heat by covering it in clay.

A shield (Aj) for the fire hearth can be made from the drum centre cut-away section (Ad)

THE FORGE IN USE

The forge can be started easily by using a small quantity of paper and wood together with charcoal.

The best results are obtained by pumping the bellows slowly with long firm strokes.

Once the fire is going with the charcoal fully ignited, it will remain alight for several hours, a few pumps on the bellows being used to bring it up to the required working heat.

THE FAN OPERATED OIL DRUM FORGE

Introduction:

The Fan Operated Oil Drum Forge was developed to give a more professional piece of equipment for blacksmiths' workshops than the existing bellows type. Anyone who has made the bellows forge and now has access to a little more equipment may like to convert their forge.

As with the bellows forge many possibilities are left open to the craftsman with an ingenious mind. So long as the basic dimensions are followed, there is no reason why the builder should not use alternative materials - for example, if ball races are available they may be used in preference to the wood bearings.

Access to arc or gas welding equipment is required, and the job is made much easier if a 16mm ($5/8$ ") capacity electric-drill is available.

THE FAN OPERATED OIL DRUM FORGE

Tools required

Metal drills - 3 mm, 5 mm, 6 mm, 12 mm, 16 mm,
($1/8"$, $3/16"$, $1/4"$, $1/2"$, $5/8"$)

Hand drill or preferably electric drill

Steel rule, protractor, and compasses

Centre punch

Clamp

Rivet set

Hammer

Hacksaw

File

Two shifting spanners 20 cm (8")

Ring spanner for 6 mm ($1/4"$) bolts

Die 12 mm $1/2"$ dia.

Woodsaw

Chisel

Materials required

Wood

<u>Quantity</u>	<u>Description</u>
2	50 mm x 50 mm x 25 mm hardwood (2" x 2" x 1")
2	585 mm x 50 mm x 38 mm hardwood (23" x 2" x $1\frac{1}{2}"$)
1	110 mm x 38 mm x 38 mm hardwood ($4\frac{1}{4}"$ x $1\frac{1}{2}"$ x $1\frac{1}{2}"$)
1	50 mm x 50 mm x 20 mm hardwood (2" x 2" x $\frac{3}{4}"$)
1	355 mm dia. x 6 mm plywood (14" dia. x $\frac{1}{4}"$)
1	305 mm dia. x 20 mm plywood (12" dia. x $\frac{3}{4}"$)
1	Approx. 400 mm x 400 mm x 35 mm lumber (16" x 16" x $1\frac{1}{2}"$)

Steel

<u>Quantity</u>	<u>Description</u>
1	230 mm dia. x 3 mm thick, flat mild steel (9" dia. x $\frac{1}{8}"$).
1	850 mm x 76 mm x 3 mm mild steel (33" x 3" x $\frac{1}{8}"$) <u>OR</u>
1	650 mm x 102 mm x 3 mm mild steel (25" x 4" x $\frac{1}{8}"$)

Steel

<u>Quantity</u>	<u>Description</u>
2	300 mm x 260 mm x 1.6 mm steel sheet ($11\frac{13}{16}$ " x $10\frac{1}{4}$ " x $\frac{1}{16}$ ")
1	855 mm x 102 mm x 1.6 mm steel sheet ($33\frac{5}{8}$ " x 4" x $\frac{1}{16}$ ")
2	140 mm x approx. 350 mm x 1.6 mm steel sheet ($5\frac{1}{2}$ " x approx. 12" x $\frac{1}{16}$ ")
1	125 mm x 65 mm x 1.6 mm steel sheet (5" x $2\frac{1}{2}$ " x $\frac{1}{16}$ ")
1	280 mm of 6 mm - 8 mm dia. mild steel bar (11" of $\frac{3}{10}$ "- $\frac{1}{4}$ " dia.)
1	200 mm of 12 mm dia. mild steel bar (8" of $\frac{1}{2}$ " dia.)
1	255 mm of 16 mm dia. bright drawn steel shaft (10" x $\frac{5}{8}$ " dia.)
1	305 mm of 16 mm dia. bright drawn steel shaft (12" x $\frac{5}{8}$ " dia.)
1	520 mm of approx. 6 mm dia. x 1.6 mm tubing (21" of approx. $\frac{1}{4}$ " dia. x 16 SWG)
2	380 mm of 50 mm x 50 mm angle (15" x 2" x 2")

Nuts & Bolts

<u>Quantity</u>	<u>Description</u>
8	40 mm x 6 mm ($1\frac{1}{2}$ " x $\frac{1}{4}$ ")
4	65 mm x 6 mm ($2\frac{1}{2}$ " x $\frac{1}{4}$ ")
4	75 mm x 6 mm (3" x $\frac{1}{4}$ ")
4	90 mm x 6 mm ($3\frac{1}{2}$ " x $\frac{1}{4}$ ")
8	115 mm x 6 mm ($4\frac{1}{2}$ " x $\frac{1}{4}$ ")
2	165 mm x 6 mm ($6\frac{1}{2}$ " x $\frac{1}{4}$ ")
4	75 mm x 12 mm (3" x $\frac{1}{2}$ ")

Other Materials

- 4 nuts - 12 mm ($\frac{1}{2}$ ")
- 2 washers - 12 mm ($\frac{1}{2}$ ")
- 5 washers - 16 mm ($\frac{5}{8}$ ")
- 30 rivets - 12 mm x 5 mm dia. ($\frac{1}{2}$ " x $\frac{3}{16}$ ")
- 20 nails - 150 mm (6")

4 steel pins - 25 mm x 3 mm dia. (1" x 1/8")

2 steel pins - 55 mm x 3 mm dia. (2 1/4" x 1/8")

2 steel pins - 65 mm x 3 mm dia. (2 1/2" x 1/8")

Small pulley - 38 mm dia. (1 1/2") cast iron or alluminium, or made from a
63 mm (2 1/2") dia. piece of hardwood.

Vee belt

Metal boss - 50 mm dia. x 25 mm mild steel (2" dia. x 1")

Old bicycle chainwheel, crank and spindle assembly.

Old bicycle rear wheel sprocket

Old bicycle chain.

KEY

<u>ITEM</u>	<u>DESCRIPTION</u>
Da	Fan back plate
Db	Fan blade
Dc	Fan hub
Dd	Fan blade supporting ring
De	Fan axle
Df	Fan cowling
Dg	Left-hand fan side plate
Dh	Right-hand fan side plate
Dj	Tubular spacers
Ea	Large pulley, sides
Eb	Large pulley centre
Ec	Large pulley hub
Ed	Large pulley bearing
Ee	Large pulley axle
Ef	Sprocket
Eg	Small pulley
Fa	Front base angle
Fb	Back base angle
Fc	Left hand wooden upright
Fd	Right-hand wooden upright
Fe	Wooden spacer
Ff	Support bar
Fg	Air chute
Ga	Air outlet grill
Gb	Vee belt
Gc	Chainwheel, crank and spindle assembly
Gd	Chain.

THE FAN OPERATED OIL DRUM FORGE

CONSTRUCTION DETAILS

FAN BACK PLATE

Made from a piece of 3 mm ($\frac{1}{8}$ ") thick mild steel plate from which it is large enough to cut a 230 mm (9") dia. circle. Mark the centre clearly with the centre-punch and draw the circle using a pair of compasses. Divide the plate into 8 equal parts by marking with lines which will later be used to position the fan blades. The angle between each blade will be 45° . Drill a 16 mm ($\frac{5}{8}$ ") dia. hole exactly at the centre of the plate.

FAN BLADES

Eight of these are required. Make the first one as shown in the drawing using the 850 mm (33") or 650 mm (25") length of 3 mm ($\frac{1}{8}$ ") mild steel. Use this first blade as a template and jig for making the other seven blades. Finally bend all eight blades at 90° along the line shown.

FAN/LARGE PULLEY HUB

These are identical and are made from the two pieces of 50 mm (2") x 50 mm (2") x 25 mm (1") hardwood. Mark the centre and draw the 50 mm (2") dia. circle. Chisel to shape or turn on a lathe. Drill the four 6 mm ($\frac{1}{4}$ ") dia. holes and the 3 mm ($\frac{1}{8}$ ") dia. cross-hole as shown. Finally drill the 16 mm ($\frac{5}{8}$ ") dia. hole through the centre.

FAN BLADE SUPPORTING RING

Bend the 280 mm (11") length of 6 mm - 8 mm ($\frac{3}{10}$ " - $\frac{1}{4}$ ") dia. bar into a 90 mm ($3\frac{1}{2}$ ") dia. ring, and braze or arc weld the ends together.

FAN AXLE

Use the 255 mm (10") length of 16 mm ($\frac{5}{8}$ ") dia. bright drawn steel shaft.

FAN BLADE ASSEMBLY

Line up the fan back plate and fan hub by sliding them together on the axle. Drill through the four 6 mm ($1/4$ " dia. holes. Now slide the axle so that its end just emerges from the wooden hub and carefully drill through the 3 mm ($1/8$ " dia. cross hole. Tap a 55 mm ($2 1/4$ " x 3 mm ($1/8$ " pin into the hole - it should be a good tight fit.

Remove the back plate, set the back edges of the blades against the marked lines and clamp in place. Drill through the 5 mm ($3/16$ " dia. holes and rivet the fan blades in position. The blade supporting ring can now be set in place and brazed at each point it contacts the blades.

Finally, reposition the back plate and blade assembly on the axle, and fasten to the hub with the four 40 mm ($1 1/2$ " x 6 mm ($1/4$ " nuts and bolts.

FAN COWLING

Bend up from the 855 mm ($33 5/8$ ") length of 102 mm (4") x 1.6 mm ($1/16$ " or 16 SWG) steel sheet into the shape shown in the drawing. This is done by first making the 90° bend 50 mm (2") from one end of the strip. Mark the required shape on the large piece of wood using chalk. Knock 150 mm (6") nails into the wood at intervals of about 50 mm (2") along the chalk line, making sure that the nails stand up at least 102 mm (4"). Hook the 90° bend round the first nail and bend the strip round the outside of the other nails. The bent cowling will spring out of shape but this will not harm.

FAN SIDE PLATES

Cut from the two pieces of 300 mm ($11 13/16$ " x 260 mm ($10 1/4$ " x 1.6 mm ($1/16$ " steel sheet. Both plates should have the same finished shape - this can be done by clamping them together for final filing.

With the plates still clamped together, mark the centre and using a pair of compasses draw the 102 mm (4") dia. circle and the 248 mm ($9 3/4$ " dia. circle as shown. Locate the position of the ten 6 mm ($1/4$ " dia. holes and drill them through both plates. Drill a 16 mm ($5/8$ " dia. hole through the centre. Now unclamp the plates and cut out the 102 mm (4") dia. hole which has been marked out already. This plate will later be referred to as the left-hand fan side plate.

TUBULAR SPACERS

Five of these are required. Made by cutting the 520 mm (21") length of tubing into 101 mm ($3\frac{31}{32}$ ") lengths.

FAN CASE ASSEMBLY

The fan case is assembled with the fan blade assembly inside. Pass the fan axle through the 16 mm ($\frac{5}{8}$ ") dia. hole in the right-hand fan side plate. Position the casing so that it surrounds the fan blades. Now line up the left-hand side plate with the right-hand plate, and push the eight 115 mm ($4\frac{1}{2}$ ") x 6 mm ($\frac{1}{4}$ ") bolts into position, leaving holes 1 and 5, and using the tubular spacers for holes 2 - 4 - 6. These will stop any distortions of the side plates when the nuts are tightened. The bolts and spacers for holes 1 and 5 are not positioned at this stage.

LARGE PULLEY AXLE

Use the 305 mm (12") length of 16 mm ($\frac{5}{8}$ ") dia. bright drawn steel shaft.

LARGE PULLEY

Made from three circular pieces of plywood and the large pulley hub. Take care when making these parts - the axle hole needs to be as near the exact centre as possible for the pulley to run true, so mark the centres clearly.

The sides of the pulley are made by cutting two 355 mm (14") dia. pieces from 6 mm ($\frac{1}{4}$ ") ply. The centre of the pulley is made by cutting a 305 mm (12") dia. disc from 20 mm ($\frac{3}{4}$ ") ply. Mark the position of the four 6 mm dia. holes on one of the pulley sides as shown. Now drill a 16 mm ($\frac{5}{8}$ ") dia. hole at the exact centre of these three pieces and push them together on the pulley axle.

Drill the four holes that have already been marked and fasten together with four 40 mm ($1\frac{1}{2}$ ") x 6 mm ($\frac{1}{4}$ ") bolts.

Now slide the hub onto the axle, push it up against the pulley, and drill the four 6 mm ($\frac{1}{4}$ ") dia. holes. Finally bolt the hub in place with the four 65 mm ($2\frac{1}{2}$ ") x 6 mm ($\frac{1}{4}$ ") bolts and remove the axle.

LARGE PULLEY BEARINGS

Two of these are required. Make them from the 110 mm ($4\frac{1}{4}$ " length of 38 mm ($1\frac{1}{2}$ ") x 38 mm ($1\frac{1}{2}$ ") hardwood as shown in the drawing. The 16 mm axle hole should be drilled as carefully as possible to make a good fit.

SMALL PULLEY

If a cast pulley of aluminium or iron is available this would be ideal. If not, one will have to be made from wood by hand (or turned if a lathe is available). The 'V' belt groove will depend on the type of belt that can be obtained. Turn the belt inside out so that its form is on the outside - it can then be used as a pattern when cutting the groove in the pulley.

BASE ANGLES

Two required, made from the two 380 mm (15") lengths of 50 mm (2") x 50 mm (2") angle. Mark out and drill the front base angle as shown in the drawing. Place back to back with the back base angle (see drawing of fan case and upright assembly) and drill through the four 6 mm dia. holes. Place base to base and drill through the two 12 mm dia. holes.

WOODEN UPRIGHTS

Two required made from the two 585 mm (23") lengths of 50 mm (2") x 38 mm ($1\frac{1}{2}$ ") hardwood. Clamp the two lengths carefully together with the 50 mm faces against each other and drill the 16 mm dia. and 12 mm dia. holes through both uprights. Now carefully re-clamp the uprights together, this time with the 38 mm faces against each other and drill the 6 mm dia. bearing - mounting holes using one of the large pulley bearings as a jig to be sure of getting the holes to match up. Do not drill the bottom holes at this stage.

WOODEN SPACERS

Two required, made from the 50 mm (2") x 50 mm (2") x 20 mm ($\frac{3}{4}$ ") piece of hardwood.

SUPPORT BAR

Made from the 200 mm (8") length of 12 mm ($\frac{1}{2}$ ") dia. mild steel bar by threading each end for a distance of 70 mm.

UPRIGHT ASSEMBLY

Position the large pulley bearings on the uprights and locate the four 90 mm ($3\frac{1}{2}$ ") x 6 mm ($\frac{1}{4}$ ") bolts - do up the nuts to finger tightness. Run a nut down each end of the support bar, then put each upright on followed by a washer and nut on the outside. Line up the bearings by positioning the large pulley axle, and adjust the inner nuts on the support bar to give 89 mm ($3\frac{1}{2}$ ") between the inside faces of the uprights. Tighten the outside nuts on the support bar.

Now clamp the uprights in position between the base angles, making sure that all is square and that the distance between the uprights is 89 mm ($3\frac{1}{2}$ ") at both the top and the bottom. Tighten the bearing bolts and check that the axle will turn smoothly.

Drill the four 6 mm dia. holes through the holes in the base angles and through the wood uprights. Position the four 75 mm (3") x 6 mm ($\frac{1}{4}$ ") bolts in these holes and fasten the nuts.

ASSEMBLY OF FAN CASE WITH UPRIGHTS

The fan case assembly and the upright assembly are now ready to be put together. The air outlet chute should be on the same side as the pulley bearings. First of all two holes must be located and drilled in the left-hand wooden upright. This is done by pushing the fan axle through the 16 mm dia. hole in the left-hand upright and then through the corresponding hole in the right-hand upright. Slide the assembly until the right-hand fan side plate is up against the left-hand upright and holes 1 and 5 are on the upright centre-line. Carefully mark the position of these two holes. Now remove the fan case assembly and fan axle and drill two 6 mm ($\frac{1}{4}$ ") dia. holes straight through the left-hand upright at the located positions. Final assembly can now begin.

The fan axle is pushed through the left-hand upright as before. Now slide the small pulley onto the axle, boss to the right, followed by a 16 mm washer. If the fan-belt to be used is without a join it will have to be slipped over the axle at this stage. Now push the axle the rest of the way, through the right-hand upright and position another 16 mm washer on the outside. Do not drill the cross holes yet.

Locate the two 165 mm ($6\frac{1}{2}$ ") x 6 mm ($\frac{1}{4}$ ") bolts, passing them through the side plates and tubular spacers, through the wooden spacers,

and finally through the left-hand upright. Fasten the nuts.

With the fan case now mounted, rotate the fan axle. If the fan catches inside the case, slide the axle from side to side until the fan clears and turns freely. Now drill the two 3 mm ($\frac{1}{8}$ " dia. cross holes through the axle as close as possible to the washers. Tap a 25 mm (1") x 3 mm ($\frac{1}{8}$ " dia. steel pin into each of these holes.

Remove the large pulley axle far enough to allow the large pulley to be placed in position. Now push the axle through the uprights until a 12 mm ($\frac{1}{2}$ ") length remains outside the left-hand upright. Place a 16 mm washer over each end of the axle and slide them up against the pulley bearings. Drill 3 mm dia. cross holes through the axle as close as possible to the washers.

Now position the large pulley mid-way between the uprights and drill the 3 mm dia. cross hole through the hub and shaft. Do not put pins in these holes yet. Slide the small pulley on the fan axle so that it runs exactly in line with the large pulley, and drill through the 3 mm dia. cross hole. Tap a 65 mm ($2\frac{1}{2}$ ") x 3 mm ($\frac{1}{8}$ ") pin into this hole. The large pulley and axle must now be removed before the assembly can be positioned inside the drum.

Mount as follows: cut a slot 102 mm (4") x 38 mm ($1\frac{1}{2}$ ") in the top centre of the drum, place the assembly on the two wood supports in the base of the drum so that the fan outlet is in line with the hole cut in the top of the drum. With the cutaway in front of the drum facing you, the pulley assembly should be on your right. Hold the assembly down with the four 75 mm (3") x 12 mm ($\frac{1}{2}$ ") bolts through the base angles and base support timbers.

Reassemble the axle and pulley, (remembering to position the fan belt if it is without a join) and push the axle through the bearings until it touches the inside wall of the drum. At this point drill or punch a 16 mm dia. hole through the drum wall and weld a thick 16 mm washer in position to support the pulley axle. The axle can now be pushed into its previous position, the washers located and the pins tapped into the cross holes.

The air chute must now be made by bending up the two pieces of 140 mm ($5\frac{1}{2}$ ") wide x 1.6 mm ($\frac{1}{16}$ ") steel sheet. The length needed must be measured from the actual job - it will be equal to the distance from the fan outlet to a point about 20 mm (1") above the slot in the

drum hearth. Cut the pieces to the correct length and bend each piece into an 'L' shape, 102 mm (4") by 38 mm (1¹/₂") to form a box section when they are put together.

Push the chute up through the underside of the drum hearth and then bring down over the fan outlet and tack weld in position.

Make a grill from the 125 mm (5") x 65 mm (2¹/₂") x 1.6 mm (1/16") steel sheet to cover the air chute outlet in the top of the drum. The holes should be 3 mm (1/8") dia.

The 'V' belt being used will probably have to be joined. Measure round the two pulleys with a length of string as a rough guide and add a little to this length. If the belt is not tight cut a small piece off and rejoin.

BICYCLE CRANK DRIVE

Cut the complete chainwheel assembly from an old or damaged bicycle, leaving about 75 mm (3") of the frame tubes. Remove the crank from the side opposite the chainwheel. Make a hole in the side of the drum, above and in line with the protruding large pulley axle. The hole should be large enough to take the spindle bearing housing. Weld the assembly in place at the points where the short lengths of frame tube contact the drum. It may be necessary to make a bracket if the crank does not feel rigid enough. Make sure that the chainwheel runs as near as possible at 90° to the large pulley axle.

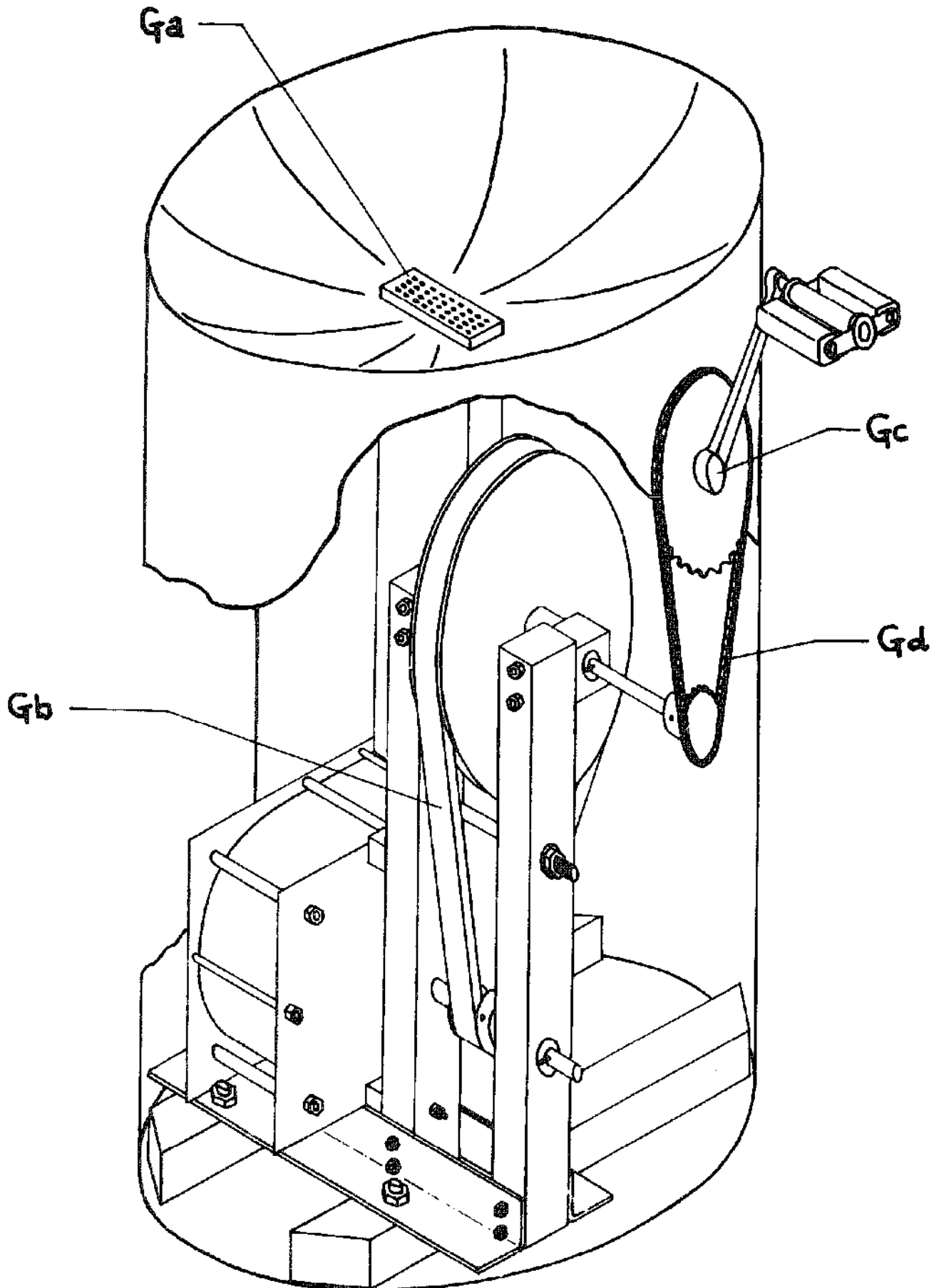
The small sprocket will have to be welded to a metal boss drilled with a 16 mm (5/8") dia. hole. It can then be fitted and lined up on the large pulley axle and cross drilled for securing with a pin.

Measure round chainwheel and sprocket to get the correct chain length and remove links to obtain the best fit.

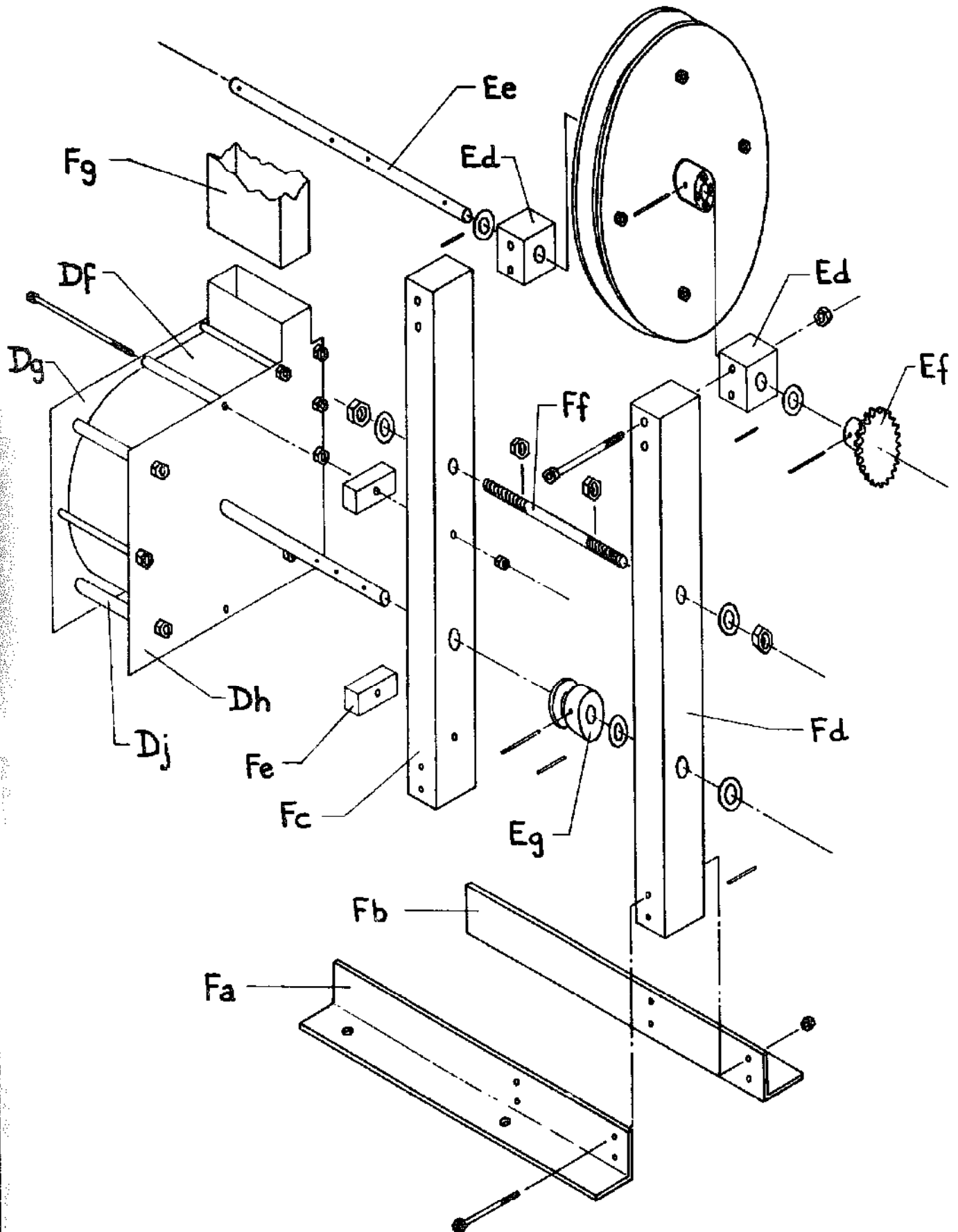
OPERATION

The crank is turned ANTI-CLOCKWISE to operate the fan.

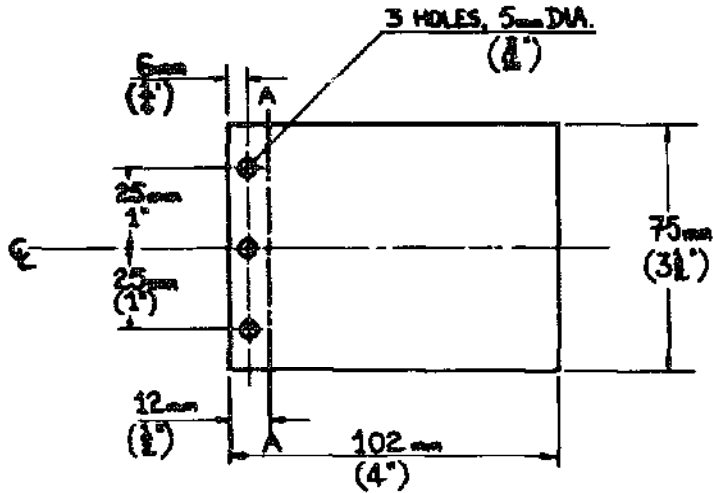
Keep all moving parts WELL OILED, especially the wood bearings for the fan and pulley axles.



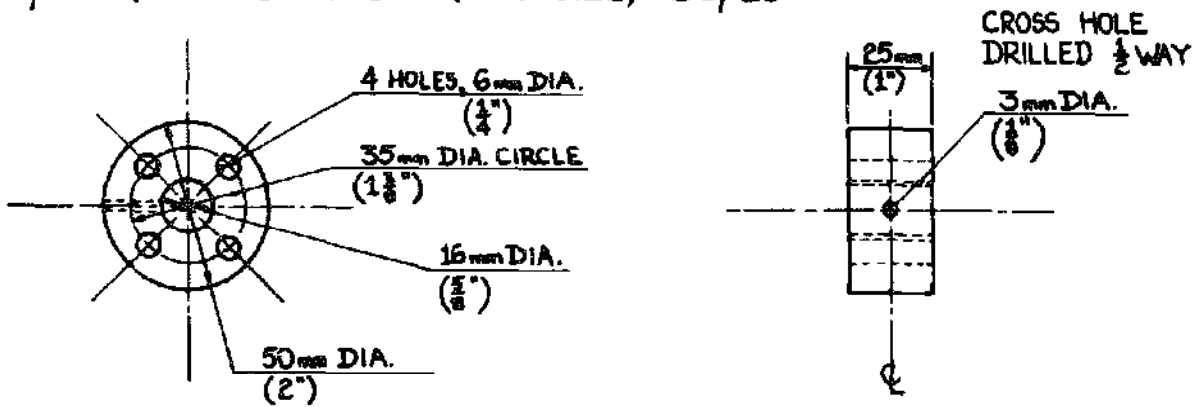
FAN CASE & UPRIGHT ASSEMBLY



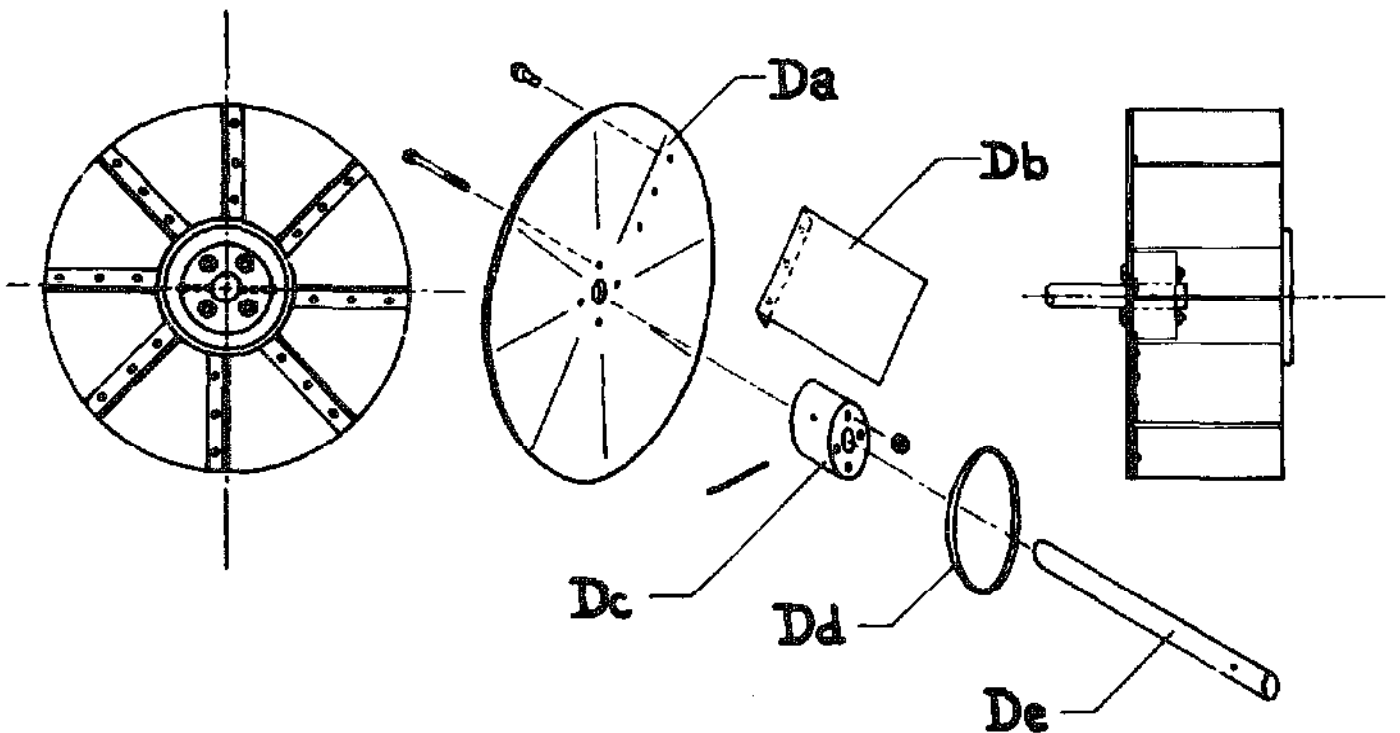
FAN BLADE (HALF SIZE) Db



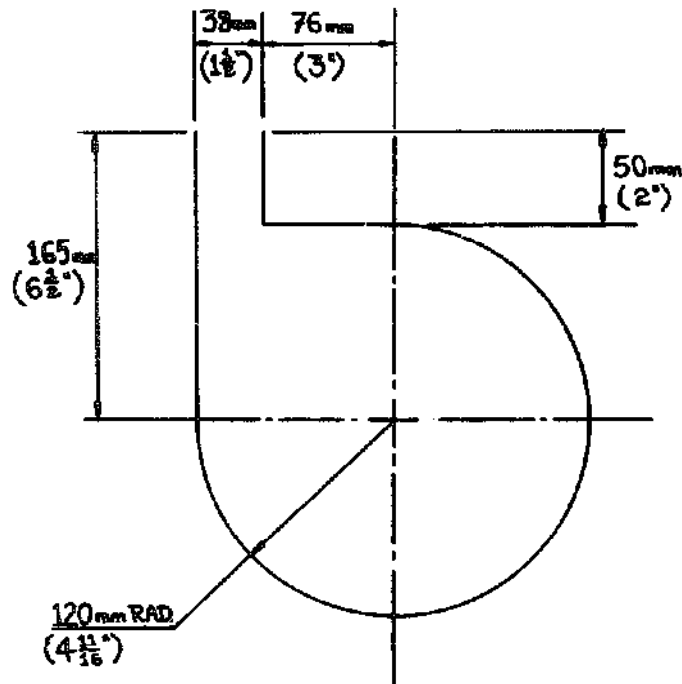
FAN / LARGE PULLEY HUB (HALF SIZE) Dc/Ec



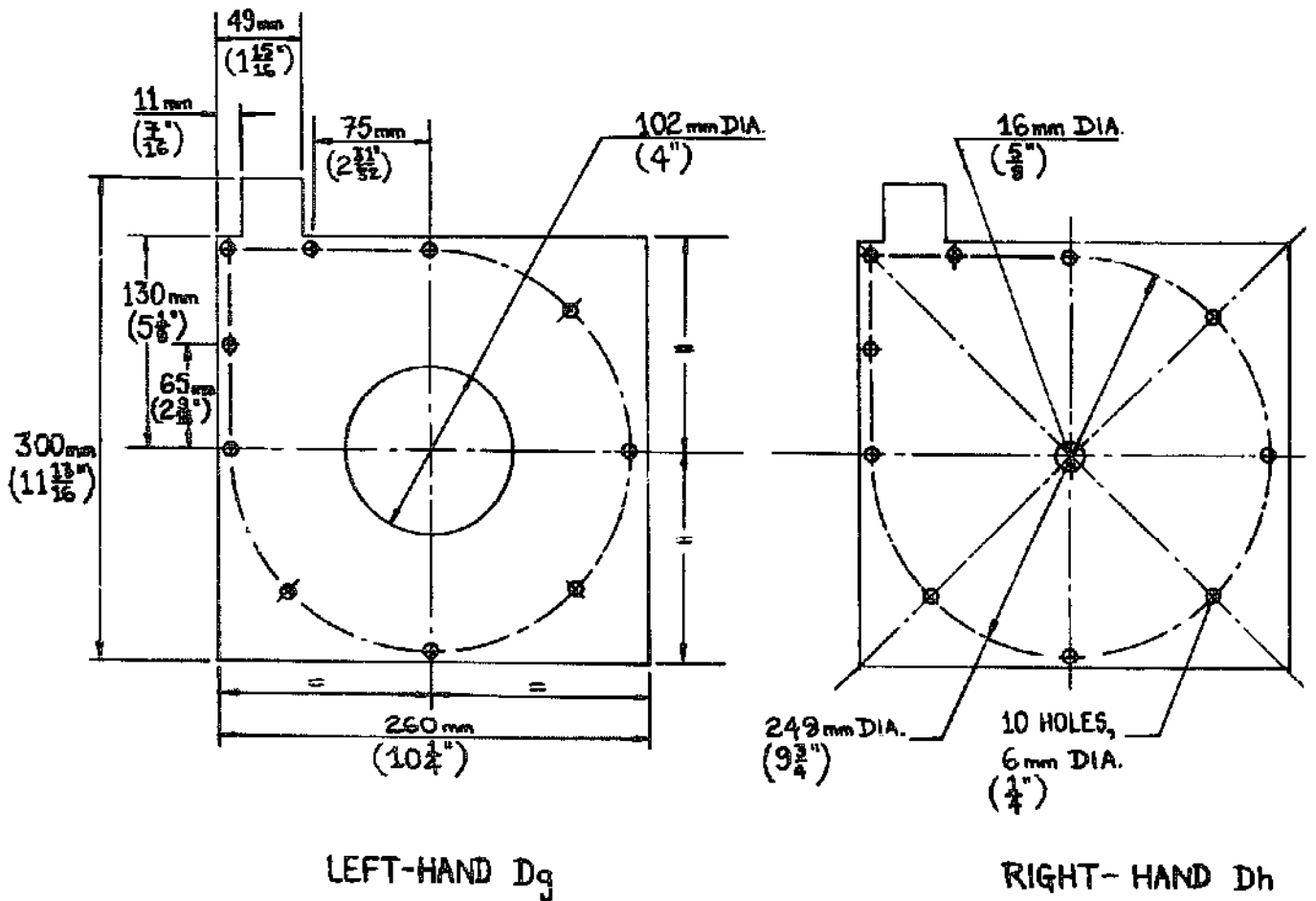
FAN BLADE ASSEMBLY



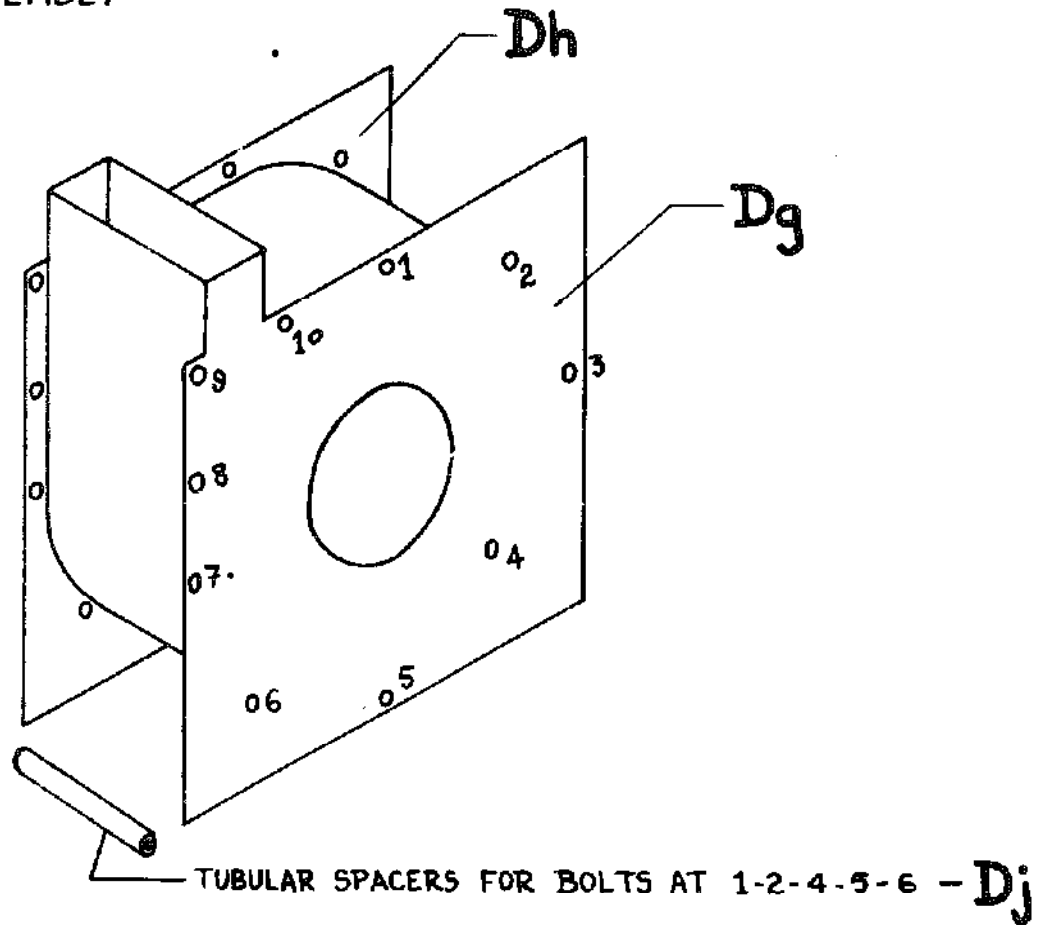
FAN COWLING (QUARTER SIZE) Df



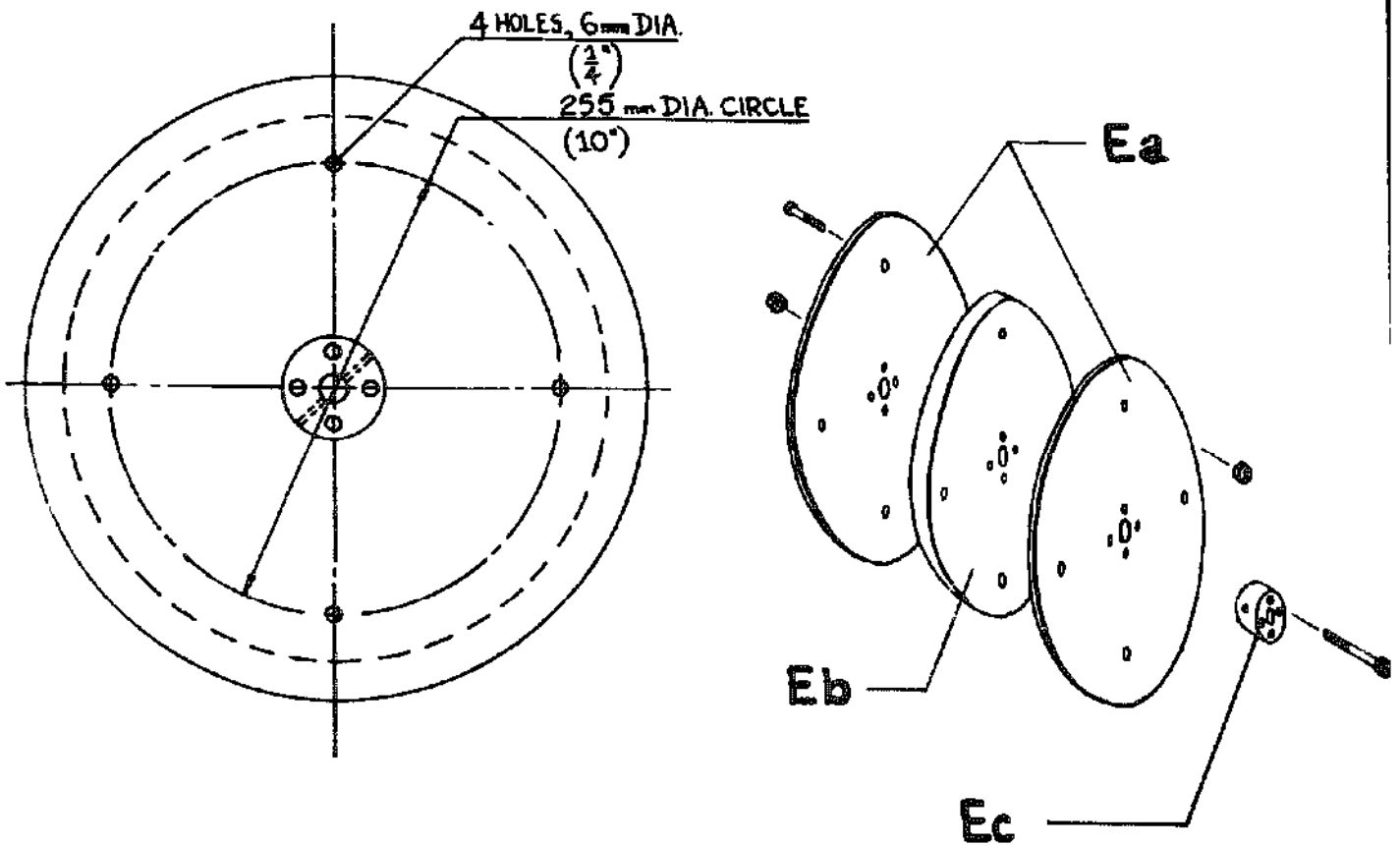
FAN SIDE PLATES (QUARTER SIZE) Dg AND Dh



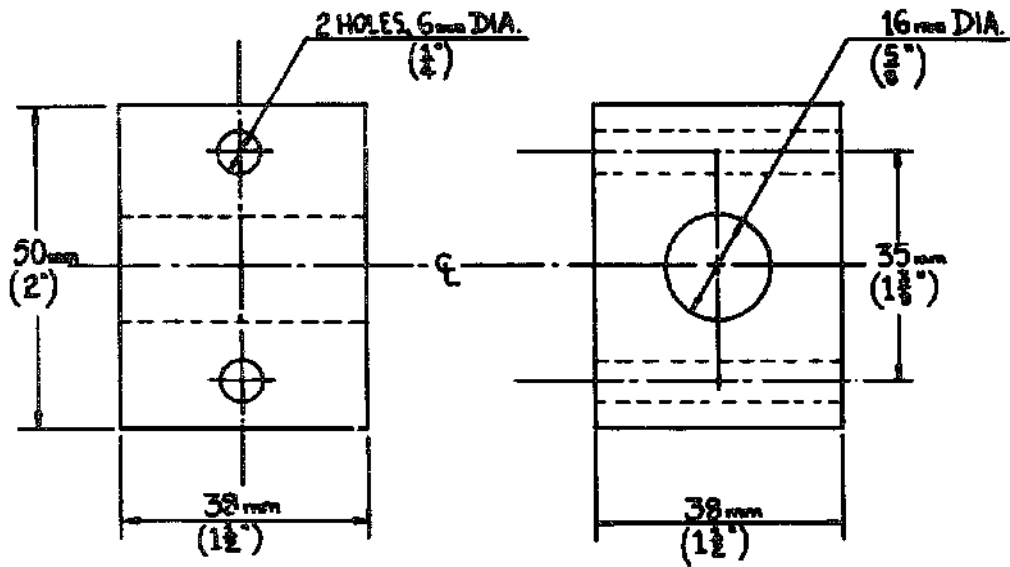
FAN CASE ASSEMBLY



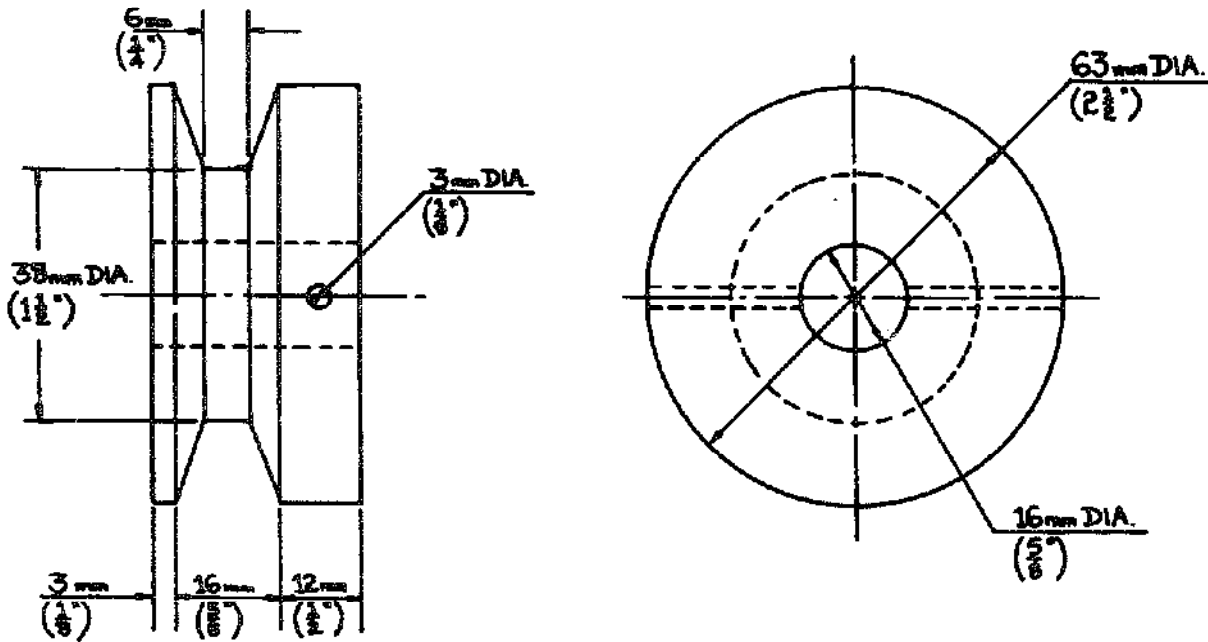
LARGE PULLEY (QUARTER SIZE)



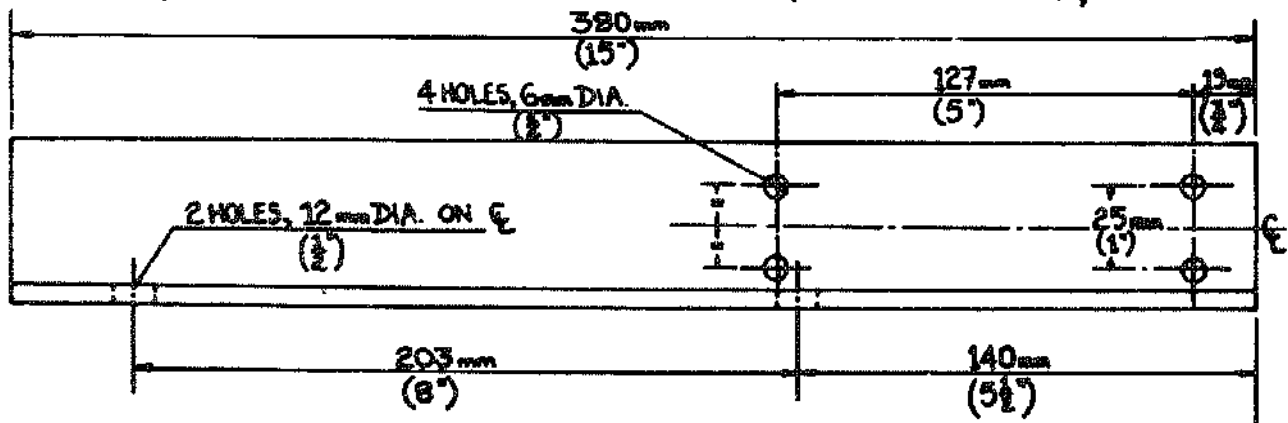
LARGE PULLEY BEARING (FULL SIZE) Ed



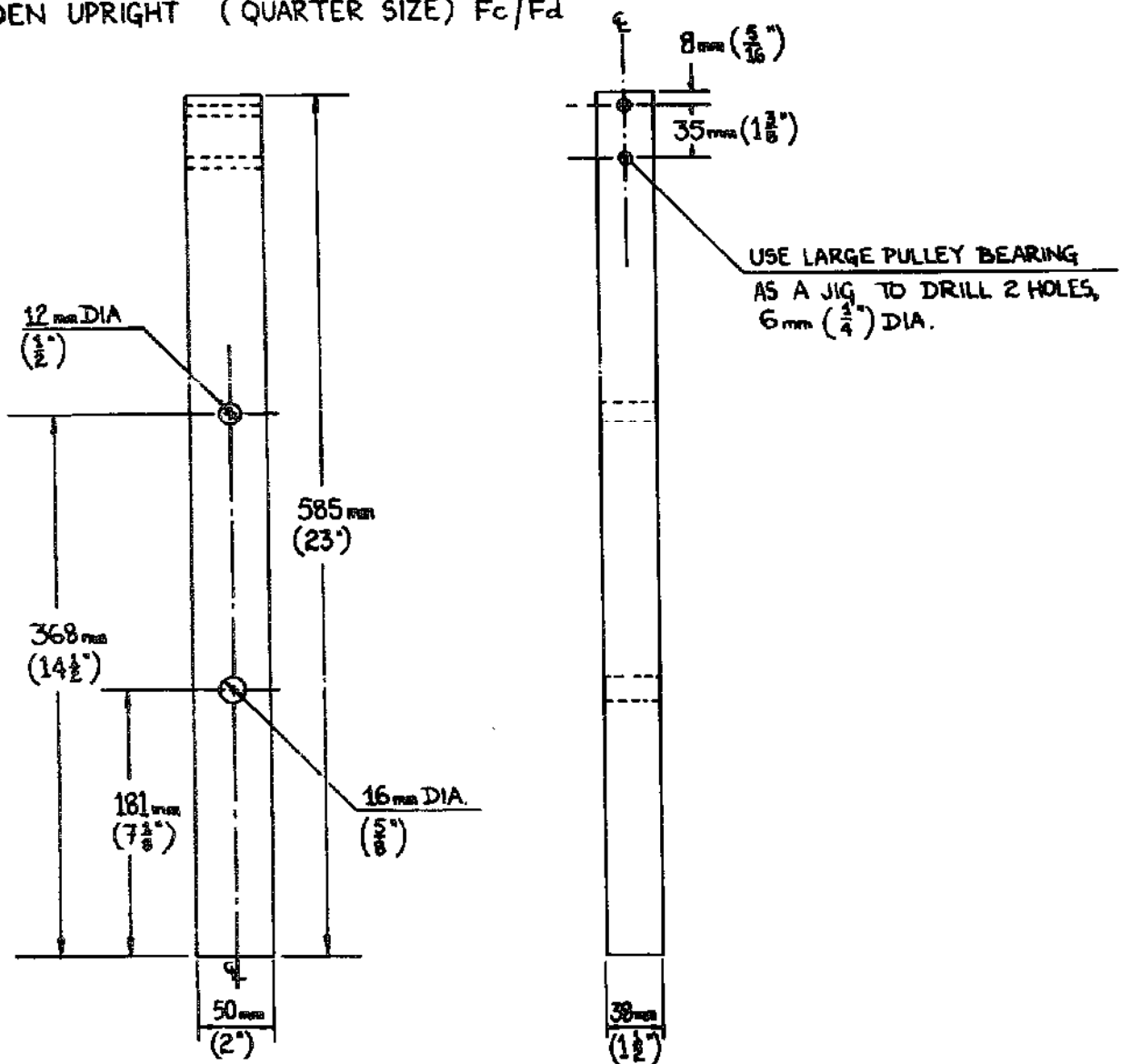
SMALL PULLEY (FULL SIZE) Eg



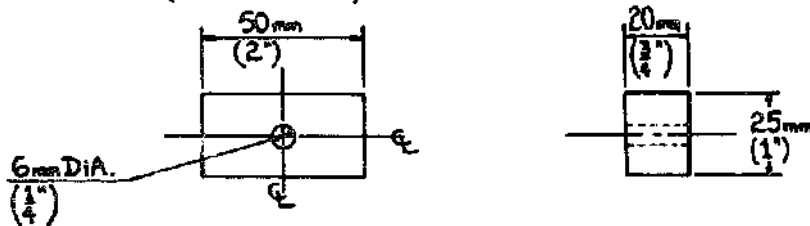
BASE ANGLE (HALF SIZE) FRONT BASE ANGLE SHOWN HERE, Fa



WOODEN UPRIGHT (QUARTER SIZE) Fc/Fd



WOODEN SPACER (HALF SIZE) Fe



SUPPORT BAR (HALF SIZE) Ff

