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Kabaryolo Toolbar

ITDG Agricultural Equipment and Tools No. 4

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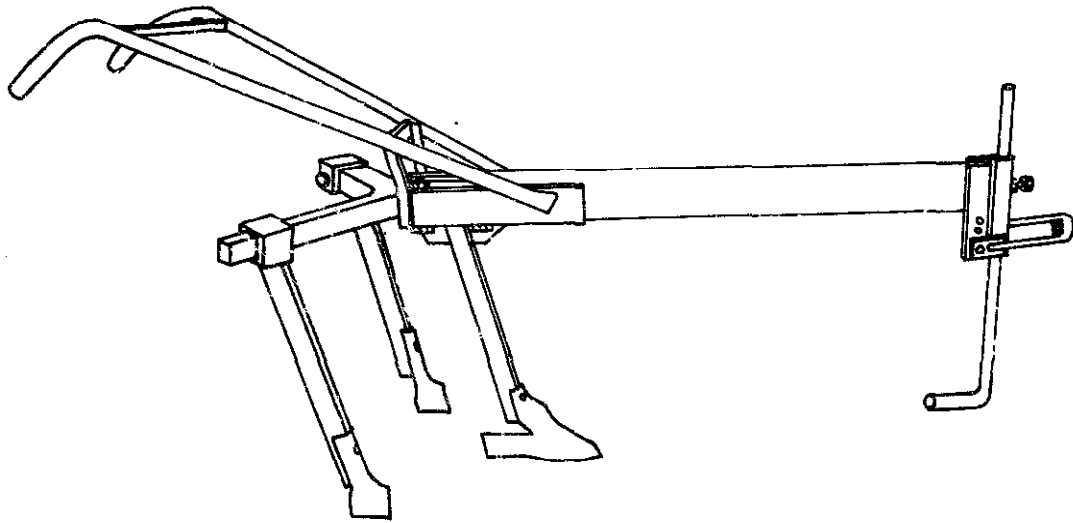
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4



"KABANYOLO" TOOLBAR

"KABANYCLO" OX TOOLFRAME

DEVELOPED BY:

Based on the "UNIBAR" developed and made by A.R. STOKES, Project Equipment Ltd., Newton Tony, Salisbury, U.K., with local modifications by L.J. Clarke, Makerere University, Uganda.

DESCRIPTION:

This multi-purpose toolframe is shown in plan and side views with a plough stem attached. When fitted with the "Y" frame it can be used as an adjustable-width 3-tine cultivator/weeder.

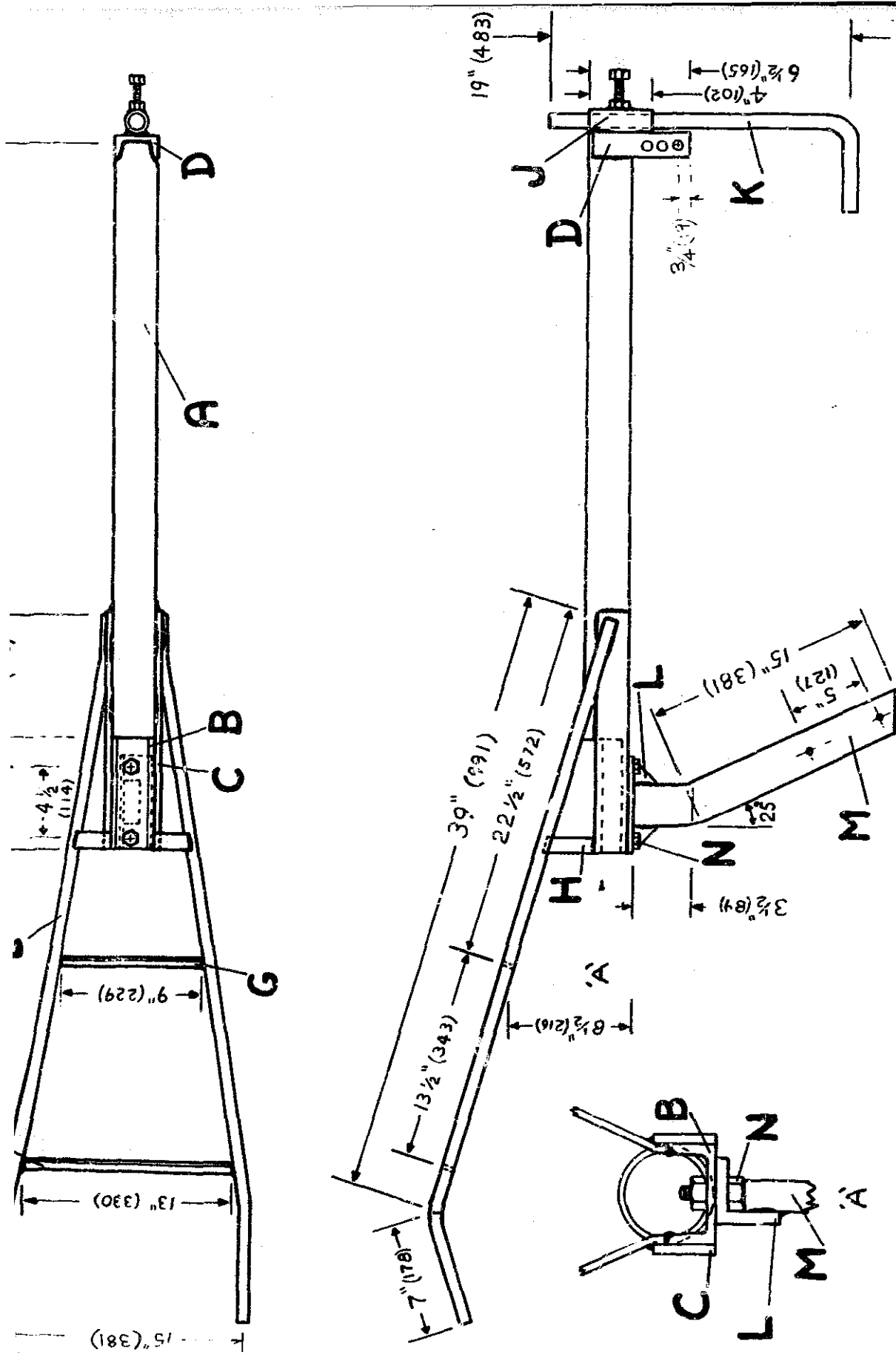
The toolframe is fabricated from mild steel flat, pipe, bar, channel, angle and box section materials. A simple skid is used instead of a depth wheel.

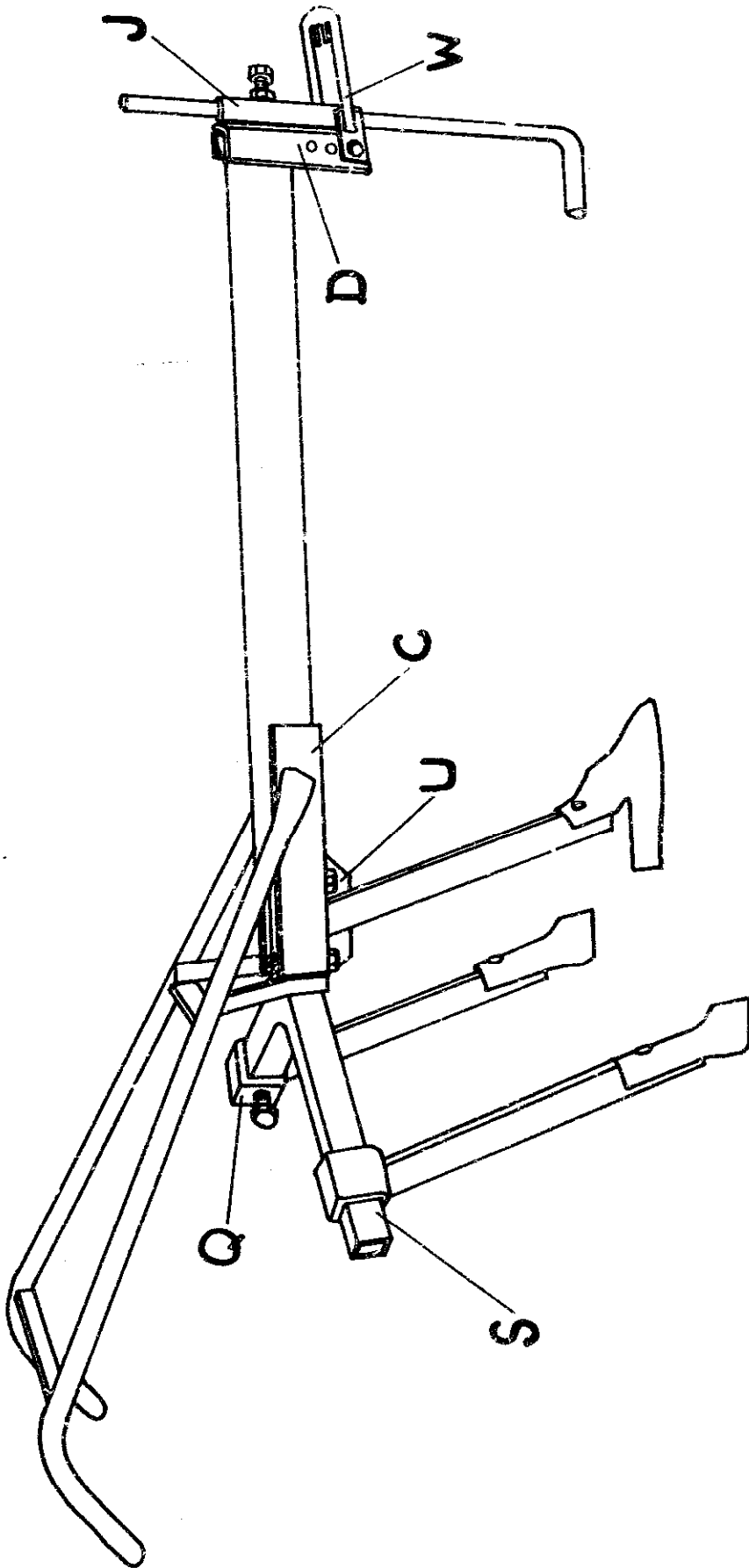
Note: Figures in brackets are in millimetres.

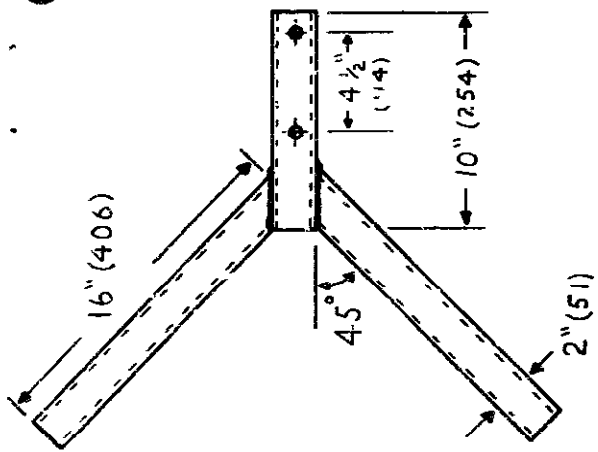
KEY:

<u>ITEM</u>	<u>NAME</u>	<u>QUANTITY</u>	<u>ITEM DESCRIPTION</u>
A	MAIN FRAME	1	Of 2 $\frac{1}{2}$ " (63) internal diameter, $\frac{1}{4}$ " (6.3) thick wall mild steel pipe, 38" (965) long.
B	REAR CHANNEL SECTION	1	Of 3" x 1 $\frac{1}{2}$ " x $\frac{1}{4}$ " (76 x 38 x 6.3) mild steel channel section, 7" (178) long.
C	SIDE PIECE	2	Of 2" x $\frac{3}{8}$ " (51 x 9.5) flat mild steel, 15" (381) long.
D	FRONT CHANNEL SECTION	1	Of 3" x 1 $\frac{1}{2}$ " x $\frac{1}{4}$ " (76 x 38 x 6.3) mild steel channel section, 6 $\frac{1}{2}$ " (165) long, 3 holes each $\frac{1}{4}$ " (19) diameter drilled 1" (25) apart.
E	HANDLE SIDE PIECE	2	Of $\frac{1}{2}$ " (19) internal diameter pipe, 46" (1168) long.
F	HANDLE BRACE	1	Of 1" x $\frac{3}{8}$ " (25 x 9.5) flat mild steel, 13" (330) long.
G	HANDLE BRACE	1	Of 1" x $\frac{3}{8}$ " (25 x 9.5) flat mild steel, 9" (229) long.
H	HANDLE SIDE BRACE	2	Of 1" x $\frac{3}{8}$ " (25 x 9.5) flat mild steel, 4 $\frac{1}{2}$ " (114) long.
J	SKID CLAMP	1	Of 1" (25) internal diameter pipe, 4" (102) long.
K	SKID	1	Of 1" (25) diameter mild steel round bar, 25" (635) long.
L	STEM BRACKET	1	Of 2" x 2" x $\frac{3}{8}$ " (51 x 51 x 9.5) mild steel angle, 6" (152) long.
M	PLOUGH STEM	1	Of 2 $\frac{1}{2}$ " x $\frac{1}{4}$ " (63 x 19) flat mild steel, 18 $\frac{1}{2}$ " (470) long.

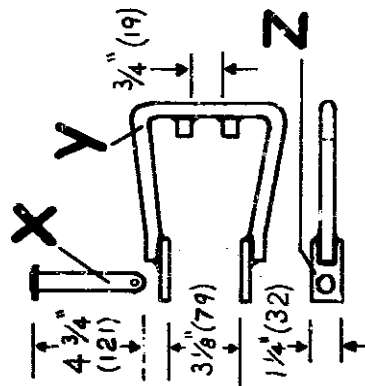
N	PLOUGH STEM/ CENTRE TINE BOLT	2	$\frac{5}{8}$ " (16) diameter mild steel bolt, $1\frac{1}{2}$ " (38) or $3\frac{1}{2}$ " (89) long as required.
P	SIDE TINE	2	Make one left hand tine and one right hand tine. Use shares of choice.
Q	SIDE TINE CLAMP	2	Each made from two 3" (76) length pieces of $2\frac{1}{2}$ " x $2\frac{1}{2}$ " x $\frac{1}{4}$ " (63 x 63 x 6.3) angle iron of section dimensions to ensure a sliding fit on the 'I' frame.
R	BOLT HOLE	1 per tine	$\frac{1}{8}$ " (9.5) diameter hole drilled through tine foot for share attachment bolt. Tine of $1\frac{1}{2}$ " x $\frac{1}{4}$ " (38 x 19) rectangular section mild steel.
<u>S</u>	'Y' FRAME	1	Made of 2" x 2" x $\frac{1}{8}$ " (51 x 51 x 3) square hollow section mild steel, two $\frac{5}{8}$ " (16) diameter holes drilled through the front end for bolting to item B.
<u>T</u>	CENTRE TINE	1	When used with the 'Y' frame the centre tine is attached to the main frame by two $\frac{5}{8}$ " (16) diameter bolts $3\frac{1}{2}$ " (89) long.
U	CENTRE TINE BRACKET	1	Of 2" x 2" x $\frac{1}{8}$ " (51 x 51 x 9.5) mild steel angle, 6" (152) long.
V	BOLT HOLE	1	$\frac{1}{8}$ " (9.5) diameter hole drilled through tine foot for share attachment bolt. Tine of $1\frac{1}{2}$ " x $\frac{1}{4}$ " (38 x 19) rectangular section mild steel.
<u>W</u>	HITCH ASSEMBLY	1	Made of mild steel, hitch height adjustment provided by holes in front channel section (item D).
X	HITCH PIN	1	Of $\frac{1}{2}$ " (19) diameter mild steel round bar.
Y	HITCH HOOK	1	Made of $\frac{1}{2}$ " (16) diameter mild steel round bar.
Z	HITCH PIVOT PIECE	2	Welded to hitch hook, each of $2\frac{1}{2}$ " x $1\frac{1}{4}$ " x $\frac{3}{8}$ " (63 x 32 x 9.5) flat mild steel.



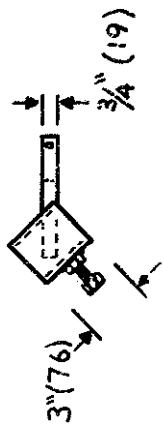




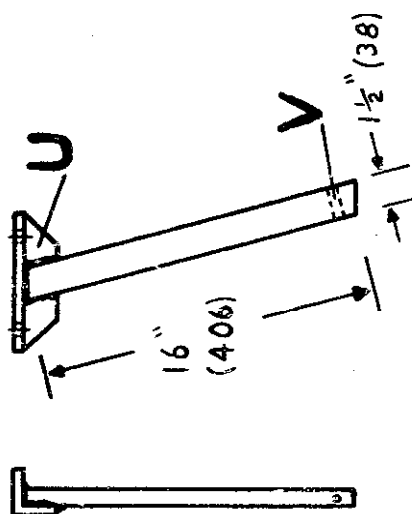
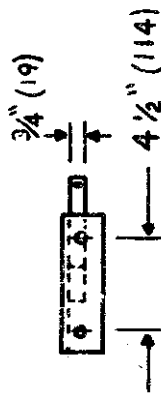
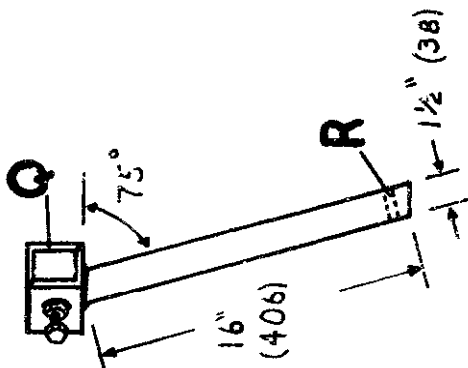
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5

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Chitedze Ridgemaster Toolbar

ITDG Agricultural Equipment and Tools No. 5

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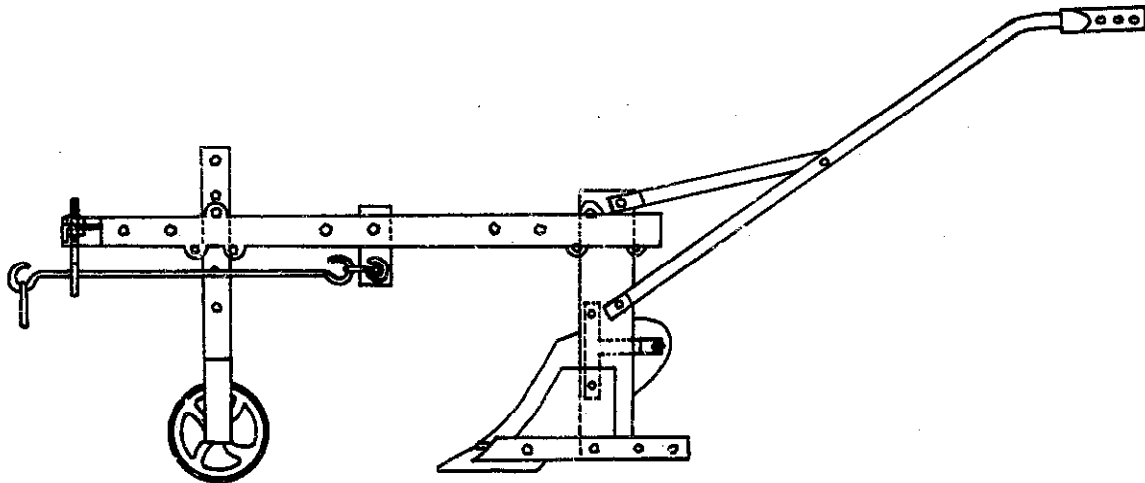
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"CHITEDZE RIDGEMASTER"
TOOLBAR

"CHITEDZE RIDGEMASTER" TOOLBAR

DEVELOPED BY: G.D. Horspool, Chitedze Agricultural Research Station, Malawi.

DESCRIPTION: This multi-purpose toolbar is shown in side and plan views with a plough body attached, but a ridger or cultivator can also be fitted to the vertical beam.

The unique design feature of this toolbar is that it combines lightness with adequate structural strength, the main parts being fabricated from rectangular hollow section (R.H.S.) mild steel.

Note: Figures in brackets are in millimetres.

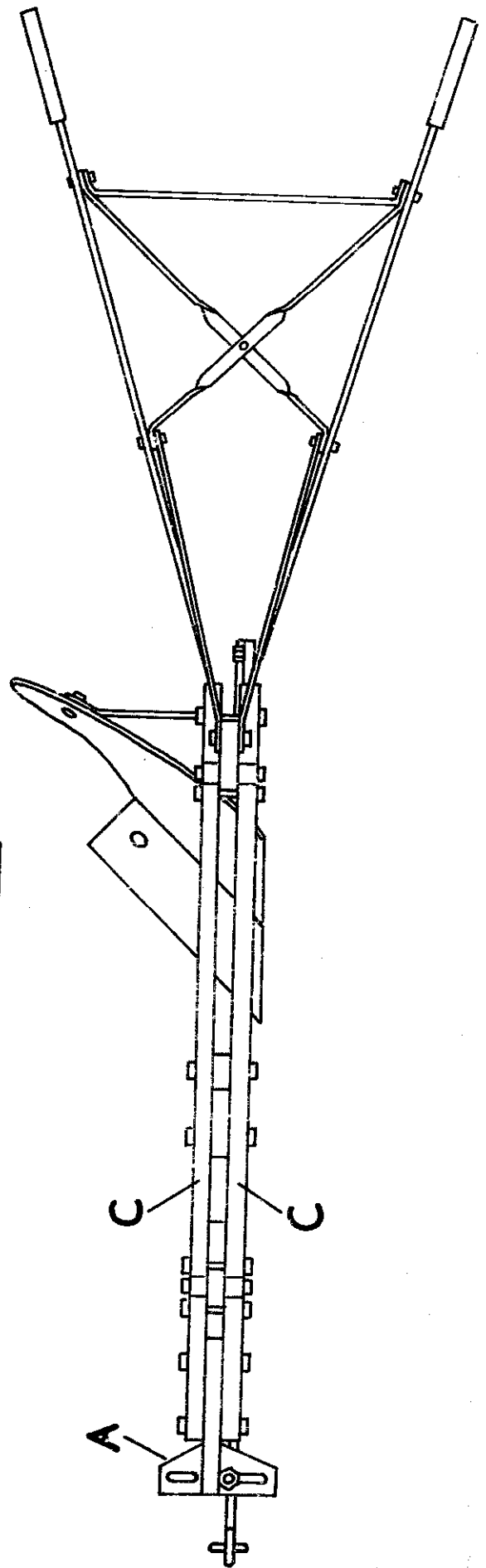
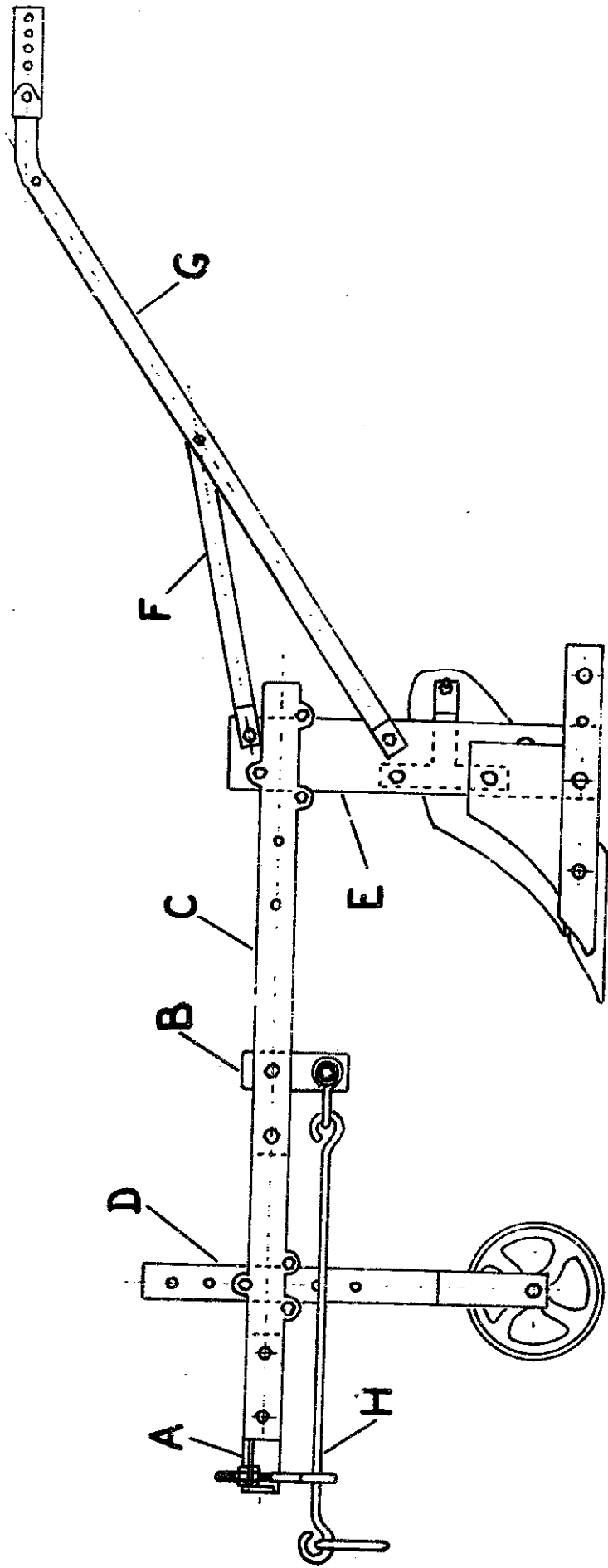
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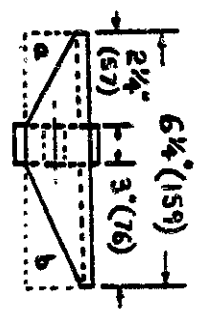
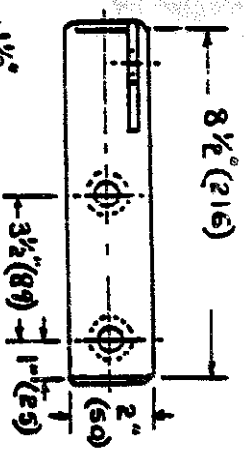
<u>ITEM</u>	<u>NAME</u>	<u>QUANTITY</u>	<u>ITEM DESCRIPTION</u>
A	HAKE PLATE	1	Plate of $\frac{1}{4}$ " x $1\frac{1}{2}$ " (6.3 x 38 x 38) mild steel angle iron, parts a and b cut off and welded on top, with plate support of 2" x 1" (50 x 25) R.H.S. steel.
B	CENTRE HITCH	1	Two pieces of 2" x 1" (50 x 25) R.H.S. welded together at right angles.
C	HORIZONTAL BEAM	2	Each of 2" x 1" (50 x 25) R.H.S. steel.
D	WHEEL ASSEMBLY	1	Of 2" x 1" (50 x 25) R.H.S. steel welded to 2" x $\frac{1}{4}$ " (50 x 6.3) 'U' shaped wheel support.
E	VERTICAL BEAM	1	Made from two pieces of 2" x 1" (50 x 25) R.H.S. steel welded together.
F	HANDLE STAY	2	Each of 1" x $\frac{1}{4}$ " (25 x 6.3) section mild steel.
G	HANDLE	2	Each of $1\frac{1}{4}$ " x $\frac{5}{16}$ " (32 x 8) section mild steel
H	HITCH ASSEMBLY	1	Of $\frac{5}{8}$ " (16) diameter mild steel rod.
J	WHEEL	1	7" (178) diameter cast iron wheel running on bush of $\frac{9}{16}$ " (14) internal diameter and $\frac{1}{2}$ " (12.5) diameter bolt.
K	BOLT HOLES		All bolt holes in R.H.S. steel formed by drilling 1" (25) through R.H.S., inserting bush of 1" (25) outside diameter x $\frac{3}{16}$ " (5) thick wall mild steel tube, welding into position and grinding flush.
L	BOLT HOLES		Formed by welding 1" (25) outside diameter x $\frac{3}{16}$ " (5) thick wall mild steel tube into position.

M R.H.S. CAPPING All open ends of R.H.S. steel capped with $\frac{1}{8}$ " x 1" (3 x 25) mild steel flat, welded and ground to a bevel edge.

KEY 2:

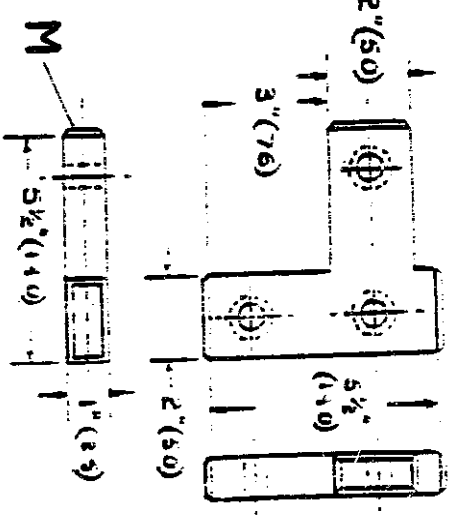
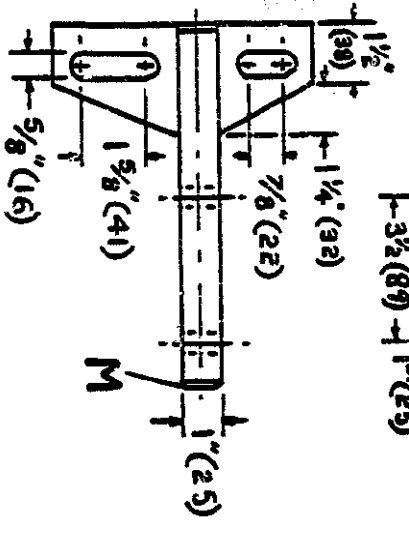
<u>ITEM</u>	<u>NAME</u>	<u>ITEM DESCRIPTION</u>
N	"CHITEDZE" MK III TOOLBAR	View showing design modifications and parts of cultivator attachment.
A2	HAKE PLATE	Plate made of $\frac{1}{2}$ " (12.5) thick flat mild steel instead of angle iron.
B2	CENTRE HITCH	Made of one piece of 2" x 1" (50 x 25) R.H.S. steel.
L2	BOLT HOLES	$\frac{1}{2}$ " (12.5) diameter bolt holes drilled through $\frac{3}{8}$ " (9.5) thick flat mild steel welded to horizontal beams.
P	CULTIVATOR MAIN FRAME	Made of 2" x 1" (50 x 25) R.H.S. steel.
Q	CULTIVATOR TINE BAR	Made of 2" x 1" (50 x 25) R.H.S. steel, 18" (457) long.
R	CULTIVATOR TINES	Fabricated of mild steel for front or rear fitting as required.



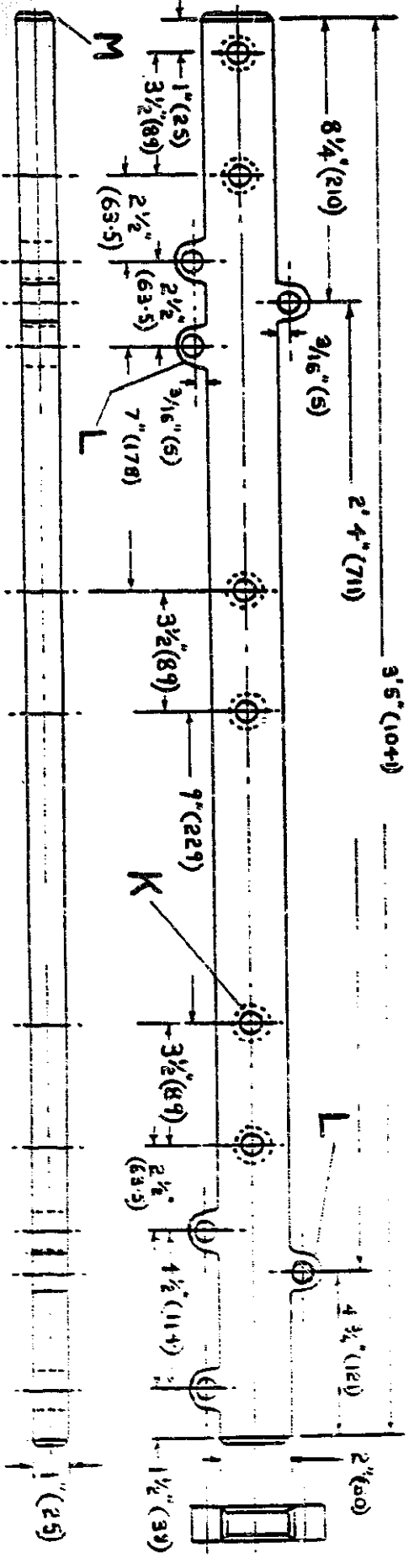


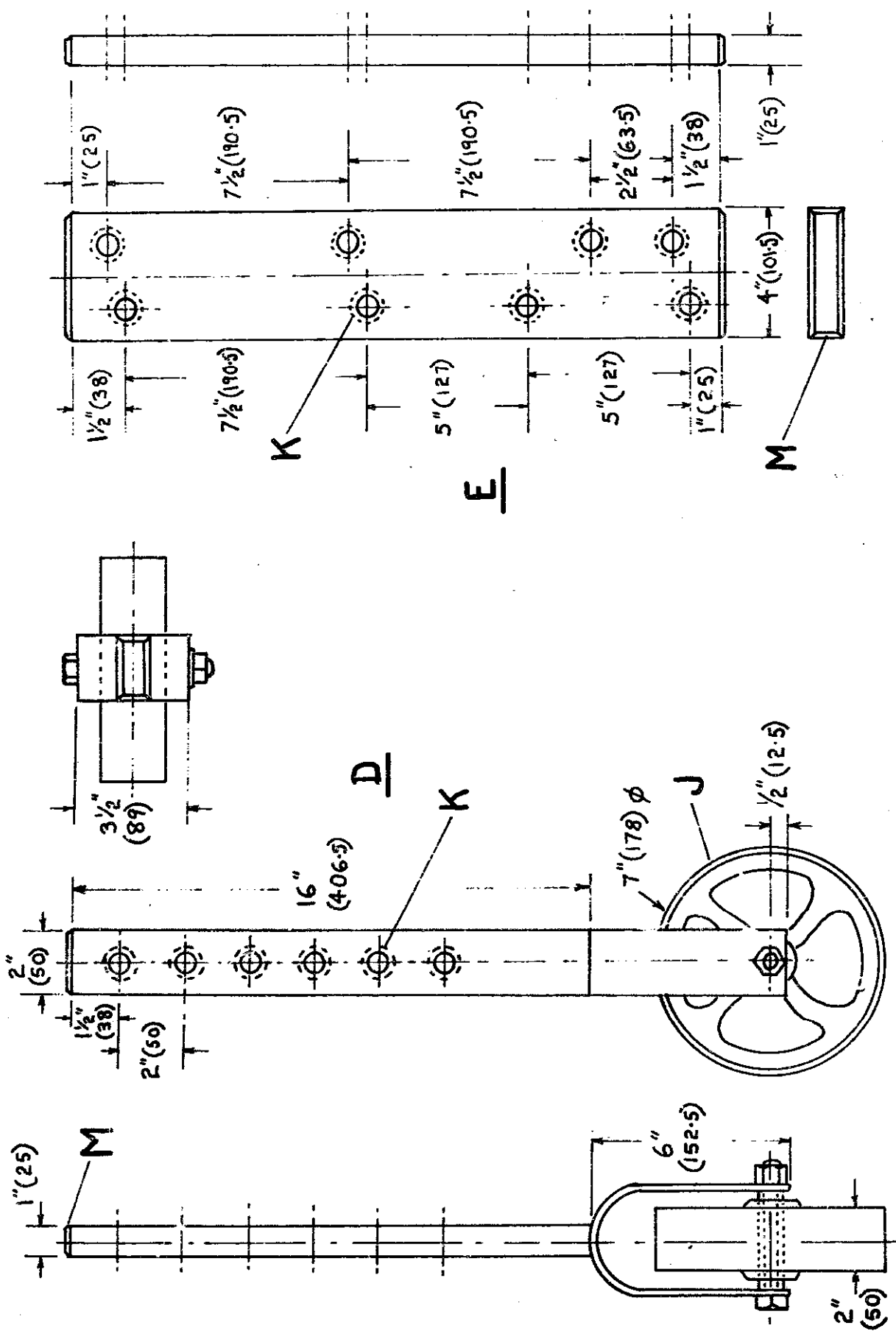
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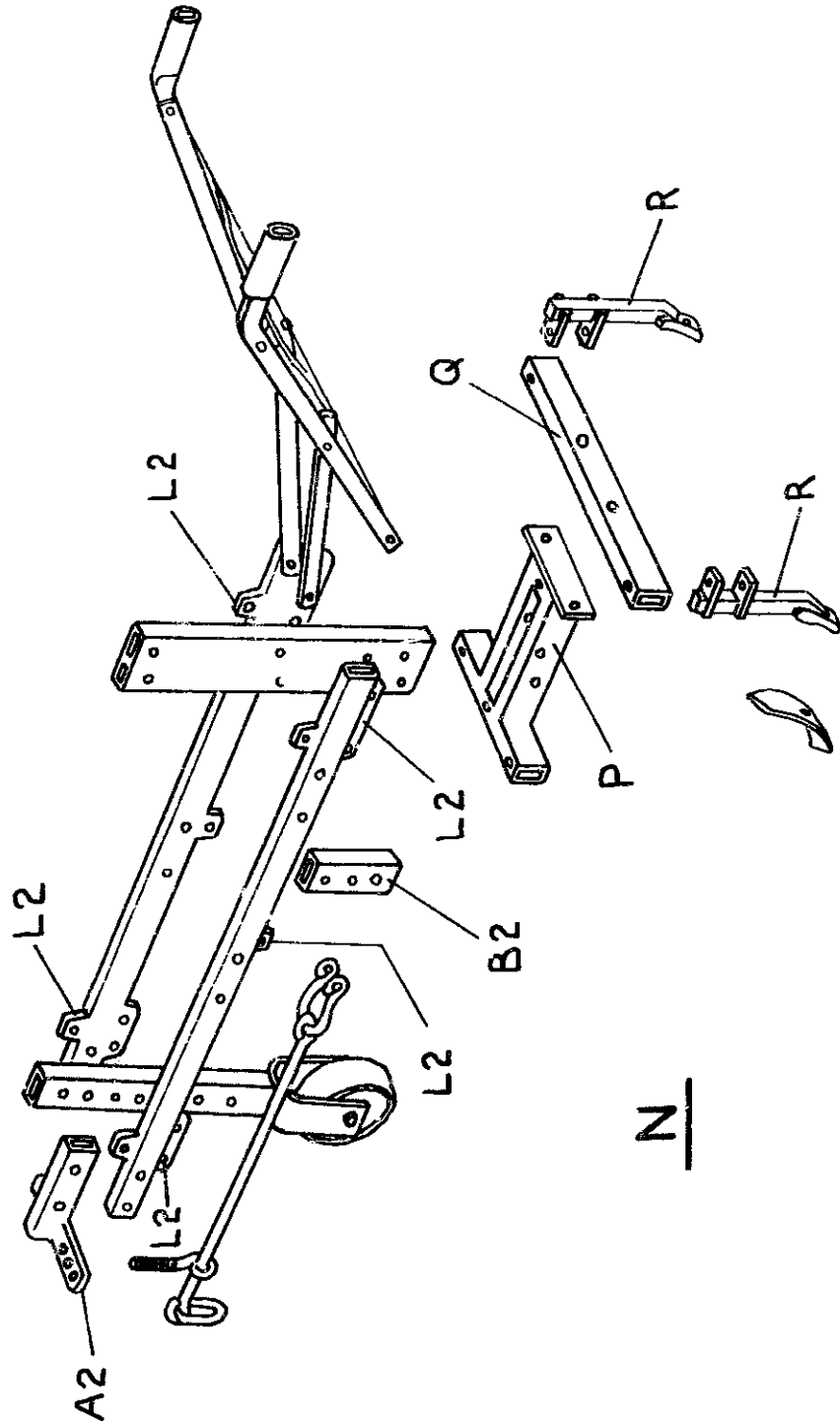
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6

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Prototype Multi-Purpose Ox-Drawn Tool
ITDG Agricultural Equipment and Tools No. 6

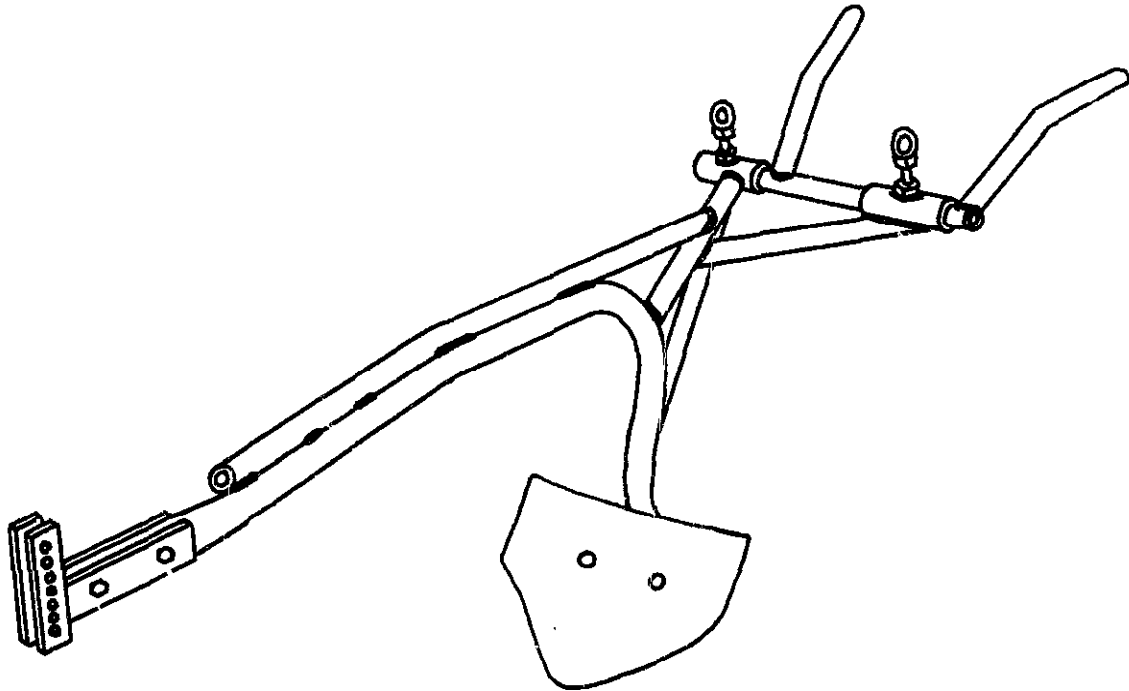
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PROTOTYPE MULTI-PURPOSE
OX-DRAWN TOOL

PROTOTYPE MULTI-PURPOSE OX-DRAWN TOOL

DEVELOPED BY: A.R. Stokes, Northern Region Research Station, Samaru, Nigeria.

DESCRIPTION: This tool was one of a series built by the engineer, Mr. A.R. Stokes, in a research programme aimed at assisting the small farmers who grow their crops on ridges in Northern Nigeria.

The share is adjustable to allow different soil cultivation operations to be carried out. In the design shown, the share angle settings obtainable with the beam horizontal are 40° , 55° , 70° and 85° approximately.

On the comparatively heavy soils at Samaru, the multi-purpose share was used for ridging, splitting ridges, cross-tying, weeding and breaking capped soil in the furrows. The tool frame was designed with an offset beam to avoid blockage when lifting groundnuts.

This tool was a prototype but does show a considerable amount of ingenuity, and the fabrication methods illustrated should be of value to field extension personnel in promoting various ideas on local construction of agricultural equipment to assist farmers in developing areas.

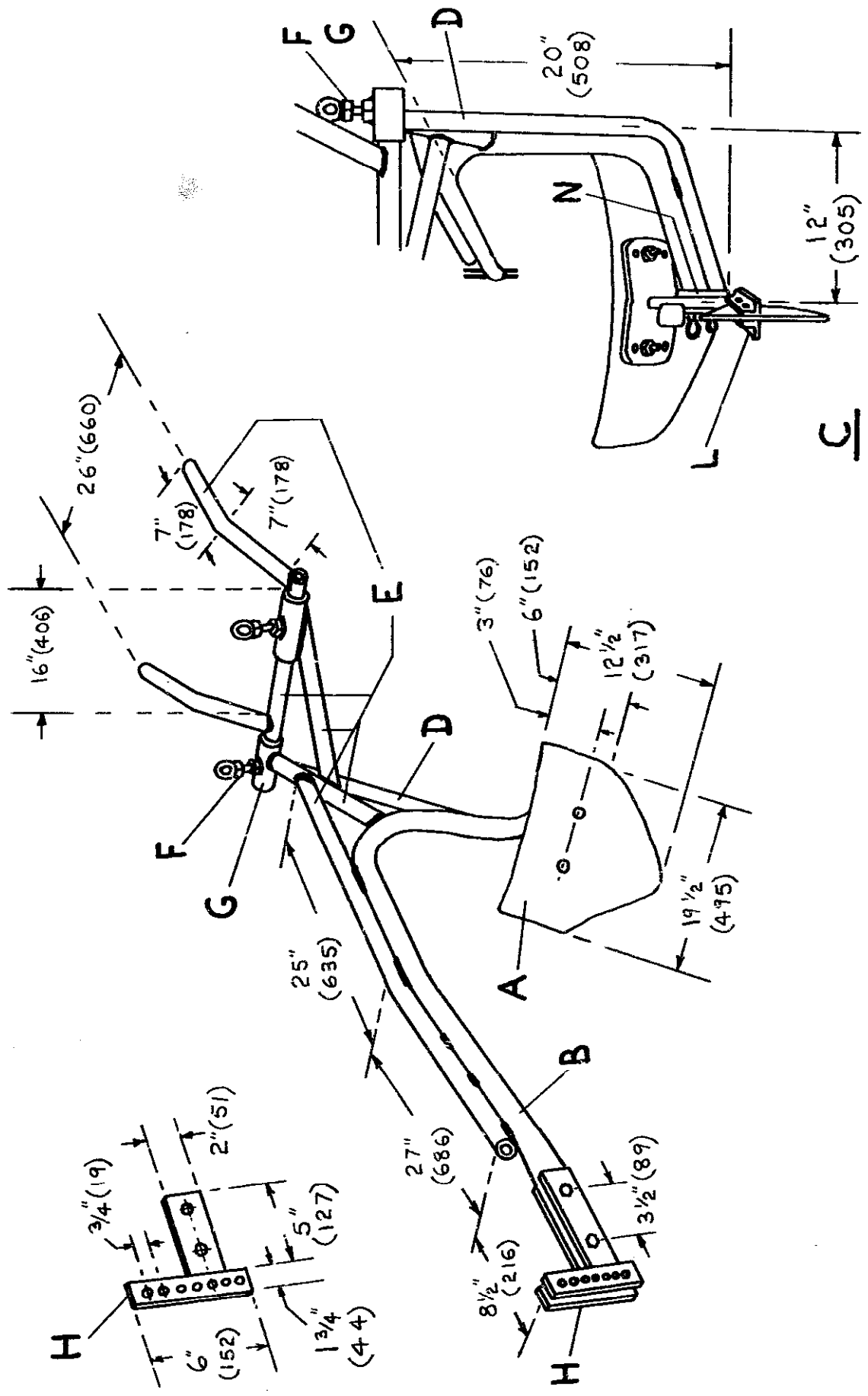
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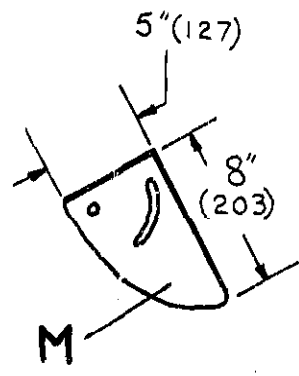
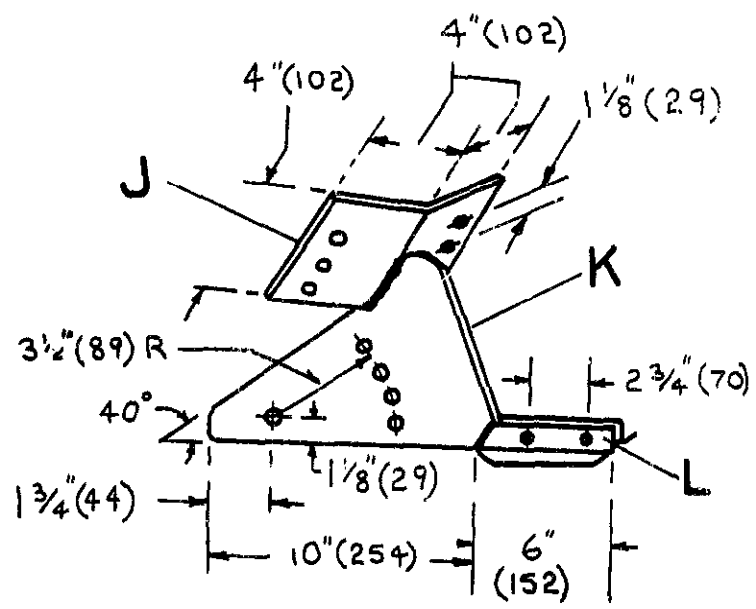
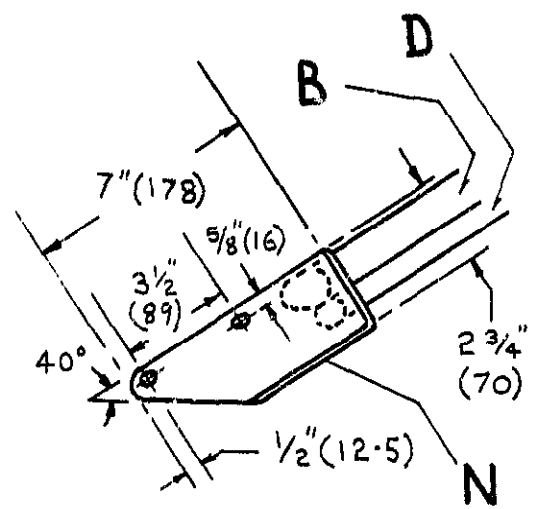
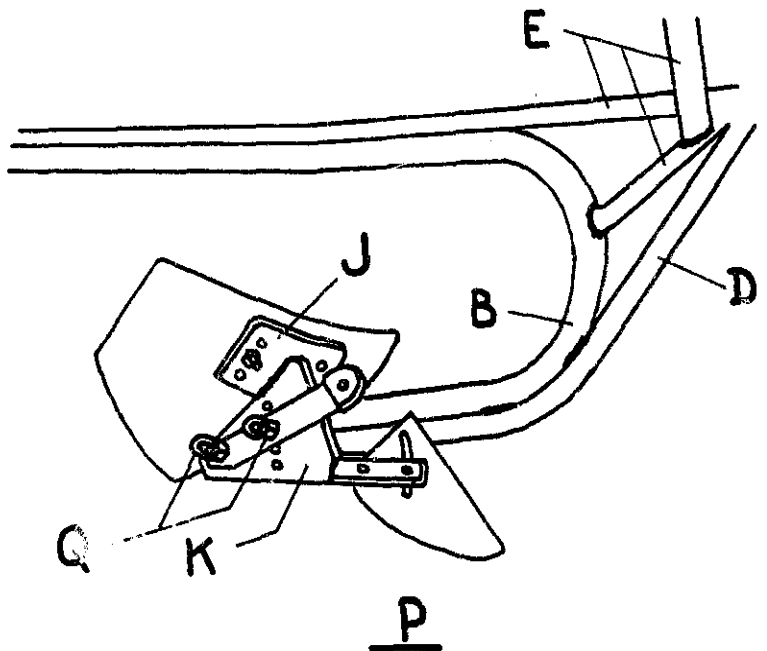
KEY:

ITEM

ITEM DESCRIPTION

- | | |
|---|--|
| A | Multi-purpose share cut from an old plough disc. |
| B | Main beam of $1\frac{1}{4}$ " (32) nominal bore pipe, the front end of the pipe flattened to facilitate fitting the hitch bracket. |
| C | Rear view of the tool showing the offset beam. |
| D | Rear brace piece of $\frac{1}{2}$ " (19) nominal bore pipe. |
| E | Handles and auxiliary frame pieces of 1" (25) nominal bore pipe. |
| F | Handle-height adjustment clamp bolts. |
| G | Handle bar clamp sleeves of $1\frac{1}{4}$ " (32) nominal bore pipe. |
| H | Hitch brackets made of $\frac{3}{8}$ " (9.5) thick mild steel, bolted together through the main beam. |
| J | Share attachment plate of $\frac{1}{4}$ " (6.3) thick mild steel. |
| K | Share plate support of $\frac{1}{2}$ " (12.5) thick mild steel, with $\frac{1}{2}$ " (12.5) diameter holes for adjusting angle of share. |
| L | Rudder support made from two pieces of 1" x 1" x $\frac{3}{8}$ " (25 x 25 x 3) mild steel angle. |
| M | Rudder of $\frac{3}{16}$ " (5) thick steel, secured with $\frac{3}{8}$ " (9.5) diameter bolts. |
| N | Beam attachment plate of $\frac{1}{2}$ " (12.5) thick mild steel. |
| P | Rear/side view of tool showing the share assembly. |
| C | Bolts of $\frac{1}{2}$ " (12.5) diameter for securing beam attachment plate. |





10

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Clod Crushers. Two Designs

ITDG Agricultural Equipment and Tools No. 10

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AGRICULTURAL EQUIPMENT
AND TOOLS FOR FARMERS
DESIGNED FOR LOCAL CONSTRUCTION

CLOD CRUSHERS (TWO DESIGNS)

DEVELOPED BY: R.B. BROCKBANK, Bunda College of Agriculture, Malawi.

DESCRIPTION: These two simple and cheaply-constructed implements are used for reducing the size of clods in cultivated land prior to ridging up the soil. They are made principally of 'gum' (Eucalyptus species) poles.

Type 1

The roller gangs are built up from short pieces of pole, each drilled and grooved so that when fitted onto the steel bar axle they rest at an angle of approximately 60° to each other. The poles are mounted on their axles with sufficient play to provide a self-cleaning effect. This implement is provided with additional weight by either ballasting the frame or fitting a seat on the frame for the operator.

Type 2

This model consists of short pole pegs attached in a staggered formation around the circumference of a single heavy log roller. The pegs need to be drilled before nailing to avoid splitting. Steel bolts, sharpened at the ends, of $\frac{1}{2}$ " (12.5) to $\frac{3}{4}$ " (19) diameter are driven into the centre of each end of the roller, to which the draught chains are attached. A swingle tree is fitted to the roller draught chains.

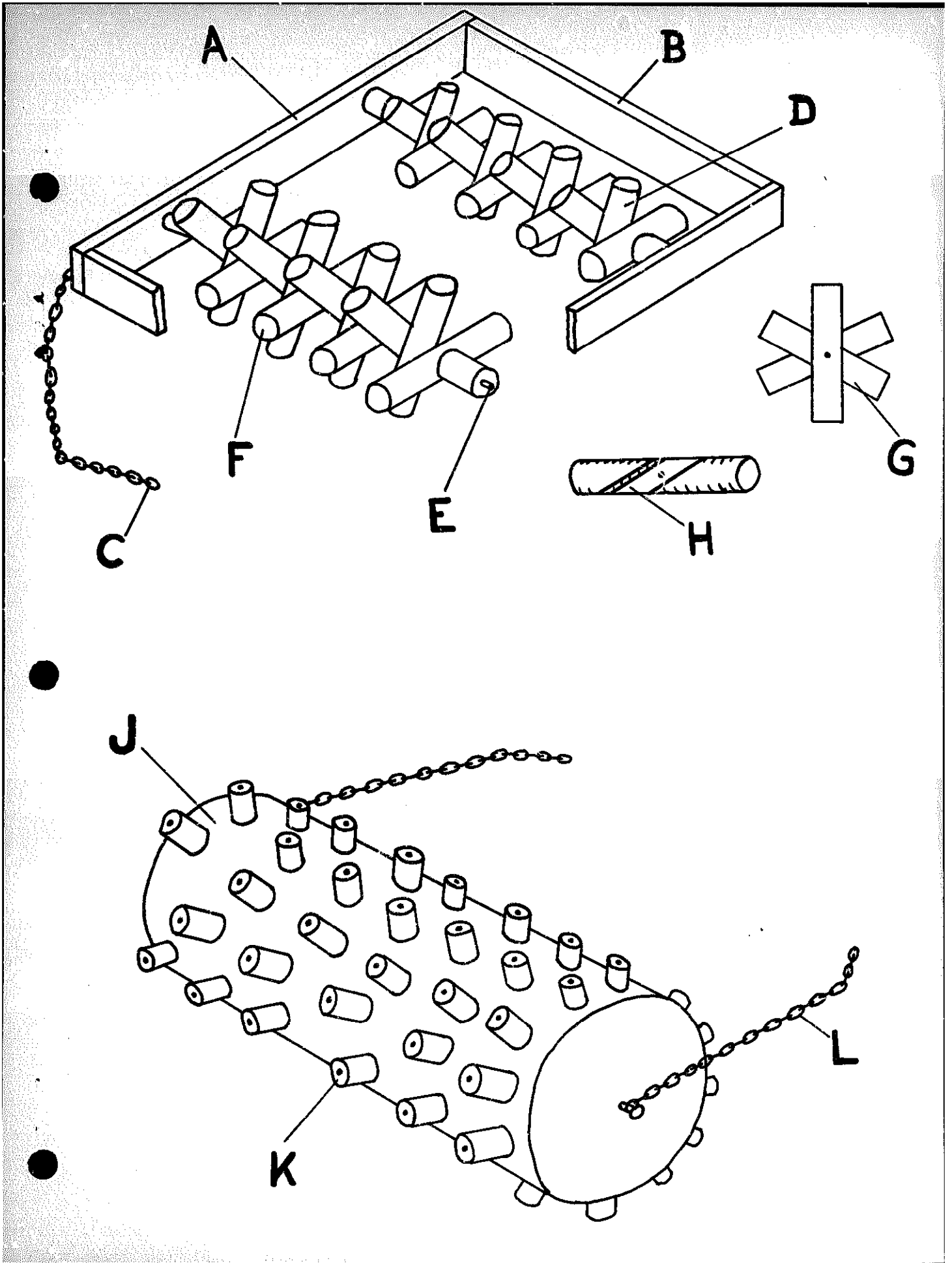
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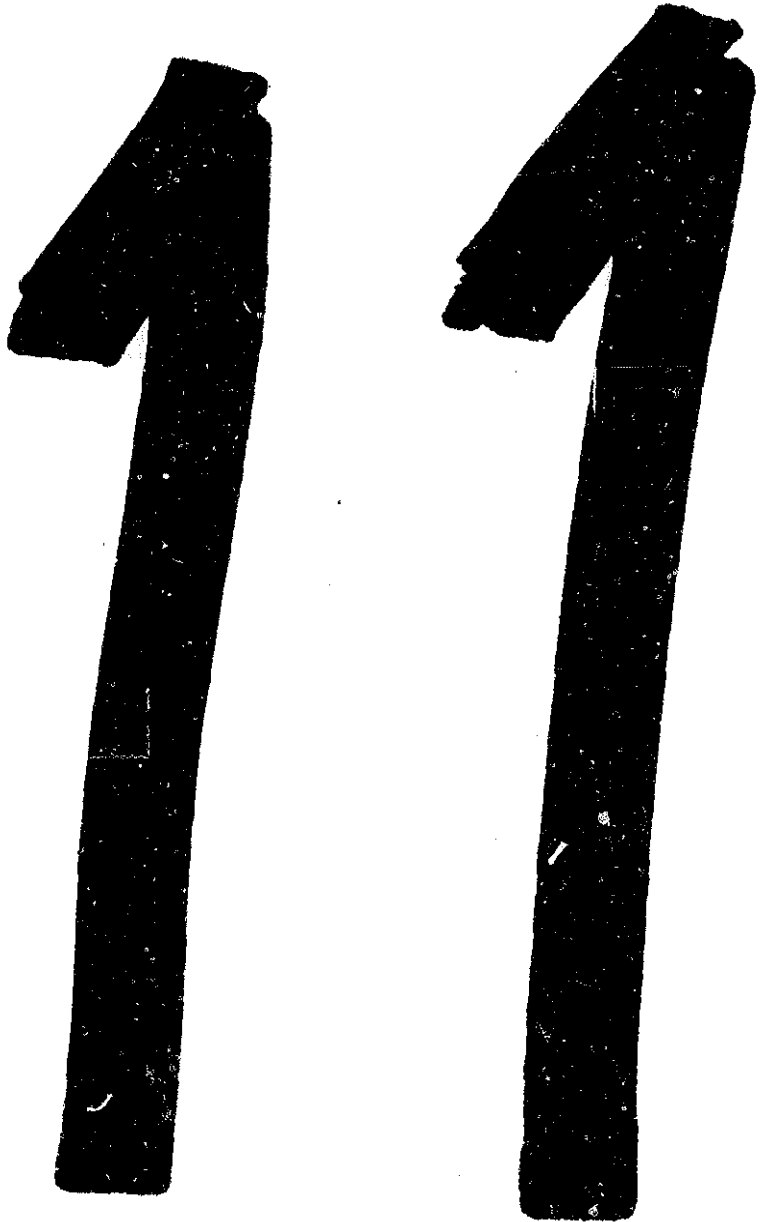
KEY: TYPE 1.

<u>ITEM</u>	<u>NAME</u>	<u>QUANTITY</u>	<u>ITEM DESCRIPTION</u>
A	FRAME SIDE MEMBER	2	Wooden plank 4" x 1" (102 x 25), 40" (1016) long.
B	FRAME END MEMBER	2	Wooden plank 4" x 1" (102 x 25), 30" (762) long.
C	DRAUGHT CHAIN	1	Mild steel link chain of convenient length.
D	REAR ROLLER PEGS	As required	Eucalyptus poles each 9" (229) long.
E	ROLLER AXLE	2	$\frac{3}{4}$ " (19) diameter mild steel bar.
F	FRONT ROLLER PEGS	As required	Eucalyptus poles each 12" (305) long.
G	-----		Diagram showing roller pegs mounted at 60° to each other.
G	-----		View showing a roller peg. Each peg has grooves cut at 60° on both sides.

KEY: TYPE 2.

<u>ITEM</u>	<u>NAME</u>	<u>QUANTITY</u>	<u>ITEM DESCRIPTION</u>
J	ROLLER	1	Eucalyptus log, 15" - 18" (381 to 457) in diameter, 36" - 48" (914 to 1219) long.
K	ROLLER PEGS	As required	Eucalyptus pegs, 2" - 3" (51 to 76) in diameter, 3" (76) long.
L	DRAUGHT CHAIN	1	Mild steel link chain of required length.





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Ox-Drawn Tie-Ridger/Weeder Implement
ITDG Agricultural Equipment and Tools No. 11

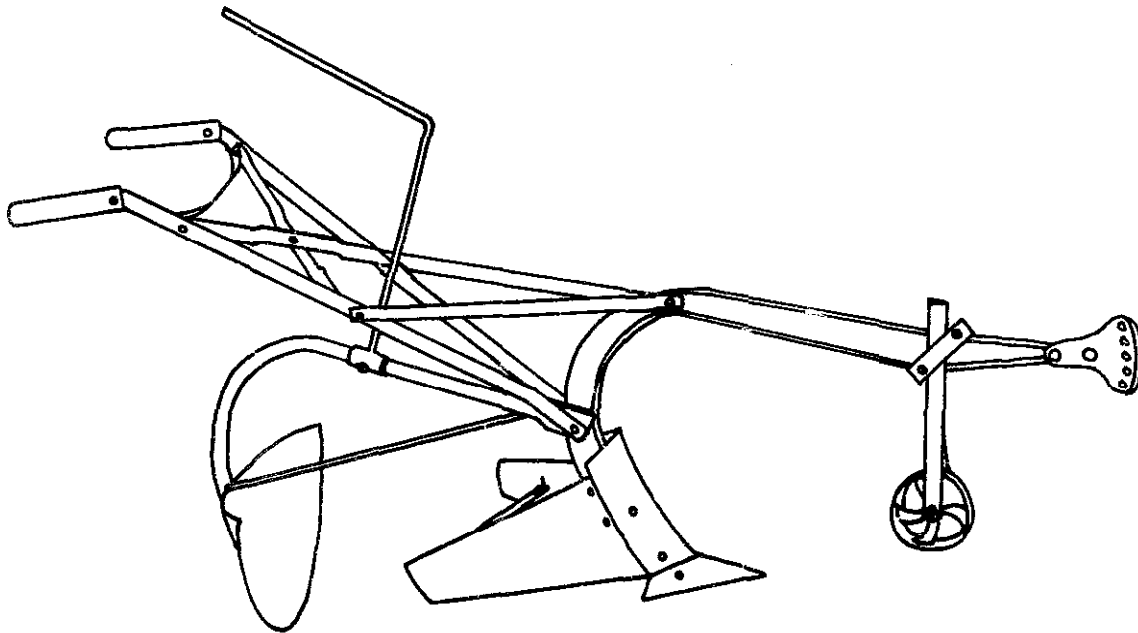
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OX-DRAWN TIE-RIDGER/WEEDEE
IMPLEMENT

OX-DRAWN TIE-RIDGER, WEEDEE IMPLEMENT
(FOR ATTACHMENT TO "EMCOT" RIDGING PLOUGH)

DEVELOPED BY: A.R. STOKES, Northern Nigeria.

DESCRIPTION: This implement is designed for attachment to the "Emcot" ox-drawn ridging plough, a $\frac{1}{2}$ " (12.5) diameter bolt (of sufficient length) with lock nuts being used to hold the ridger handles to the plough beam, allowing the attached implement to pivot freely.

This attachment can be used for crosstying when ridging is carried out, and for crosstying and/or weeding after the ridging operation. During field use the implement handle is raised, then quickly dropped, every 6' to 9' or as required, leaving a crosstie of earth and/or weeds in the furrow.

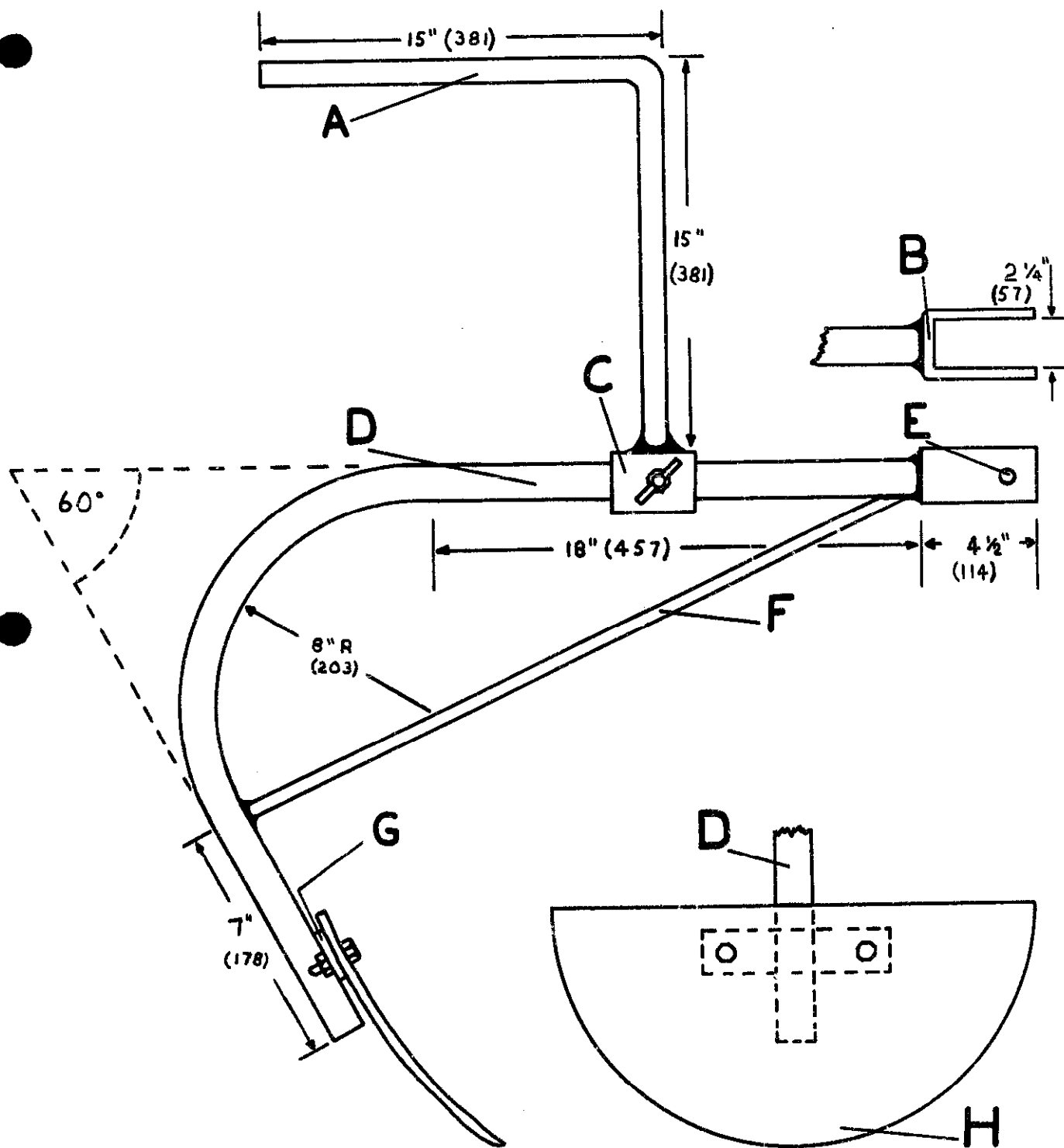
On certain free-draining soils in Africa, the use of this implement has:

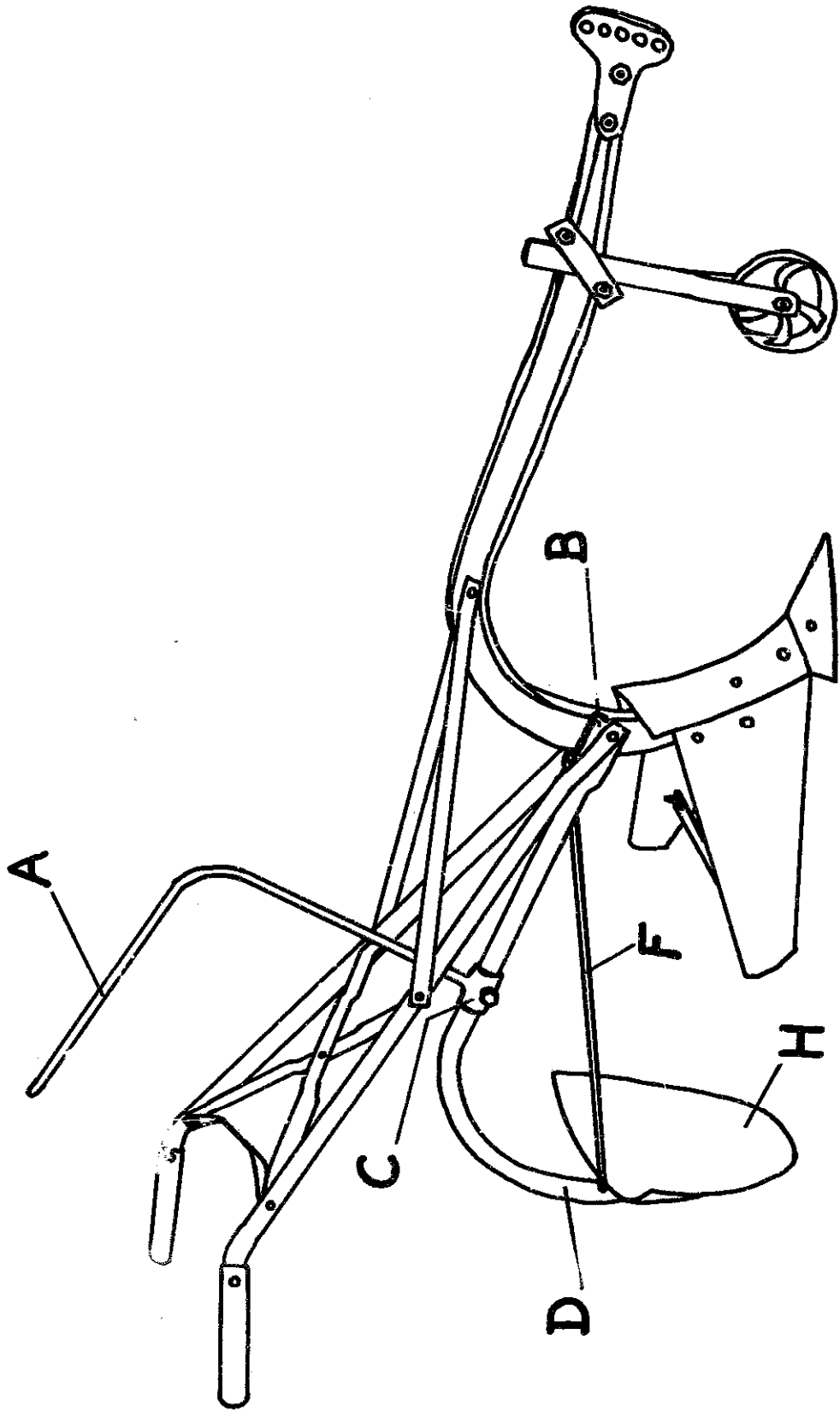
- (1) increased crop yields by up to 100% where planting on tied-ridges was compared with planting on the flat;
- (2) reduced the labour requirement for the combined land preparation and weeding operations by 60% when compared with cultivation by hand.

Note: Figures in brackets are in millimetres.

KEY:

<u>ITEM</u>	<u>NAME</u>	<u>QUANTITY</u>	<u>ITEM DESCRIPTION</u>
A	HANDLE	1	Of $\frac{1}{2}$ " (12.5) internal diameter mild steel pipe.
B	ATTACHMENT BRACKET	1	Made of one piece 2" x $\frac{1}{4}$ " x 11" (51 x 6.3 x 279) mild steel.
C	SLEEVE	1	Of $1\frac{1}{2}$ " (38) internal diameter mild steel pipe 3" (76) long, fitted with $\frac{1}{2}$ " (12.5) diameter locking bolt.
D	BEAM	1	Of 1" (25) or $1\frac{1}{4}$ " (32) internal diameter mild steel pipe.
E	PIVOT BOLT HOLE	1	$\frac{1}{2}$ " (12.5) diameter hole to take pivot/attachment bolt.
F	BRACE	1	Of $\frac{3}{8}$ " (9.5) diameter mild steel round bar.
G	SHARE SUPPORT PLATE	1	Of 7" x 2" x $\frac{1}{4}$ " (178 x 51 x 6.3) mild steel.
H	SHARE	1	An old plough disc of 22" to 24" (559 to 610) diameter, cut in half for share.
J	REAR VIEW OF SHARE		Showing method of securing the beam D to share support plate G.
K	BRACKET	2	Each of 1" x 1" (25 x 25) mild steel angle iron, 2" (51) long, welded to D and G.





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IDC Weeding Attachment for Emcot Plow
ITDG Agricultural Equipment and Tools No. 12

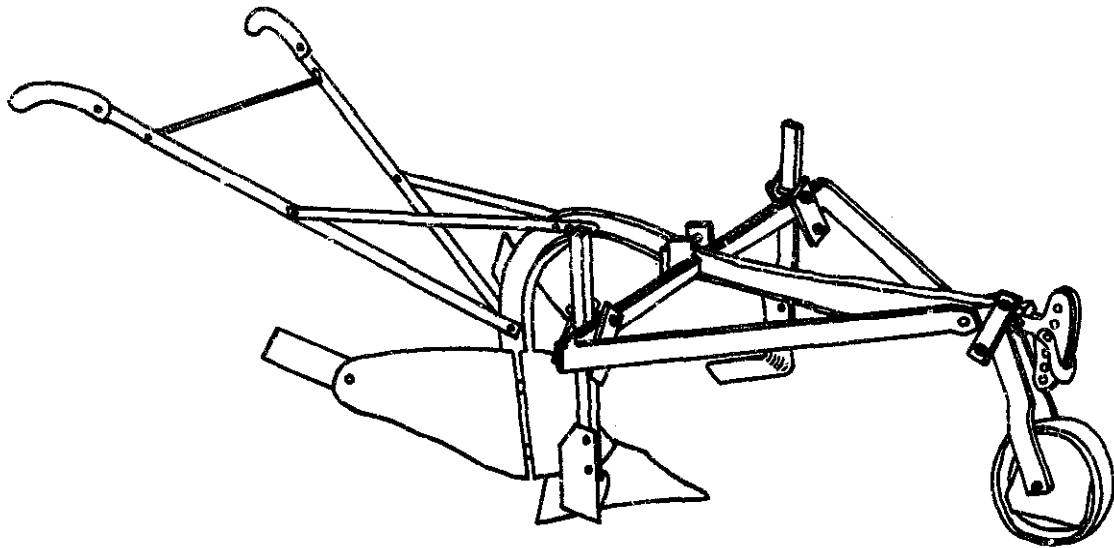
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"I.D.C." WEEDING ATTACHMENT
FOR "EMCOT" PLOUGH

"I.D.C." WEEDING ATTACHMENT

(FOR USE ON "EMCCT" RIDGING PLOUGH)

DEVELOPED BY: Industrial Development Centre, Zaria, Nigeria.

DESCRIPTION: This attachment enables weeding in ridged row crops to be carried out by animal power instead of by hand.

The plough, with weeding attachment, can be pulled by a single ox or two oxen.

The tool standards can be adjusted for height, and also for width according to the row spacing. The weeding knives should be positioned to run close to the plants without damaging the roots, and should dig deep enough to cut down the sides of the ridges. The sides of the ridges are remade by the ridger body following behind.

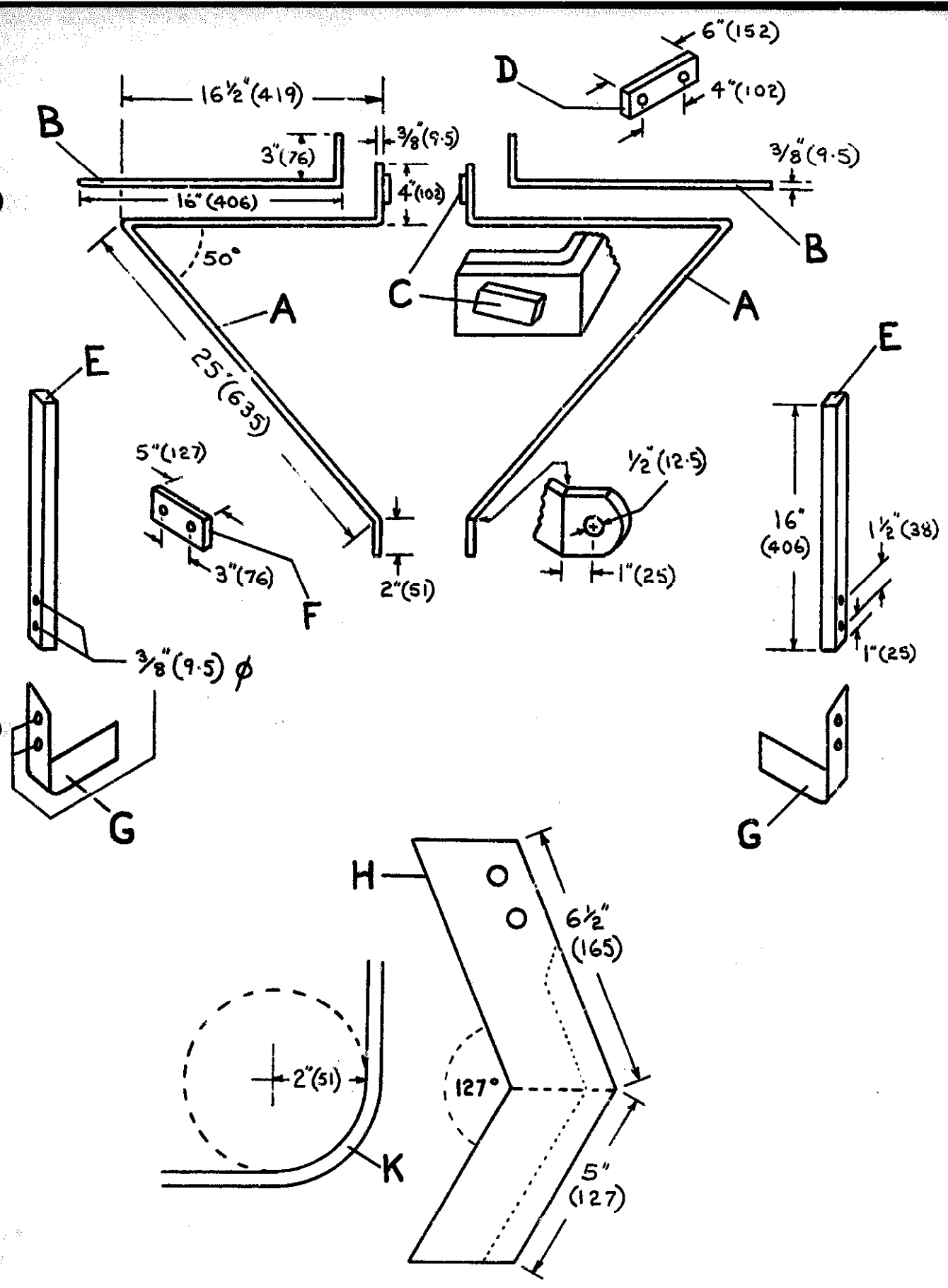
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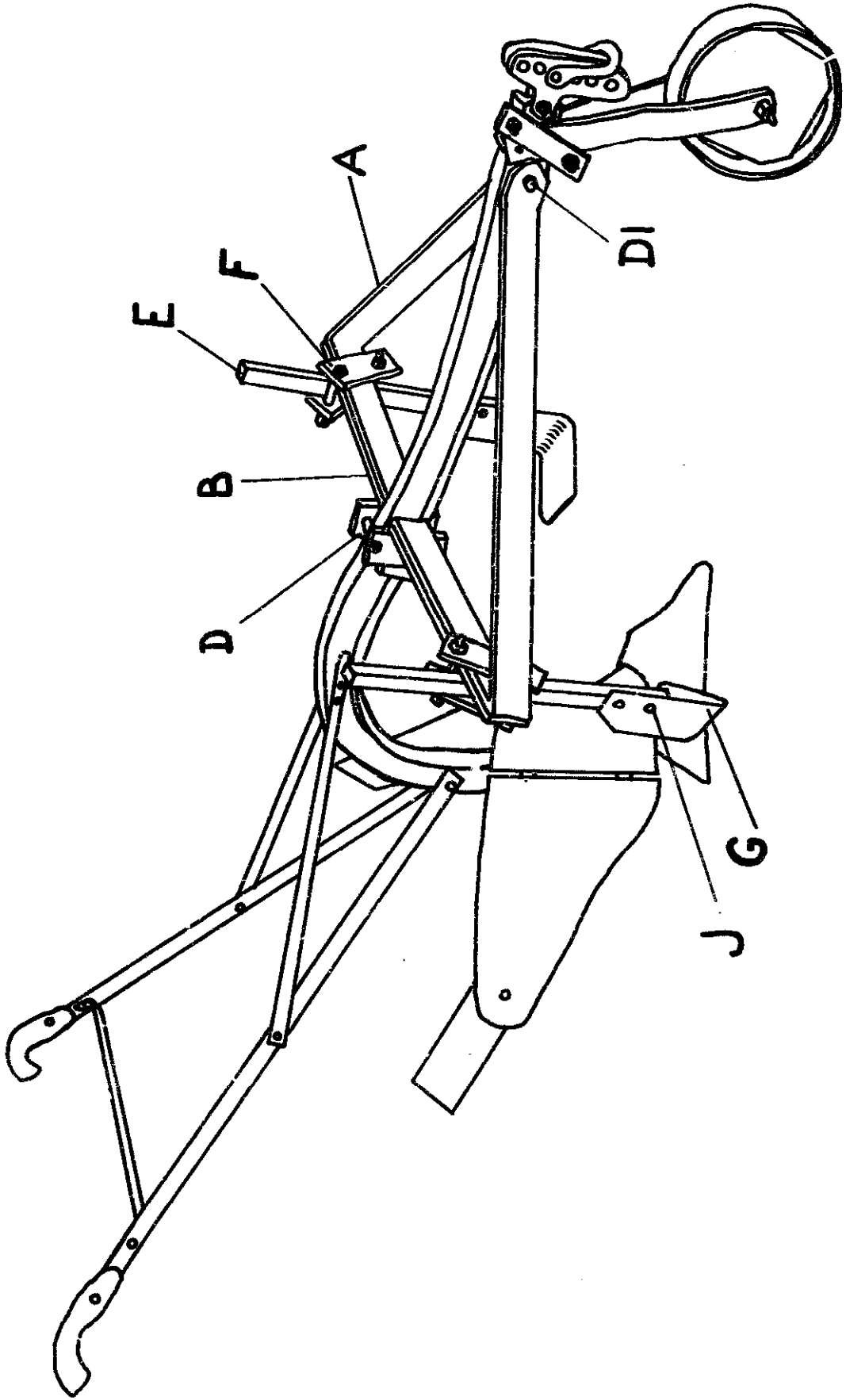
KEY:

<u>ITEM</u>	<u>NAME</u>	<u>QUANTITY</u>	<u>ITEM DESCRIPTION</u>
A	MAIN FRAME	2	Each made from one piece of $\frac{1}{8}$ " x 2" x 48" (9.5 x 51 x 1219) mild steel.
B	MAIN FRAME BRACKET	2	Each of $\frac{1}{8}$ " x 2" x 20" (9.5 x 51 x 508) mild steel, riveted or welded to main frame.
C	POSITIONING BLOCKS	2	Each of $\frac{1}{8}$ " x 1" x 2" (9.5 x 25 x 51) mild steel, welded or riveted inside rear part of main frame to fit on I-beam of the plough.
D	MAIN FRAME CLAMP PLATE	2	Each of $\frac{1}{8}$ " x 2" x 6" (9.5 x 51 x 152) mild steel, held together by two $\frac{1}{2}$ " (12.5) diameter mild steel bolts $3\frac{1}{2}$ " (89) long.
D1	FRAME BOLT	1	Of $\frac{1}{2}$ " (12.5) diameter mild steel, $2\frac{1}{2}$ " (63) long.
E	TOOL STANDARD	2	Each of 1" x 1" (25 x 25) mild steel square bar, 16" (406) long.
F	TOOL STANDARD CLAMP PLATE	4	Each of $\frac{1}{8}$ " x 2" x 5" (9.5 x 51 x 127) mild steel. Each pair of plates held together by two $\frac{1}{2}$ " (12.5) diameter mild steel bolts, 3" (76) long.
G	WEEDING KNIFE	2	Made of $\frac{1}{4}$ " (6.3) thick high grade steel; light car spring or old railway sleeper is suitable.
H	KNIFE TEMPLATE	1	Make one full size in sheet metal and use as a pattern for cutting out the knives.
J	KNIFE BOLT	4	Each of $\frac{1}{8}$ " (9.5) diameter mild steel, 2" (51) long.

Note on making the weeding knives:

- (1) Cut out a piece of metal to the shape of the template H.
- (2) Draw out the leading edge, as indicated by the dotted line in H, to make it sharp.
- (3) Bend the knife material to a right angle, with the corner rounded (as shown at K) as this will help to avoid damage to roots when cultivating close to the plants.





13

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A project of Volunteers in Asia

Adjustable-Width V-Drag Ditcher/Bund Former
ITDG Agricultural Equipment and Tools No. 13

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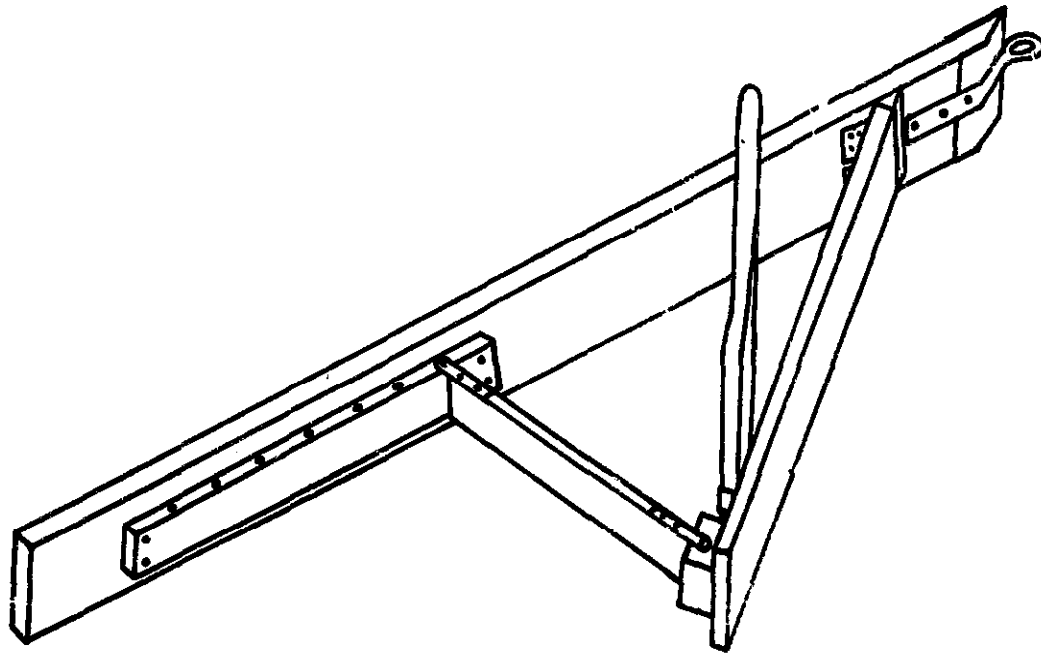
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ADJUSTABLE-WIDTH 'V-DRAG'
DITCHER/BUND FORMER

ADJUSTABLE-WIDTH 'V-DRAG' DITCHER/BUND FORMER

SOURCE: United States Department of Agriculture, Soil Conservation Service.

DESCRIPTION: This implement is used for making irrigation ditches, and can also be used to construct low-height contour bunds for border irrigation.

When making earth ditches for conveying water to crops or drainage channels, a furrow is first opened with a plough (running down and back the required number of times according to the depth required) along the line of the ditch. The V-drag is then used with the runner board riding in the furrow bottom, the crowder board deflecting the soil sideways. Weight can be added by the operator standing on the runner board. The depth of cut can be increased by placing additional weight towards the front of the implement and/or lengthening the hitch.

When using the 'V-drag' to construct contour bunds for irrigation, a plough is run down and back twice, throwing the soil into the border line. The implement is then run down the line, the crowder board pushing the soil into a ridge.

Several passes are made in each direction until the required size of ditch or border has been formed.

Note: Figures in brackets are in millimetres.

KEY:

<u>ITEM</u>	<u>NAME</u>	<u>QUANTITY</u>	<u>ITEM DESCRIPTION</u>
A	METAL CUTTING POINT	1	12" (305) x 12" (305) heavy sheet metal.
B	HITCH	1	$\frac{3}{8}$ " x 2" x 36" (9.5 x 51 x 914) strap iron, with $\frac{1}{4}$ " (19) round $2\frac{1}{2}$ " (63) diameter hitch ring.
C	HINGES	2	3" (76) surface hinges.
D	HANDLE	1	$1\frac{1}{2}$ " x $2\frac{1}{2}$ " x 54" (38 x 63 x 1372) hardwood.
E	CROWDER BLOCK	1	12" x 2" (305 x 51) triangular section hardwood.
F	CROWDER BOARD	1	2" x 12" x 72" (51 x 305 x 1829) wooden board.
G	SPREADER BOARD	1	2" x 6" x 36" (51 x 152 x 914) wooden board.
H	SPREAD ADJUSTER BOARD	1	2" x 6" x 48" (51 x 152 x 1219) wooden board with holes drilled at 6" (152) intervals for implement-width adjustment.

J	SPREADER BLOCK	1	4" x 6" x 6" (102 x 152 x 152) wooden block.
K	RUNNER BOARD	1	2" x 12" x 132" (51 x 305 x 3353) wooden board. Bottom edge may be protected with 2" x 2" (51 x 51) angle iron if desired.
L	HANDLE SUPPORT	2	$\frac{3}{8}$ " x 2" x 10" (9.5 x 51 x 254) strap iron.
M	SPREADER BOARD END END PIECES	4	$\frac{3}{8}$ " x $1\frac{1}{4}$ " x 8" (9.5 x 44 x 203) strap iron.

BOLTS AND SCREWS.

<u>QUANTITY</u>	<u>SIZE</u>	<u>PURPOSE</u>
3	$\frac{3}{8}$ " x 3" (9.5 x 76)	Hitch ring to runner board.
3	$\frac{1}{4}$ " x 4" (6.3 x 102)	Crowder block to runner board.
16	$\frac{1}{4}$ " x $2\frac{1}{2}$ " (6.3 x 63)	For surface hinges.
8	$\frac{1}{8}$ " x $2\frac{1}{2}$ " (6.3 x 63)	For handle supports.
4	$\frac{3}{8}$ " x 7" (9.5 x 178)	For spreader block.
2	$\frac{1}{2}$ " x 7" (12.5 x 178)	For spreader board pivots.
4	$\frac{3}{8}$ " x 7" (9.5 x 178)	For spreader board end pieces.
6	$\frac{1}{2}$ " x 5" (12.5 x 127)	For spread adjuster board to runner.

1

2

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A project of Volunteers in Asia

Sled-Type Corrugator/Irrigation-Furrow Former
ITDG Agricultural Equipment and Tools No. 14

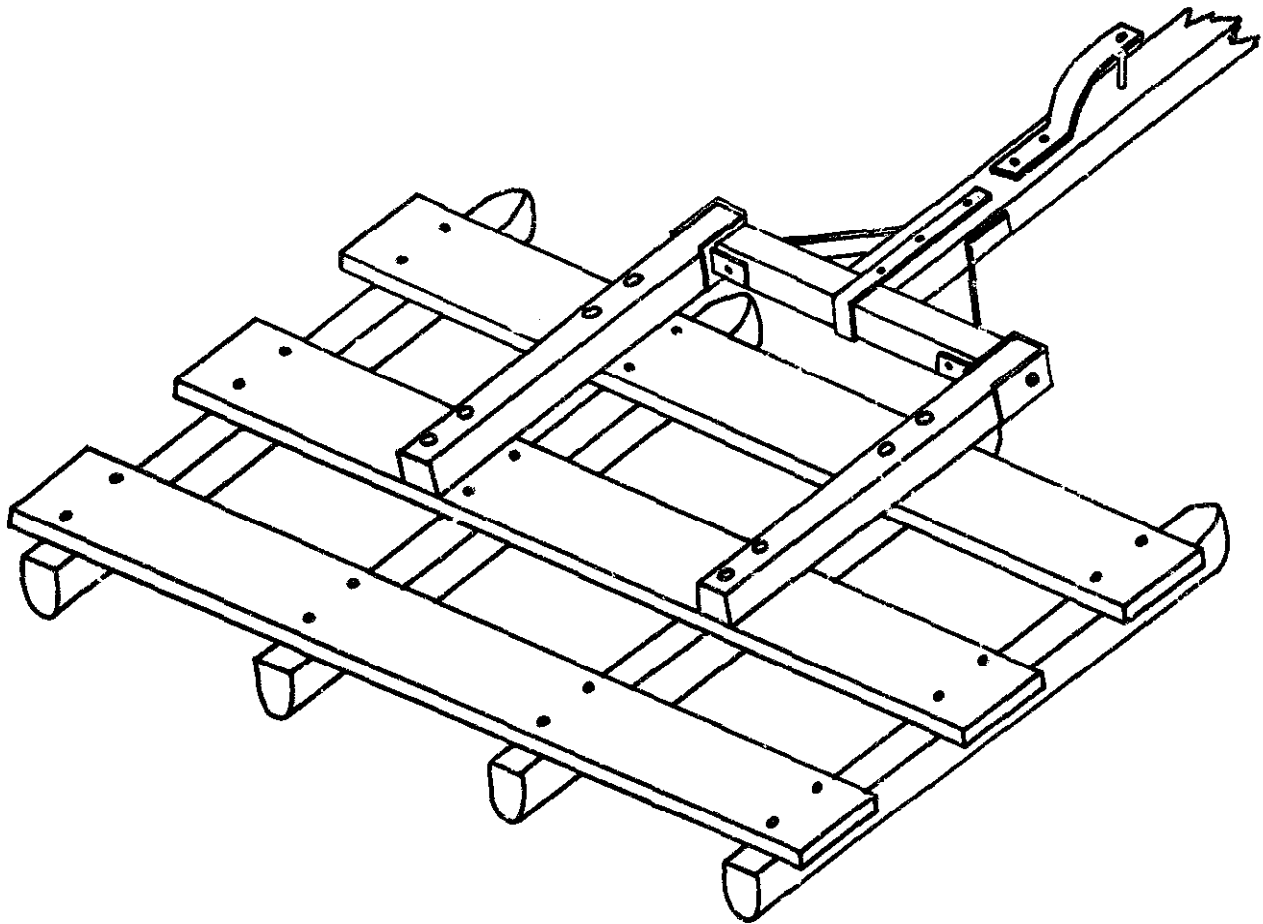
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SLED-TYPE CORRUGATOR/
IRRIGATION-FURROW FORMER

SLED-TYPE CORRUGATOR/IRRIGATION-FURROW FORMER

SOURCE: United States Department of Agriculture,
Soil Conservation Service.

DESCRIPTION: The function of this implement is to make small furrows,
or corrugations, for distributing water over a field.

The corrugations are run down the slope of the land. This implement can be used after the field has been broadcast seeded or before row-crop planting.

For maximum water carrying capacity, the inside surfaces of the corrugations should be compressed and smooth. To achieve this, ballast can be added to the implement as required.

The spacing of the corrugations will depend upon how rapidly the water moves laterally through the soil. The lighter the soil texture, the wider apart the corrugations can be.

The implement design shown can be modified in size to suit animal-draught or tractor-hitching as required.

Note: The figures in brackets are in millimetres.

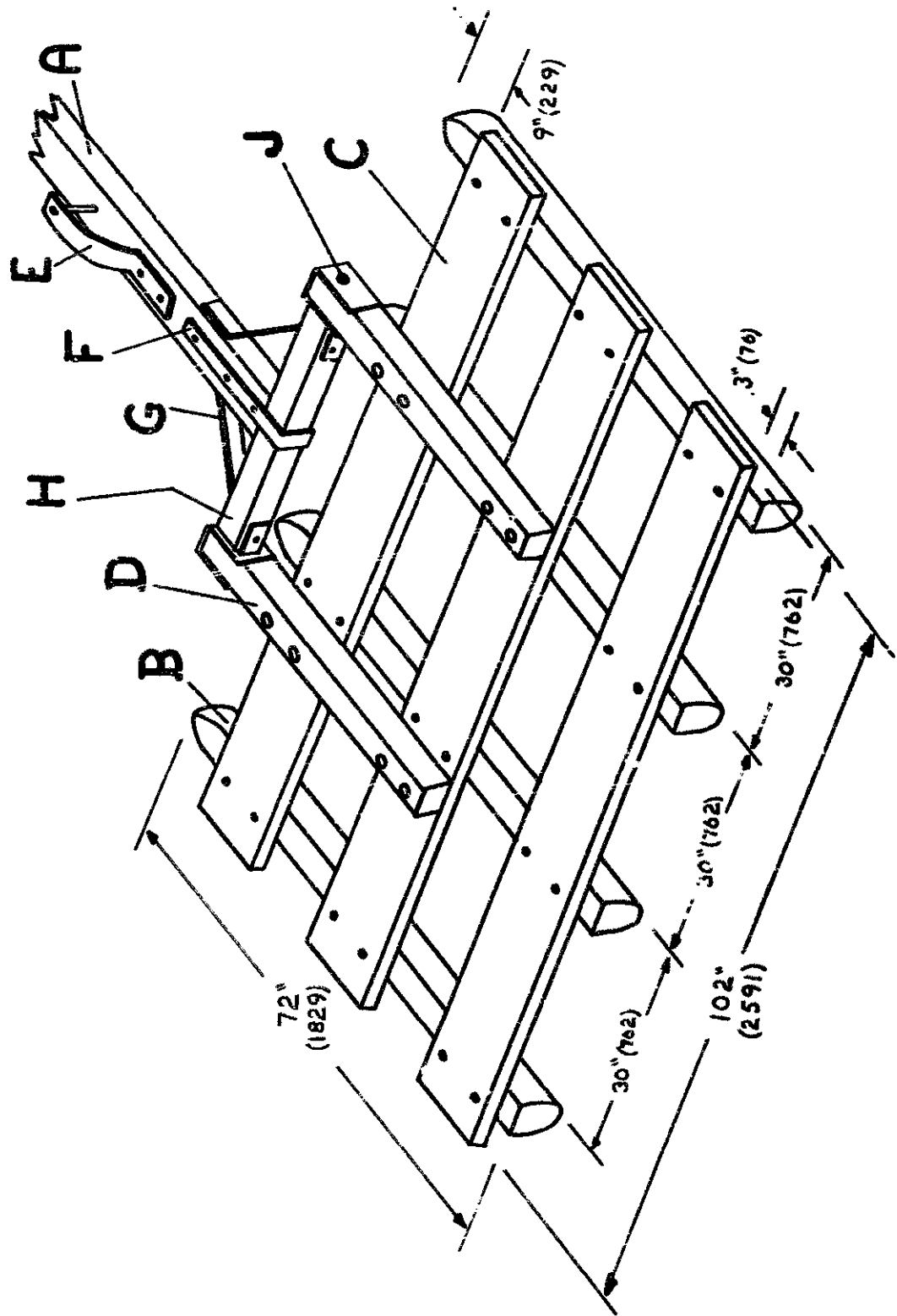
KEY:

<u>ITEM</u>		<u>QUANTITY</u>	<u>ITEM DESCRIPTION</u>
A	DRAUGHT SHAFT	1	4" x 6" (102 x 152) wooden beam of desired length.
B	RUNNERS	4	4" x 6" (102 x 152) hard wood, 72" (1829) long. Steel points can be fitted to the leading ends.
C	CROSS BOARDS	3	2" x 12" x 102" (51 x 305 x 2591) wooden board.
D	SHAFT CONNECTOR	2	4" x 4" x 48" (102 x 102 x 1219) wood, leading end reinforced with $\frac{1}{4}$ " x 4" x 16" (6.3 x 102 x 406) strap iron.
E	CLEVIS	1	$\frac{1}{4}$ " x 2 $\frac{1}{2}$ " x 12" (6.3 x 63 x 305) strap iron.
F	SHAFT STRAP	1	$\frac{1}{4}$ " x 1 $\frac{1}{2}$ " x 36" (6.3 x 38 x 914) strap iron.
G	SHAFT BRACE	2	$\frac{1}{4}$ " x 2" x 36" (6.3 x 51 x 914) strap iron.
H	CROSS PIECE	1	4" x 4" x 34" (102 x 102 x 864) wooden beam, reinforced with $\frac{1}{4}$ " x 4" x 16" (6.3 x 102 x 406) strap iron at each end.

J CROSS PIECE SCREWS 2 $\frac{7}{8}$ " (16) diameter steel screw,
12" (305) long.

BOLTS AND SCREWS

<u>QUANTITY</u>	<u>SIZE</u>	<u>PURPOSE</u>
1	$\frac{3}{4}$ " x 8" (19 x 203)	For attaching 'animal-draught' doubletree to clevis.
2	$\frac{3}{8}$ " x 6" (9.5 x 152)	Clevis to draught shaft.
7	$\frac{1}{2}$ " x 6" (12.5 x 152)	Shaft to cross piece.
8	$\frac{1}{8}$ " x 8" (9.5 x 203)	Shaft connectors to cross boards.
24	$\frac{5}{16}$ " x 8" (8 x 203)	Cross boards to runners.



15

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A project of Volunteers in Asia

Single-Row and Three-Row Rice Seeders
ITDG Agricultural Equipment and Tools No. 15

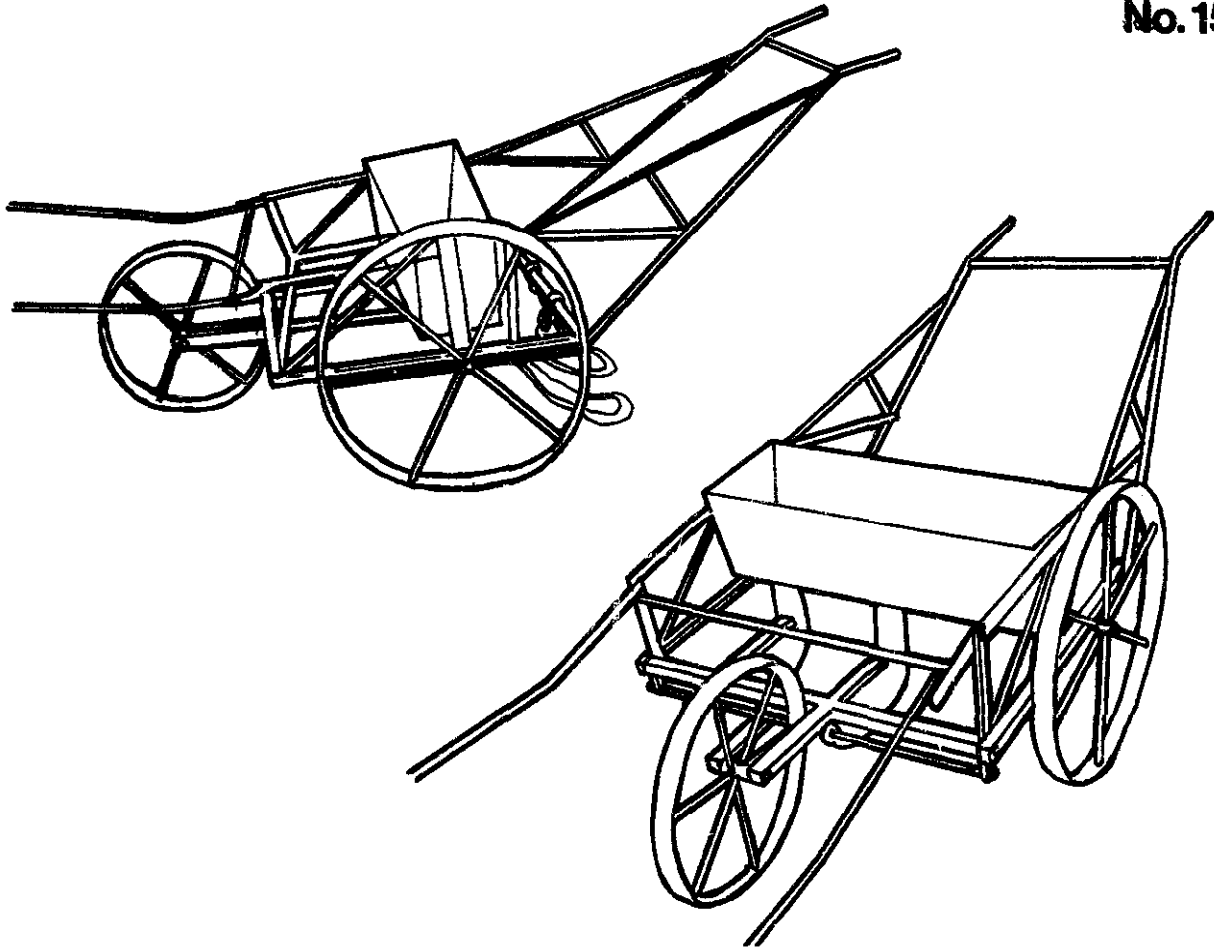
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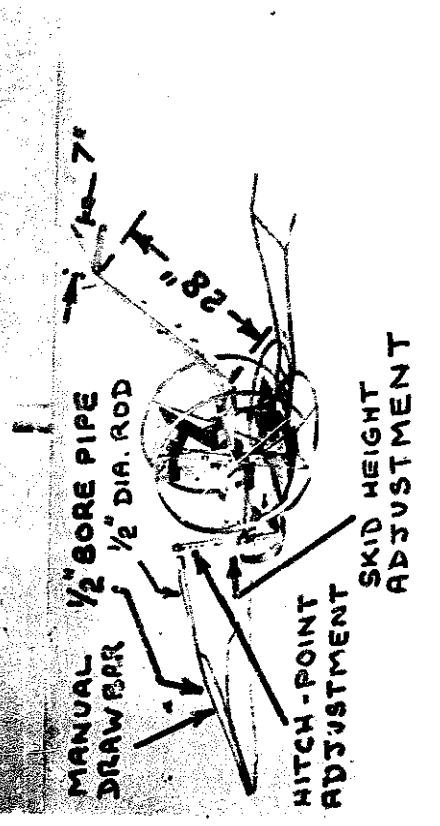
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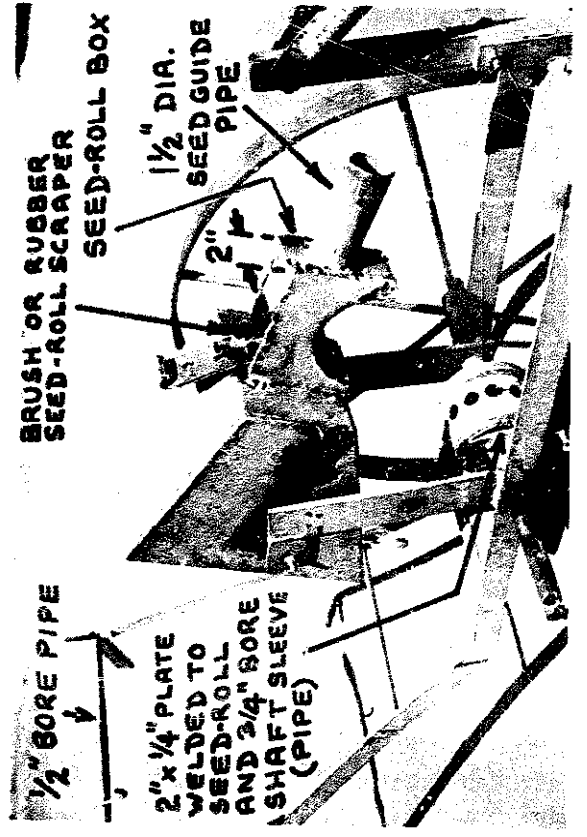


SINGLE-ROW AND THREE-ROW
RICE SEEDERS (ZAMBIA)

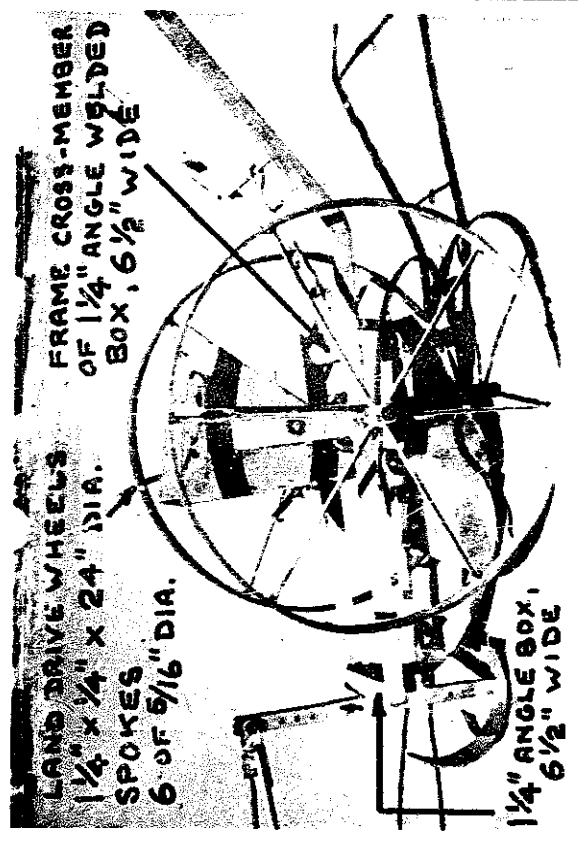
**LOCALLY - BUILT SINGLE - ROW
RICE SEEDER**



**FIG.
P.1.**



**FIG.
P.3.**



**FIG.
P.2.**



**FIG.
P.4.**

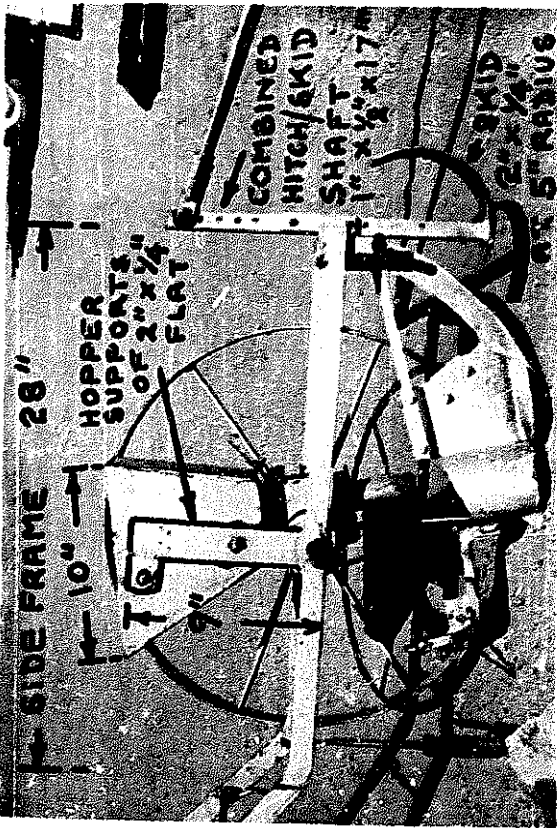


FIG.
P. 5.

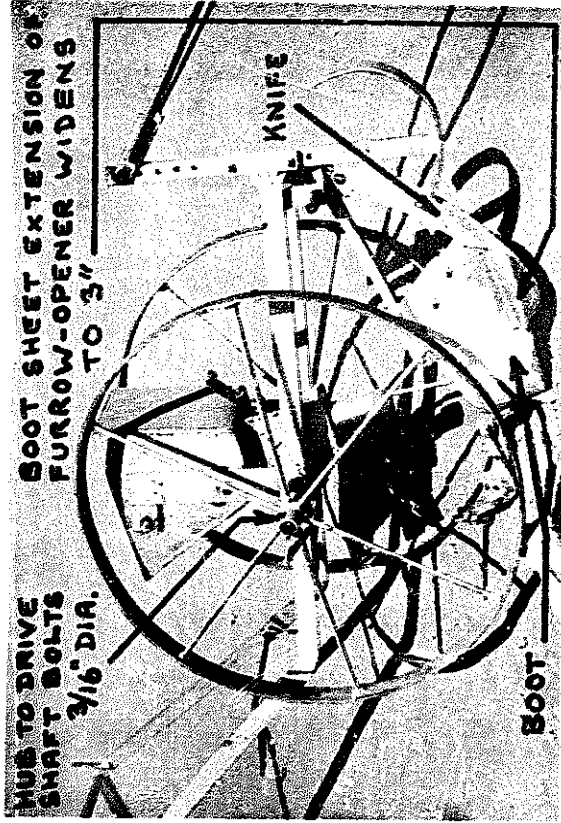


FIG.
P. 6.

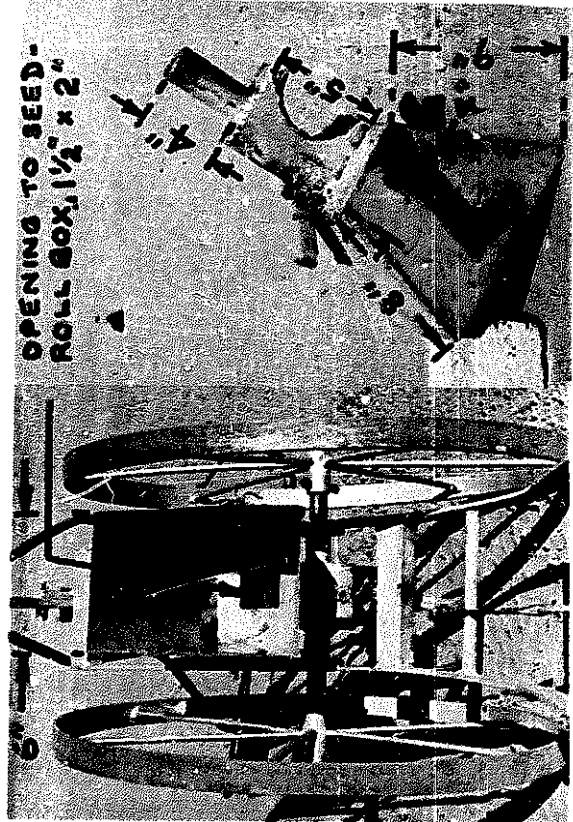


FIG.
P. 7.

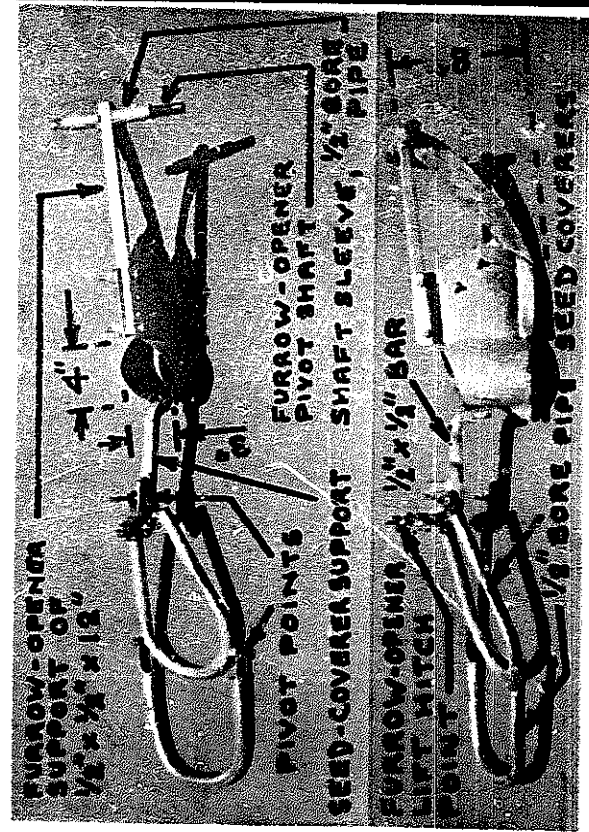


FIG.
P. 8.

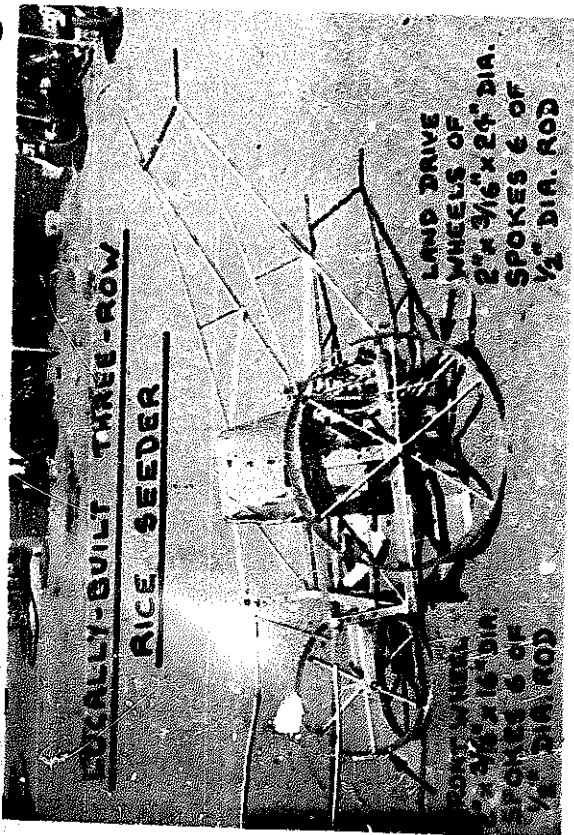


FIG.
P.9.

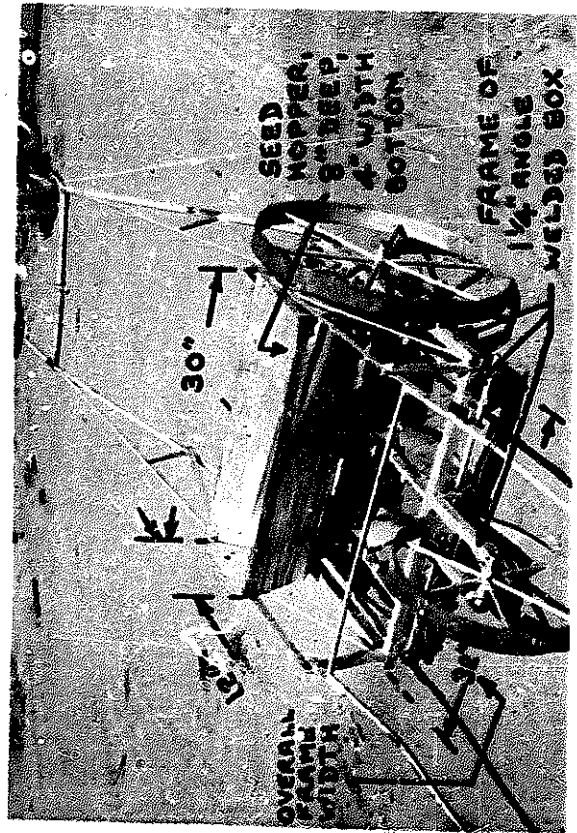


FIG.
P.10.

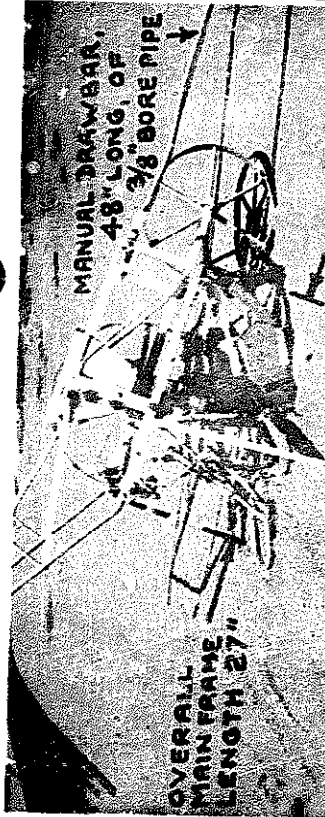


FIG.
P.11.

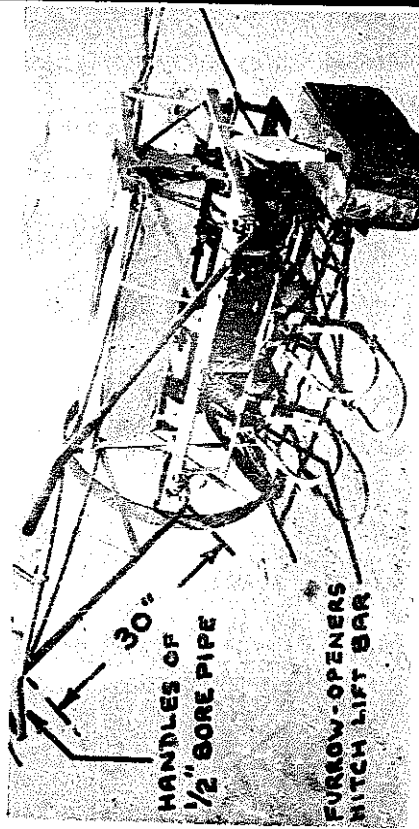


FIG.
P.12.

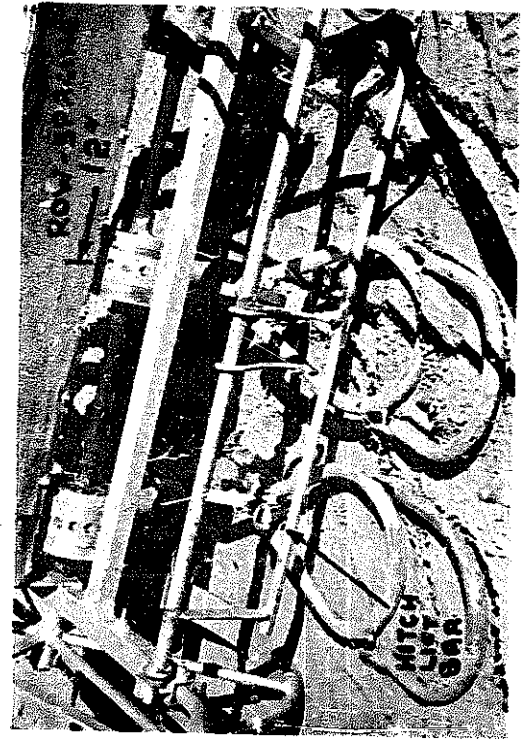


FIG.
P.13.

16

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A project of Volunteers in Asia

Rotary Weeder for Row-Planted Rice
ITDG Agricultural Equipment and Tools No. 16

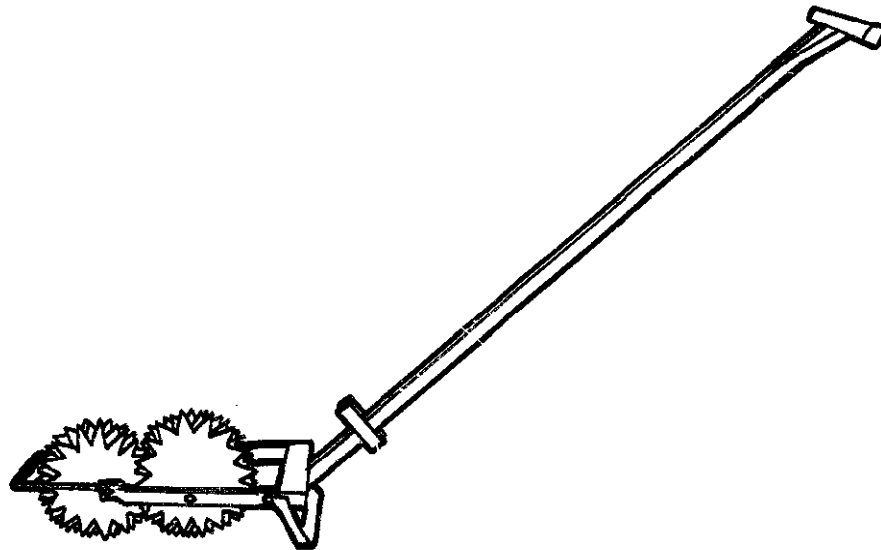
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ROTARY WEEDER
FOR ROW-PLANTED RICE

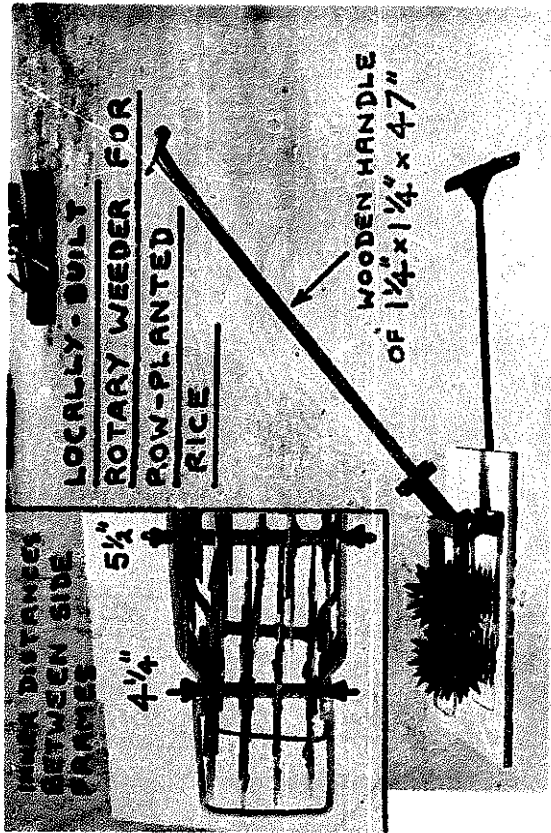


FIG.
W.1.

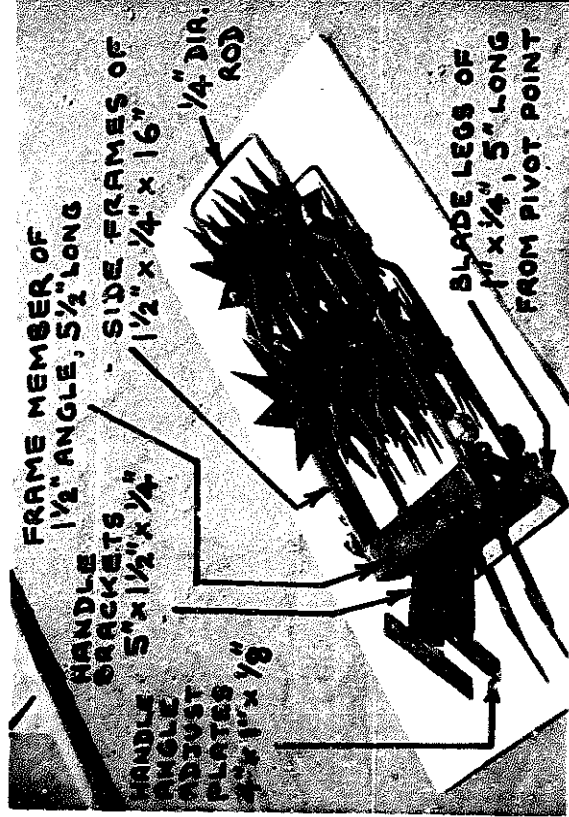


FIG.
W.2.

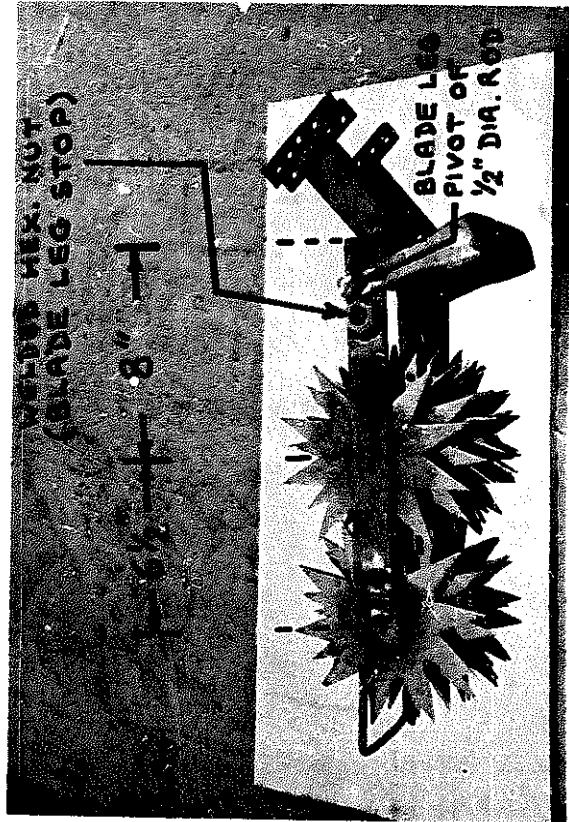


FIG.
W.3.



FIG.
W.4.

17

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Multi-Action Paddy-Field Puddling Tool
ITDG Agricultural Equipment and Tools No. 17

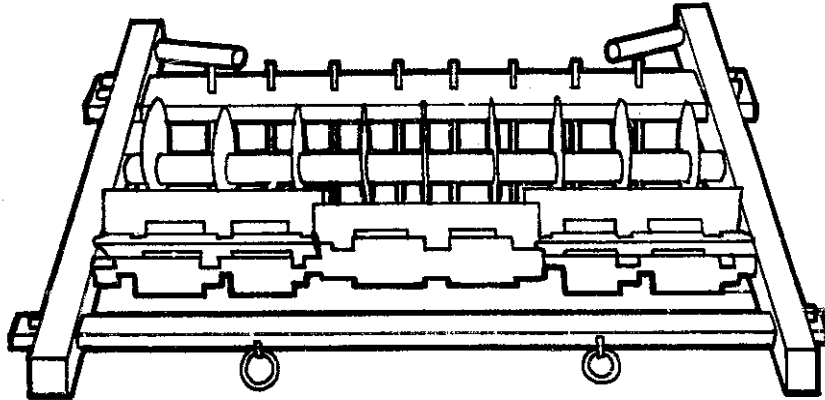
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MULTI-ACTION PADDY-FIELD
PUDDLING TOOL (JAPAN)

MULTI-ACTION PADDY FIELD PUDDLING TOOL, SUITABLE FOR LOCAL CONSTRUCTION.

FIG.
CP.1.

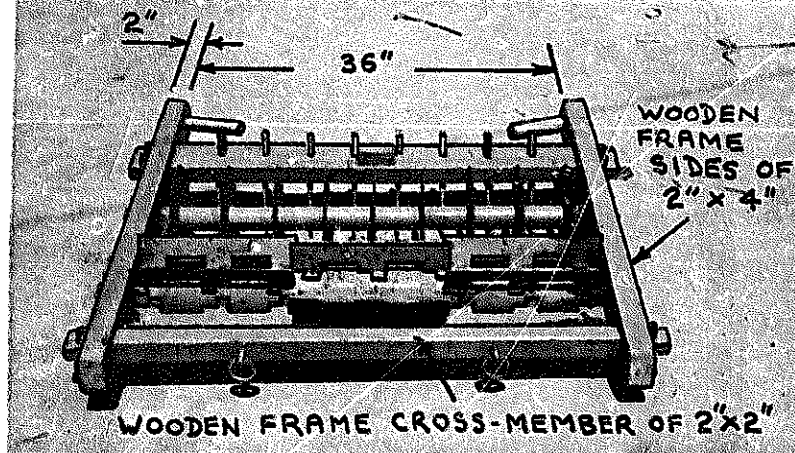
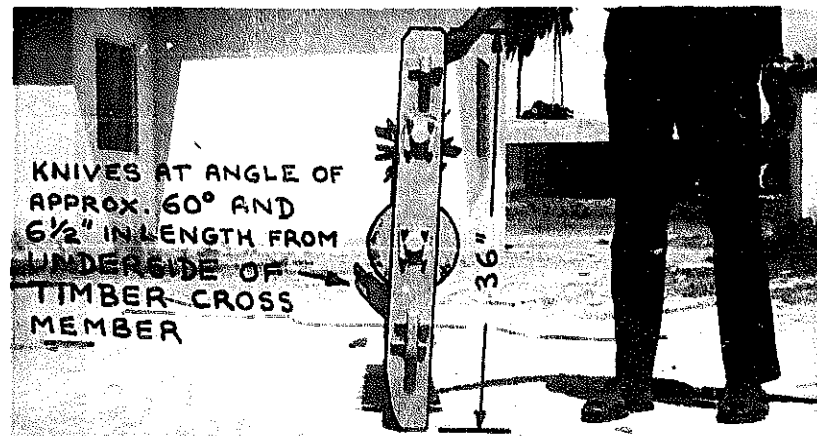


FIG.
CP.3.



KNIVES AT ANGLE OF APPROX. 60° AND 6 1/2" IN LENGTH FROM UNDERSIDE OF TIMBER CROSS MEMBER

FIG.
CP.2.

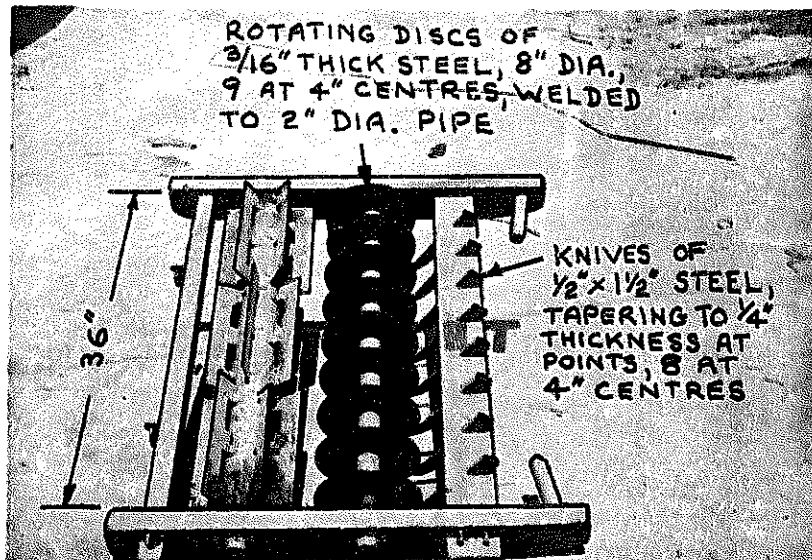


FIG.
CP.4.

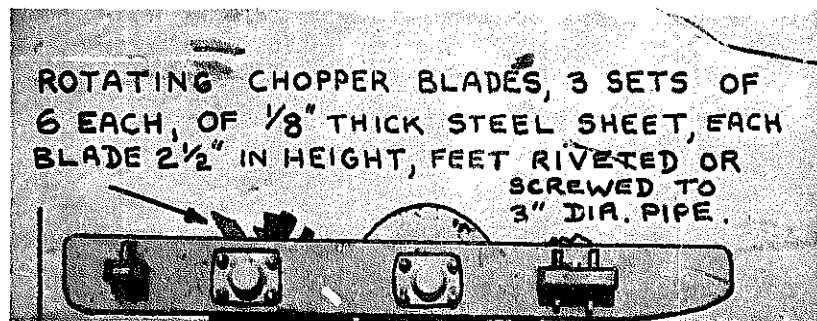
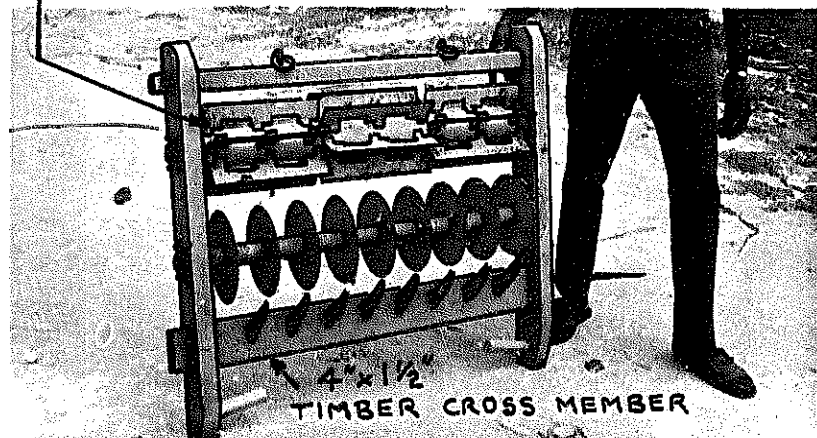


FIG.
CP.5.



4" x 1 1/2" TIMBER CROSS MEMBER

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Cassava Grinder

ITDG Agricultural Equipment and Tools No. 27

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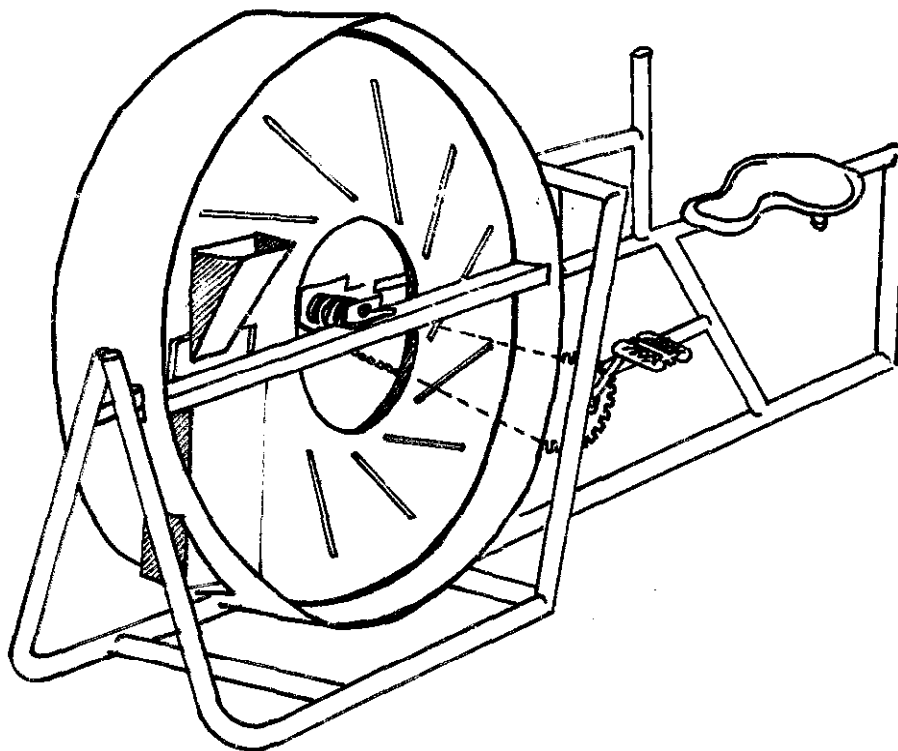
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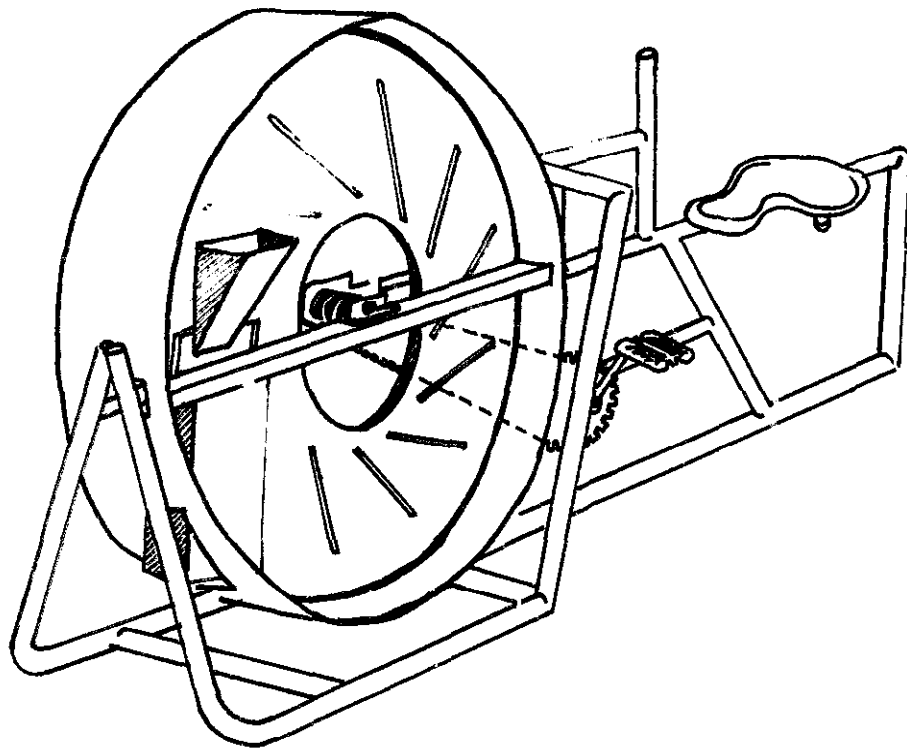
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CASSAVA GRINDER
(ZARIA, NIGERIA)

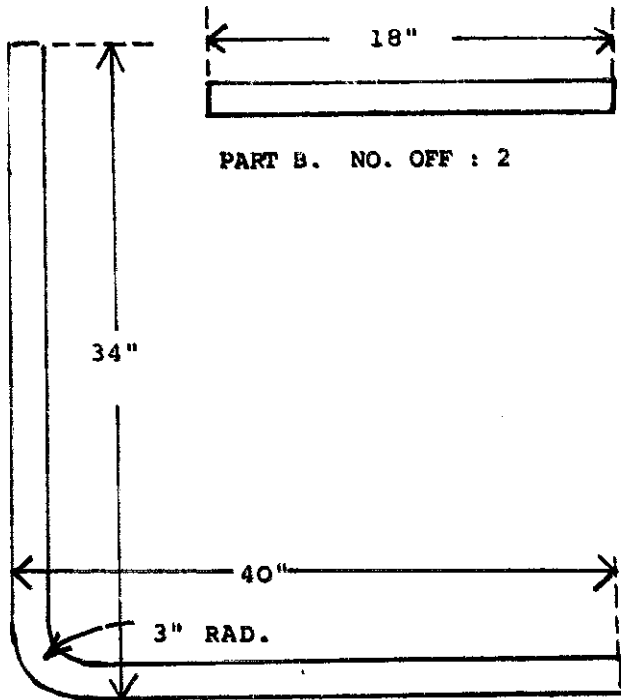
DESIGN: S. W. EAVES

DRAWING: C. J. HILL AND J. LEE

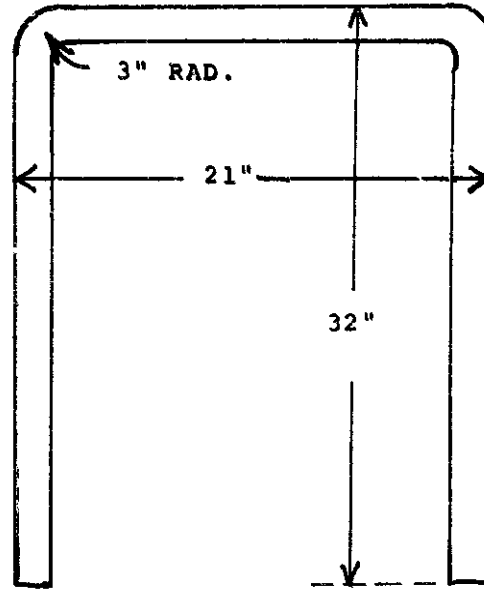


STAGE 1. A-FRAME

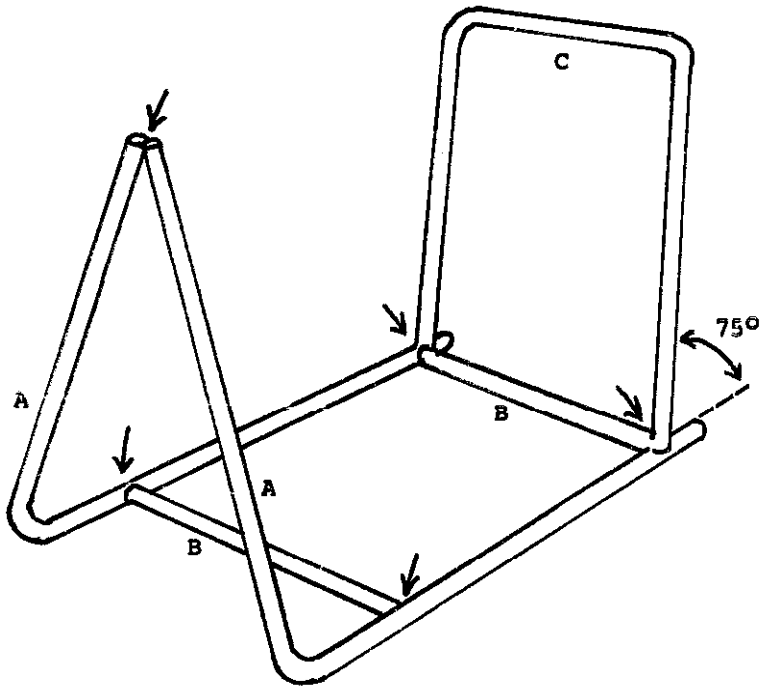
MATERIAL : 1½" GALVANIZED IRON TUBE (G.I.)



PART A. NO. OFF : 2
TRUE LENGTH : 69"



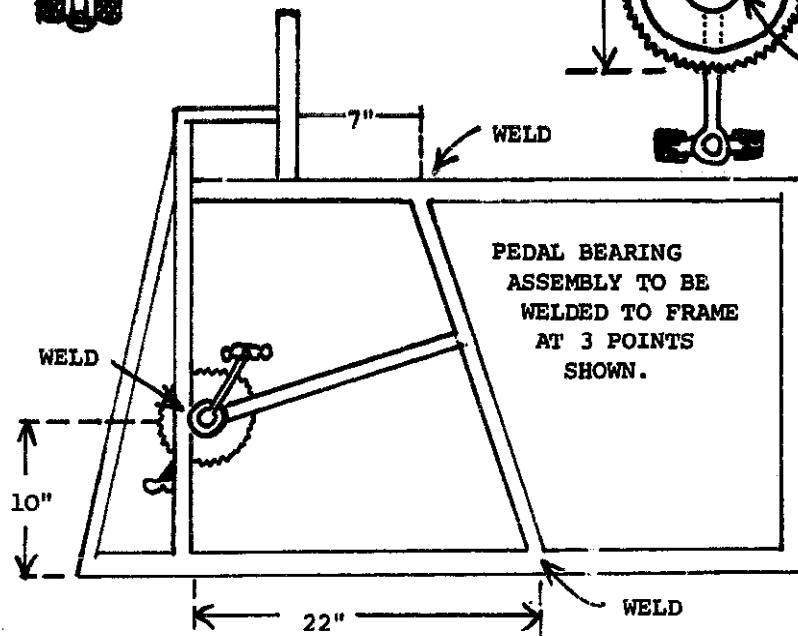
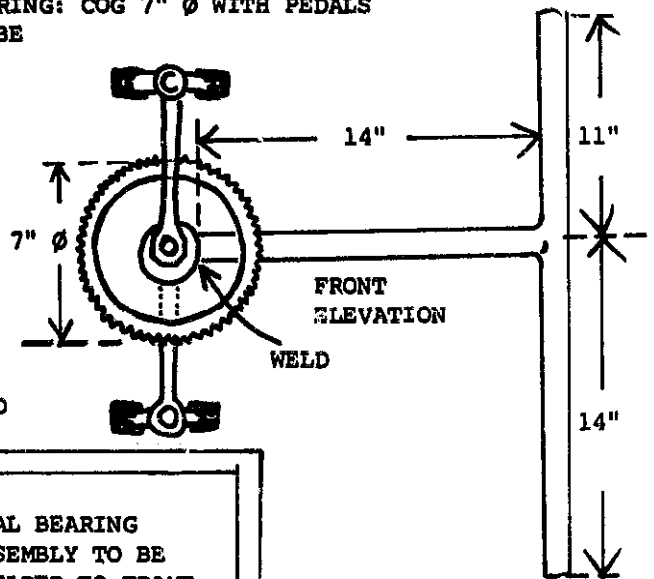
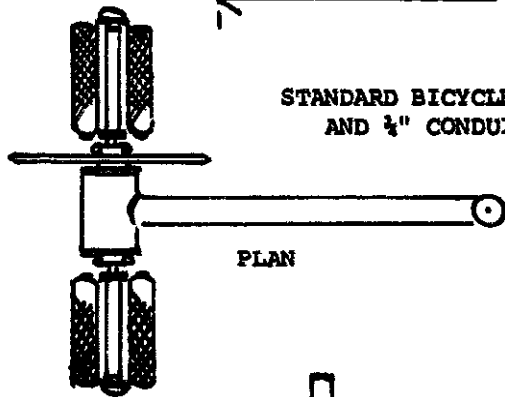
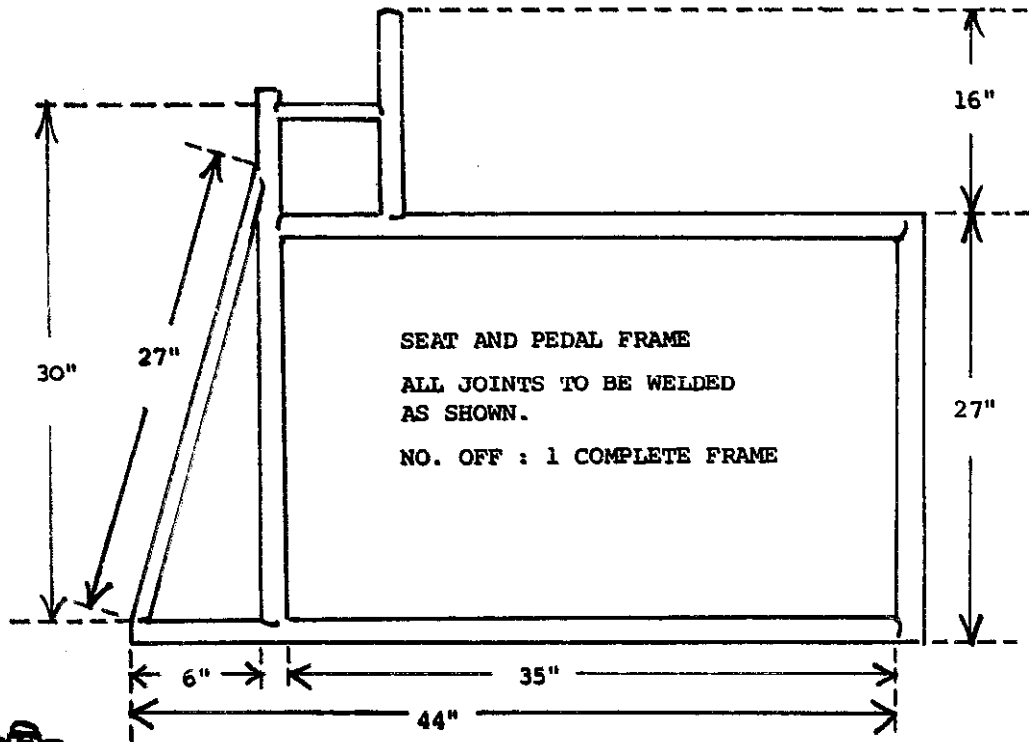
PART C. NO. OFF : 1
TRUE LENGTH : 80"



FRAME ASSEMBLY : WELD ALL JOINTS AT ARROWS AS SHOWN

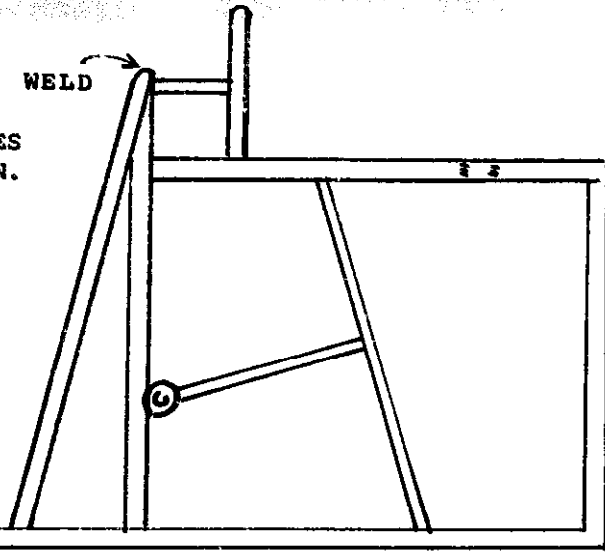
STAGE 2. SEAT AND PEDAL FRAME

MATERIAL : 1 1/2" G.I. TUBE AND 1/2" CONDUIT

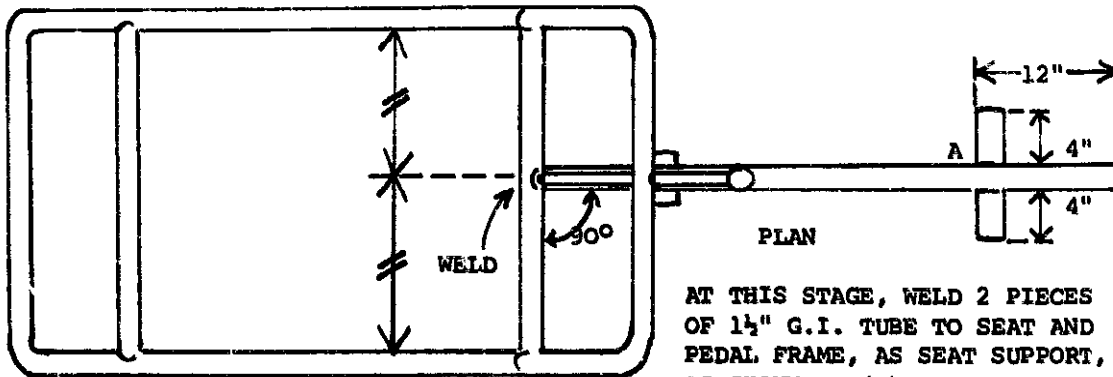


ASSEMBLY OF FRAMES : THE FRAMES ARE WELDED AT THE POINTS SHOWN. THE SEAT AND PEDAL FRAME MUST BE LOCATED

- A) IN THE CENTRE OF THE "A" FRAME (STAGE 1)
- B) VERTICAL
- C) 90° TO THE "A" FRAME (AS SHOWN BELOW)



FRONT ELEVATION

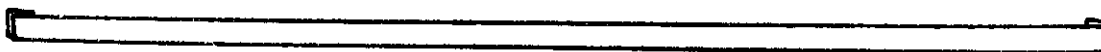
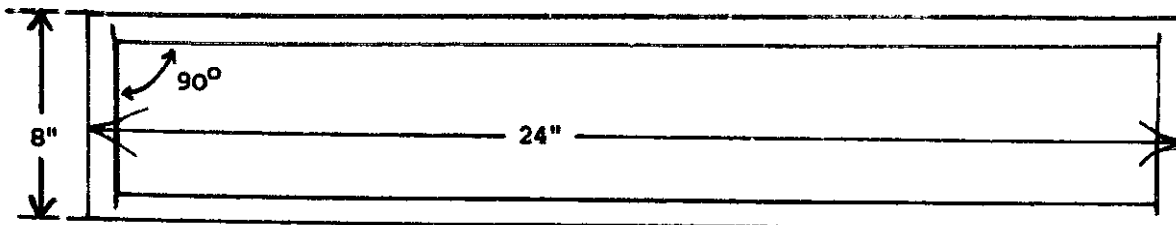
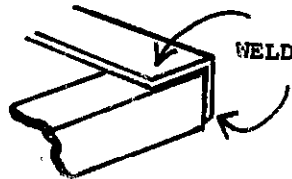


AT THIS STAGE, WELD 2 PIECES OF 1½" G.I. TUBE TO SEAT AND PEDAL FRAME, AS SEAT SUPPORT, AS SHOWN AT (A) ABOVE

WHEEL SUPPORT FRAME :

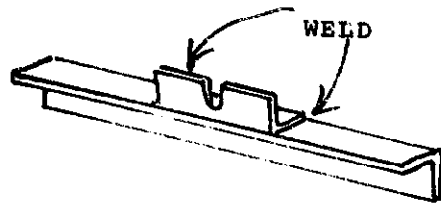
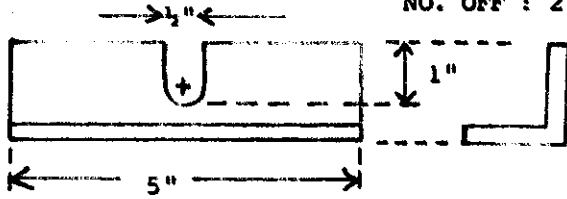
CUT 2 LENGTHS OF 24"
AND 2 LENGTHS OF 8"
AND WELD AS SHOWN

MATERIAL : 1½" x 1½" M.S. ANGLE
NO. OFF : 1 COMPLETE FRAME

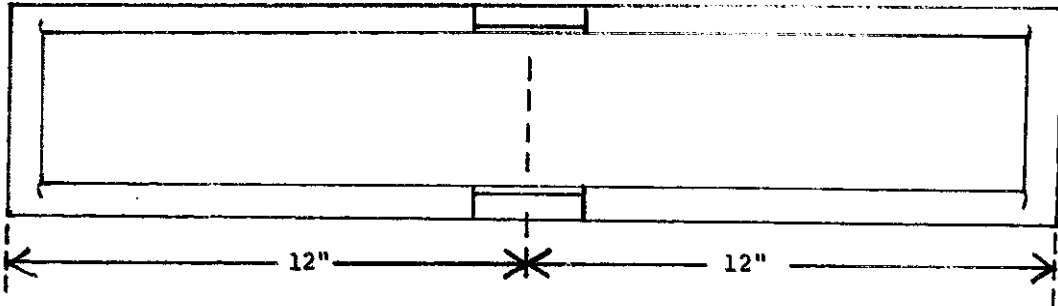


WHEEL SUPPORT BRACKETS . MATERIAL : 1½" x 1½" M.S. ANGLE

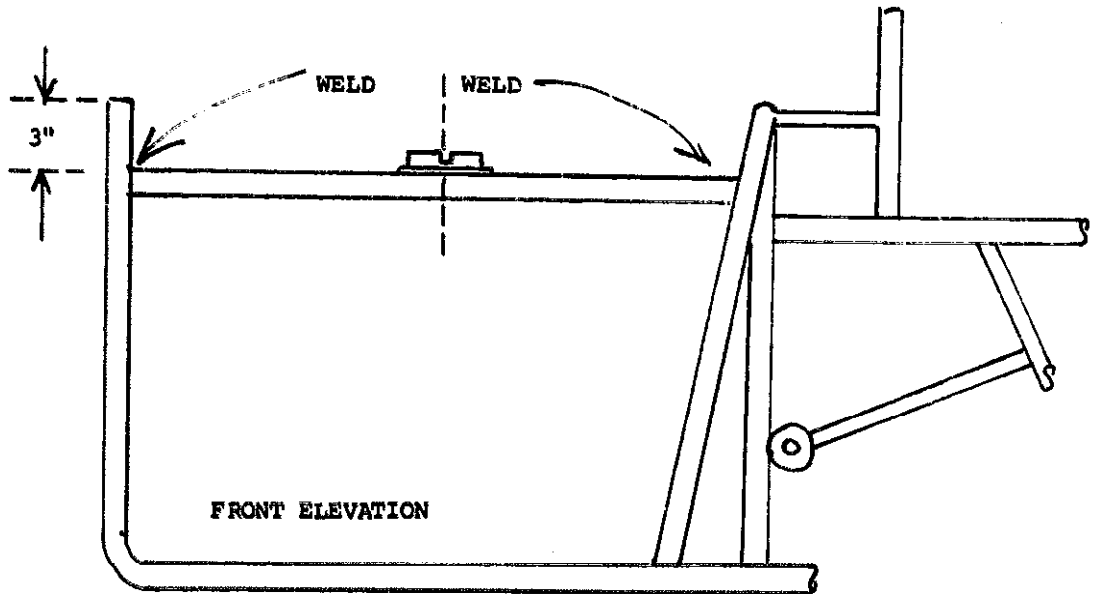
NO. OFF : 2



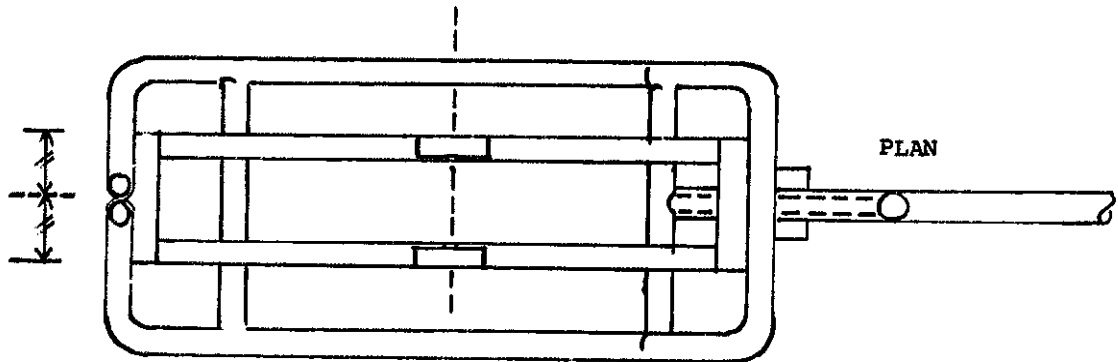
WHEEL SUPPORT FRAME



WELD WHEEL SUPPORT FRAME TO "A" FRAME AS SHOWN BELOW :



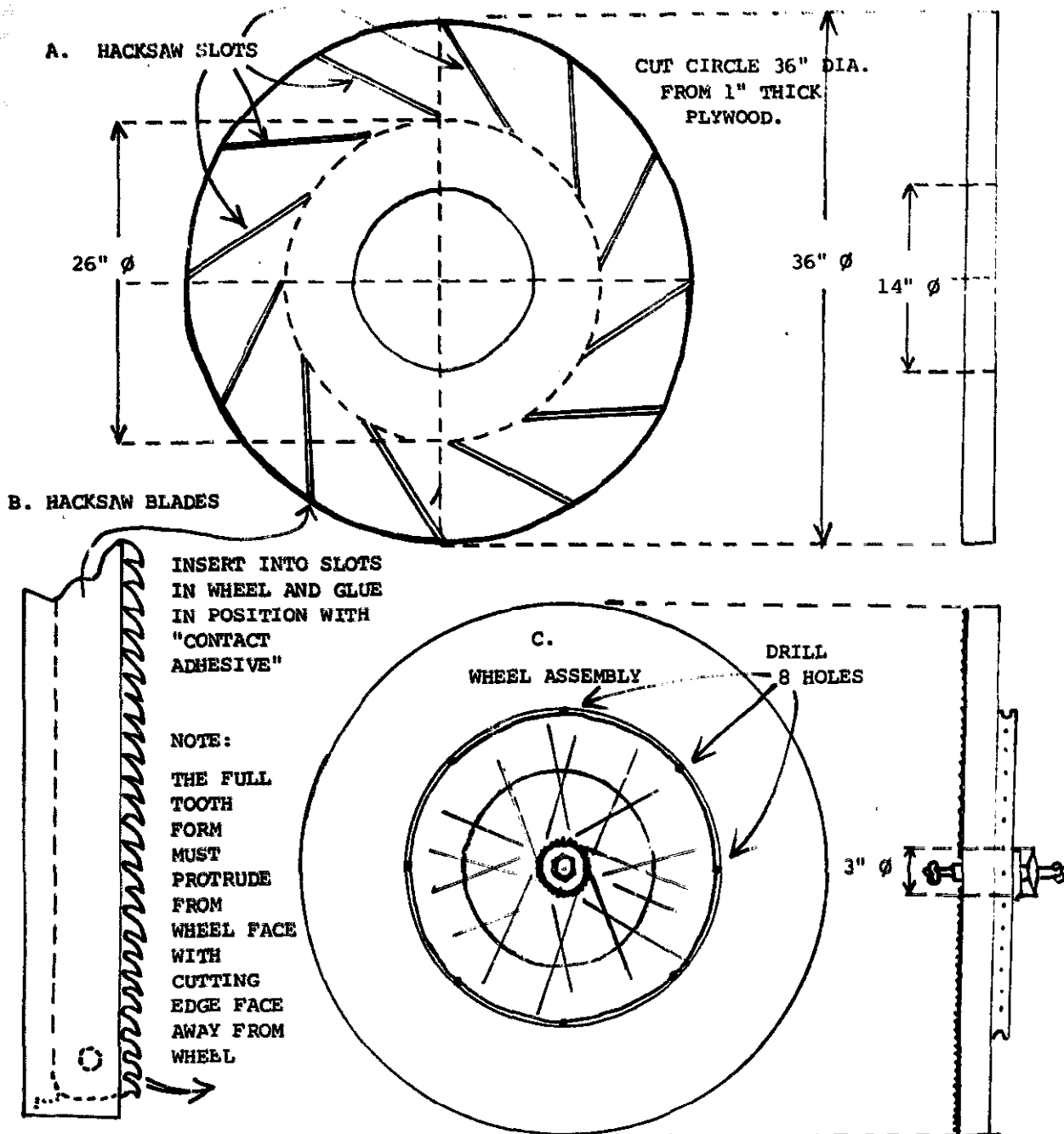
FRONT ELEVATION



PLAN

STAGE 3. GRINDING WHEEL

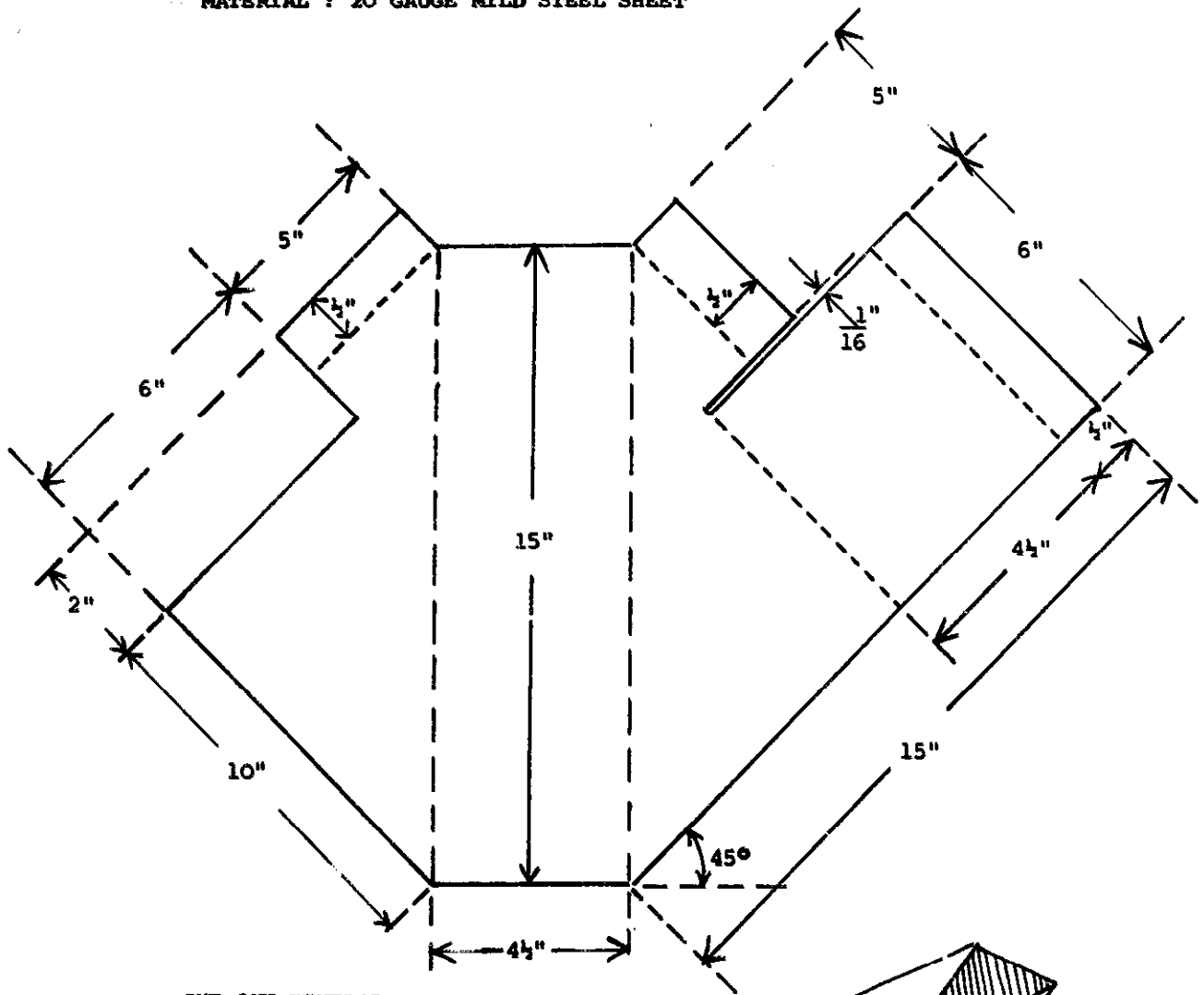
MATERIAL : 1" THICK PLYWOOD; 12 HACKSAW BLADES 9" LONG;
SPOKED BICYCLE WHEEL 26" ϕ WITH BEARING AND GEAR 3" ϕ



- A. TO CUT HACKSAW SLOTS IN WHEEL :
- 1) DIVIDE CIRCUMFERENCE OF WHEEL (36" DIA.) INTO 12 EQUAL PARTS.
 - 2) DRAW CIRCLE 26" DIA. AND ALSO DIVIDE INTO 12 EQUAL PARTS.
 - 3) CUT SLOTS WITH HACKSAW BLADE IN PATTERN SHOWN ABOVE.
- IMPORTANT ! SLOTS MUST BE MADE BEFORE CENTRE HOLE (14" DIA.) IS CUT OUT.
- C. BICYCLE WHEEL IS DRILLED AT POINTS SHOWN AND SCREWED ONTO REVERSE SIDE OF GRINDING WHEEL.

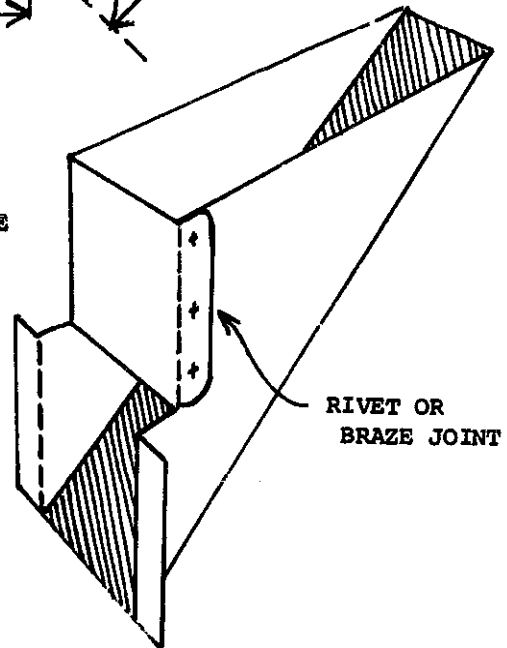
STAGE 4. INPUT HOPPER

MATERIAL : 20 GAUGE MILD STEEL SHEET



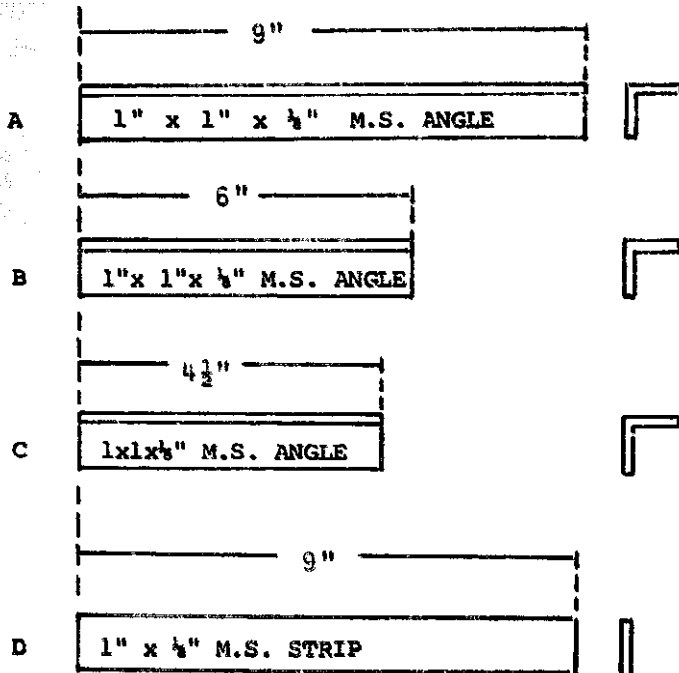
CUT OUT DEVELOPMENT

BEND INTO SHAPE
AS SHOWN HERE

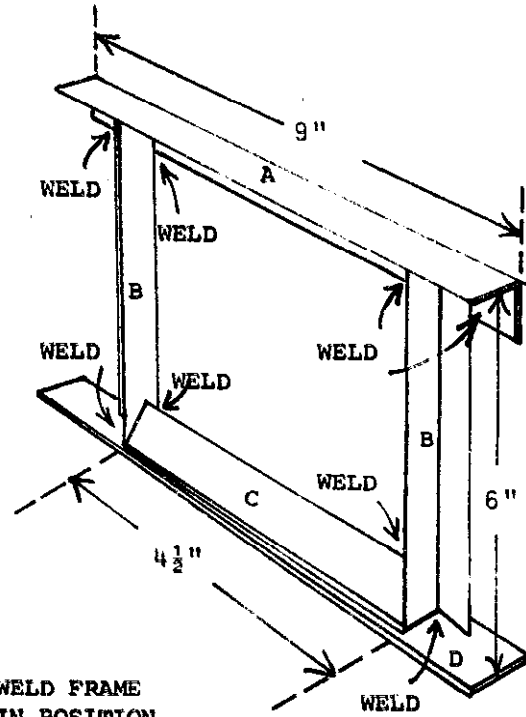


RIVET OR
BRAZE JOINT

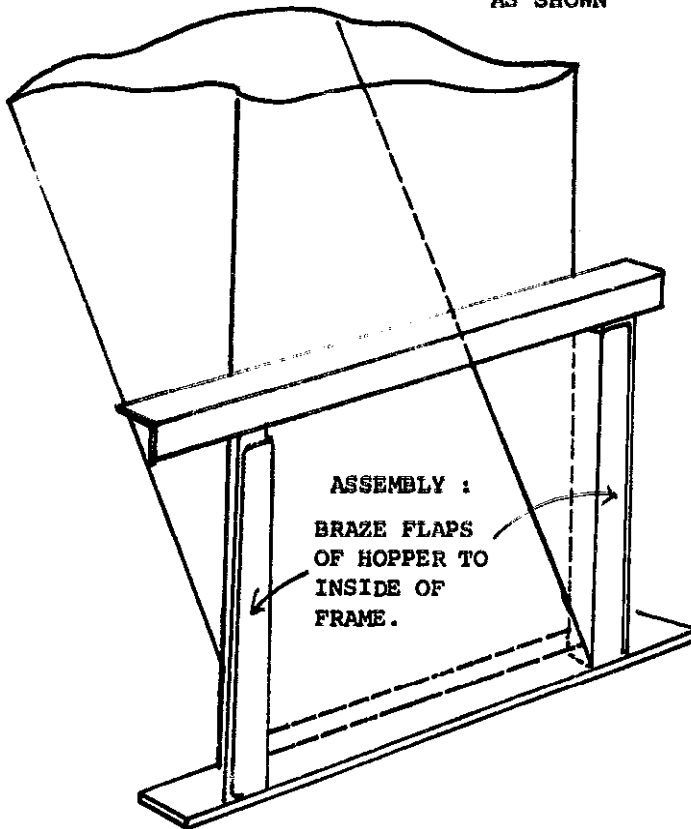
STAGE 5. HOPPER HOLDER AND ASSEMBLY WITH HOPPER



CUT 1 EACH OF A, C AND D. CUT 2 OF B.

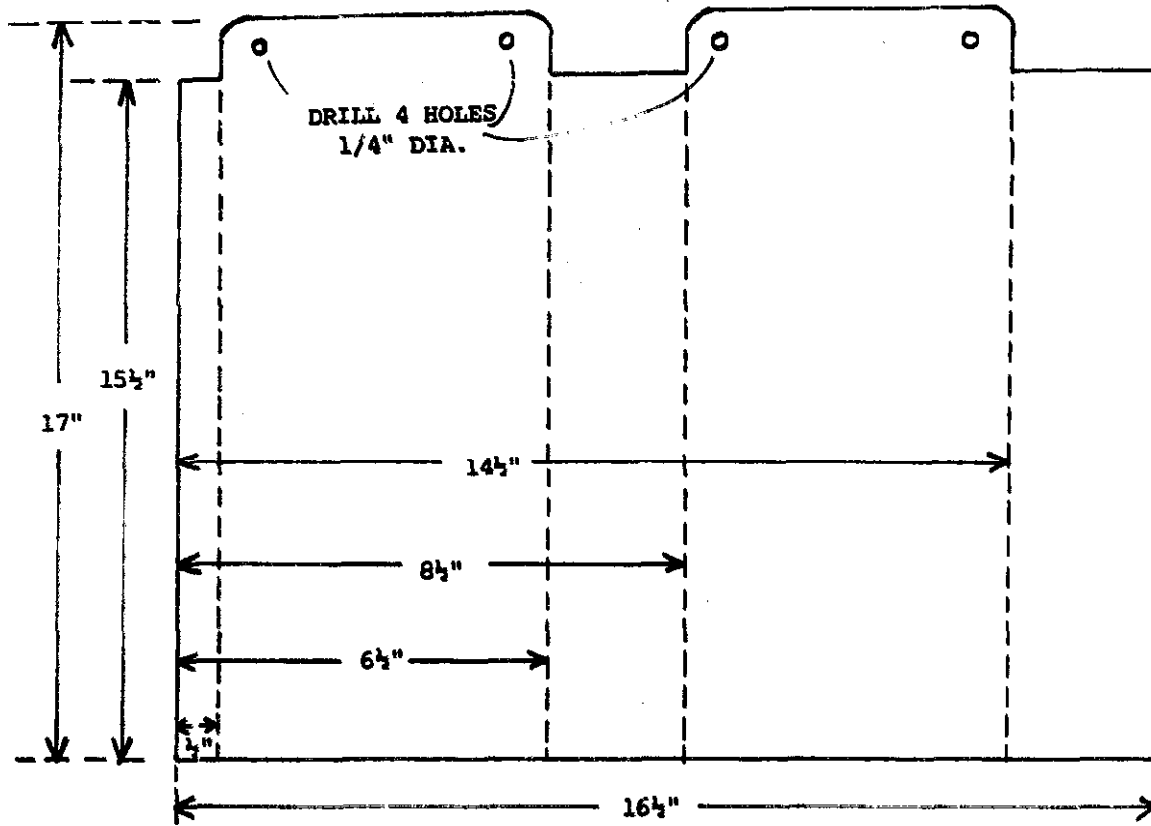


WELD FRAME
IN POSITION
AS SHOWN



STAGE 6. DELIVERY CHUTE

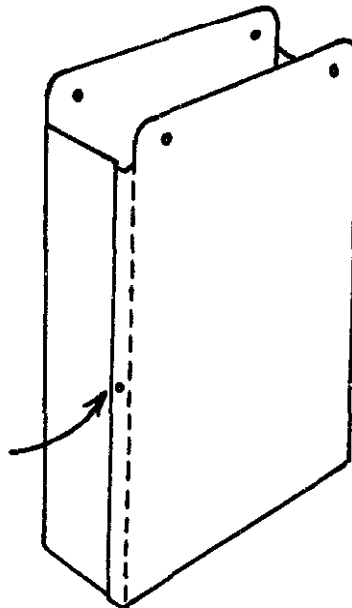
MATERIAL : 20 GAUGE M.S. SHEET. NO. OFF : 1



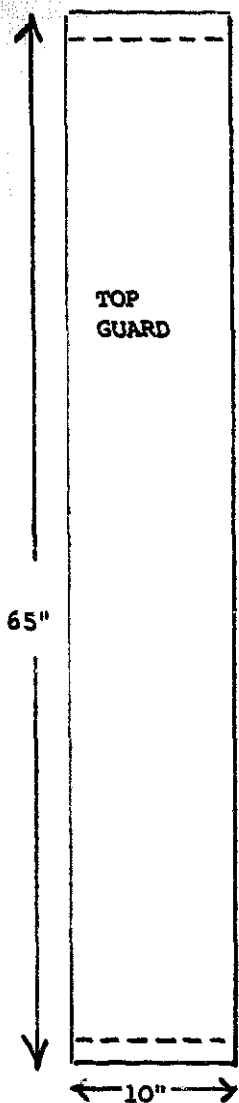
CUT OUT DEVELOPMENT

BEND INTO
SHAPE SHOWN

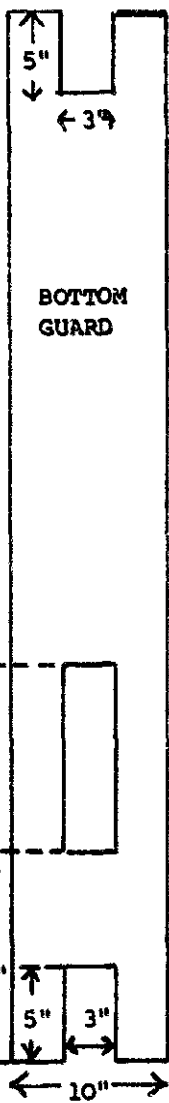
RIVET OR
BRAZE JOINT



STAGE 7. GUARD AND SEAT

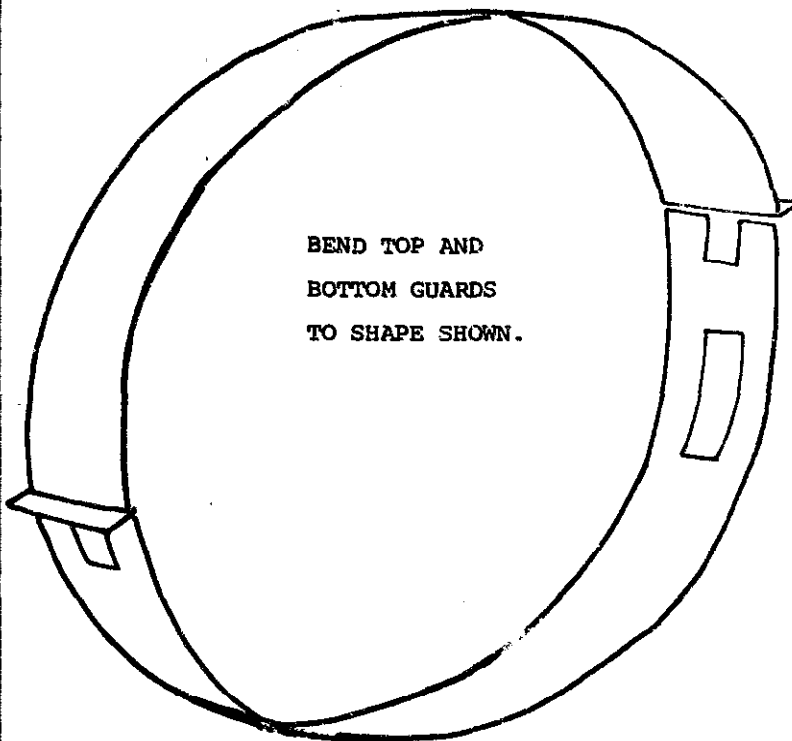


TOP
GUARD

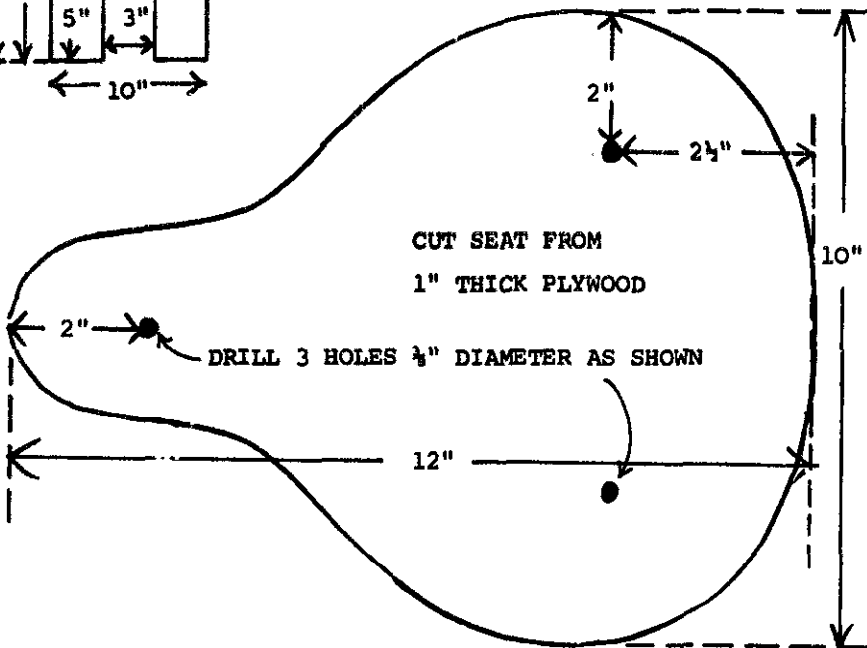


BOTTOM
GUARD

CUT 1 EACH TOP AND BOTTOM GUARD
FROM 20 GAUGE M.S. SHEET.



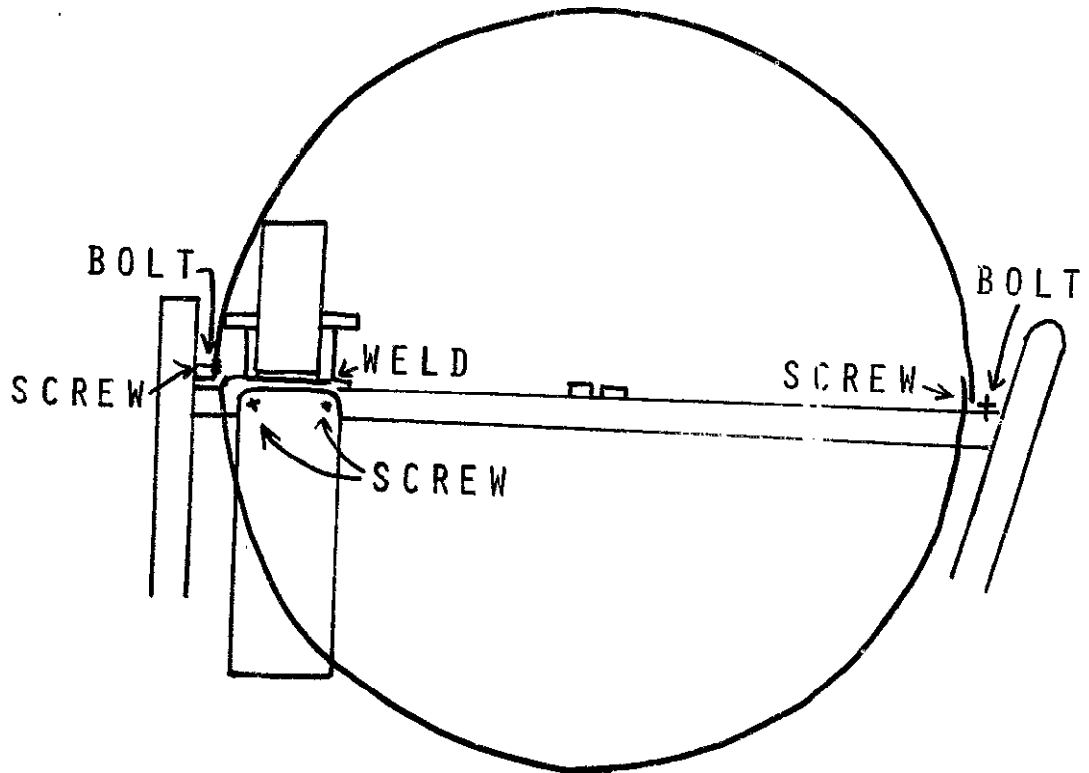
BEND TOP AND
BOTTOM GUARDS
TO SHAPE SHOWN.



CUT SEAT FROM
1" THICK PLYWOOD

DRILL 3 HOLES 3/4" DIAMETER AS SHOWN

STAGE 8. FINAL ASSEMBLY



1. BOLT TOP GUARD TO WHEEL SUPPORT FRAME.
2. WELD INPUT HOPPER TO WHEEL SUPPORT FRAME AT POINT 3" FROM L. H. SIDE.
3. SCREW DELIVERY CHUTE TO WHEEL SUPPORT FRAME DIRECTLY UNDER INPUT HOPPER.
4. LOCATE SLOT IN BOTTOM GUARD ONTO DELIVERY CHUTE AND SCREW BOTTOM GUARD TO TOP GUARD.
5. LOCATE GRINDING WHEEL ONTO WHEEL SUPPORT BRACKETS AND TIGHTEN NUTS.
6. CONNECT WHEEL COG TO PEDAL COG WITH CORRECT LENGTH OF DRIVE CHAIN.
7. BOLT SEAT TO SEAT FRAME.
8. CLEAN WELDED AREAS AND PAINT.
9. APPLY TWO COATS OF POLYURETHANE VARNISH TO GRINDING WHEEL.
10. TEST.

28

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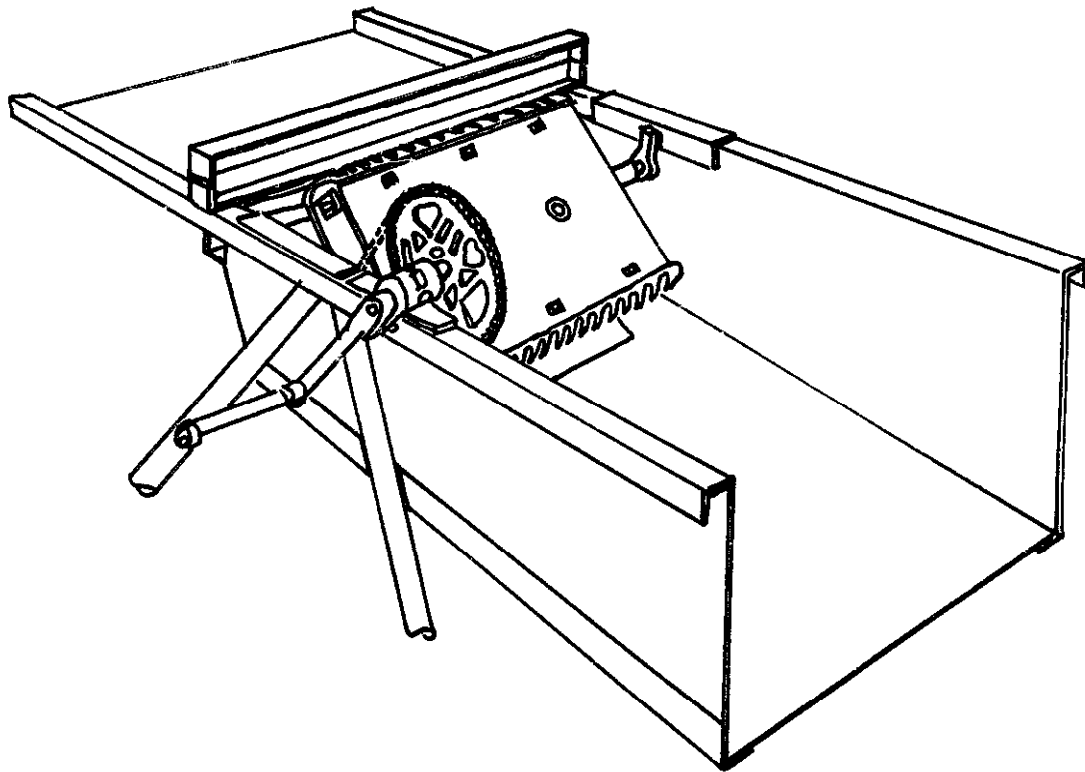
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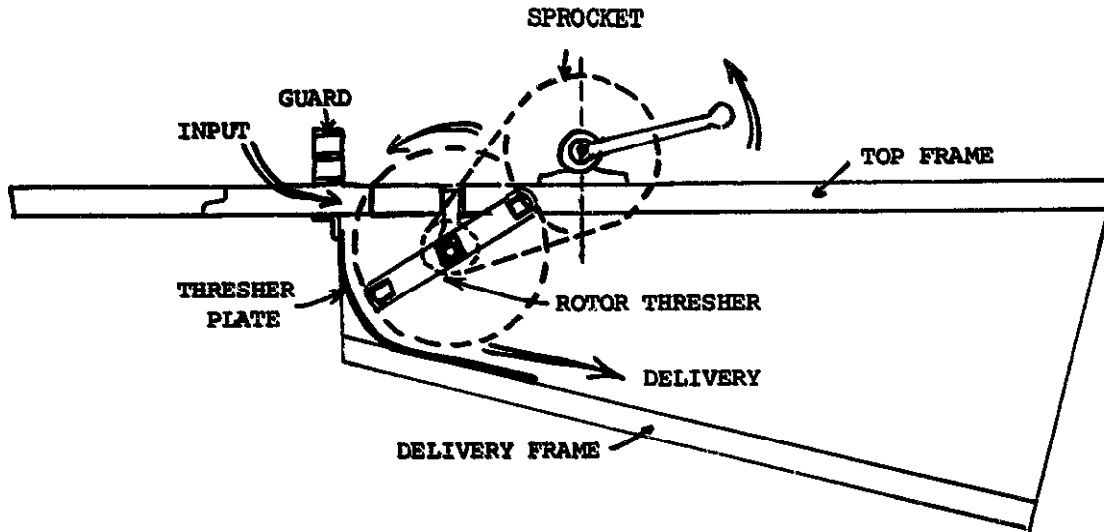
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(ZARIA, NIGERIA)

DESIGN: S.W. EAVES
DRAWING: C.J. HILL AND J. LEE

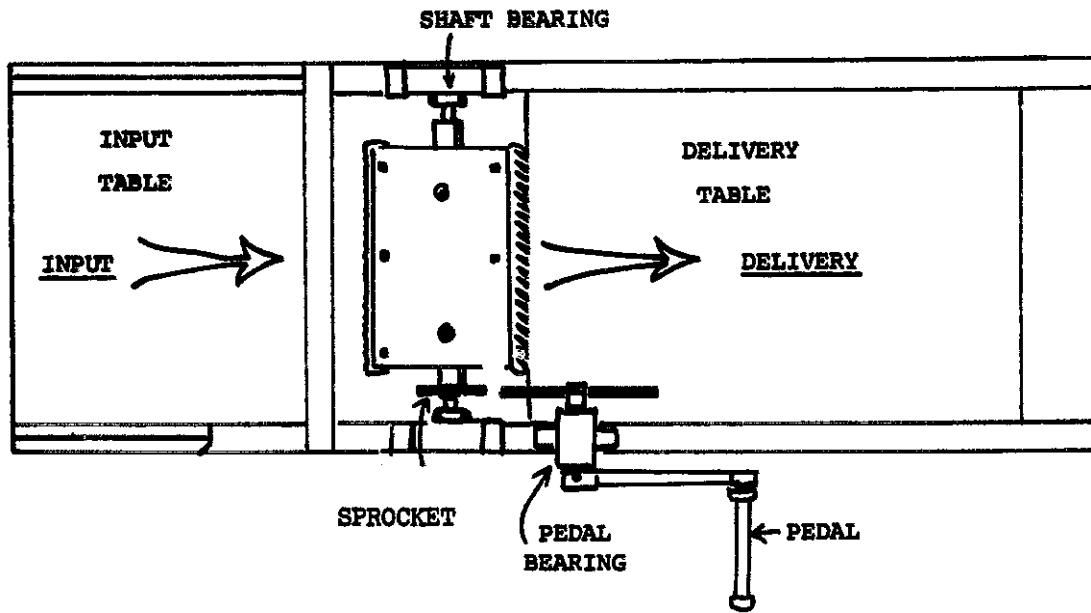
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ROTARY CORN THRESHER

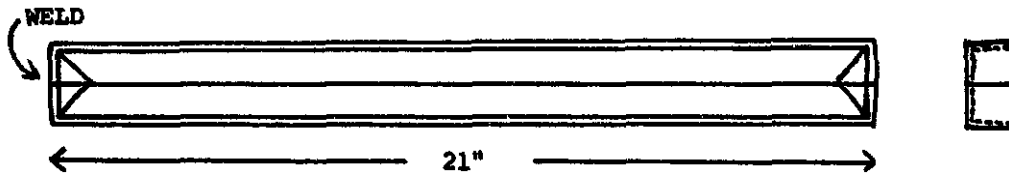
OPERATION :
(SIDE ELEVATION)



OPERATION (PLAN) :



STAGE 1. GUARD AND COMPONENT PARTS AND TOP FRAME



THE GUARD IS MADE BY CUTTING TWO PIECES OF ANGLE IRON 24" LONG, FORMING A 90° ANGLE ON EACH END (FIG. 1) AND WELDING.

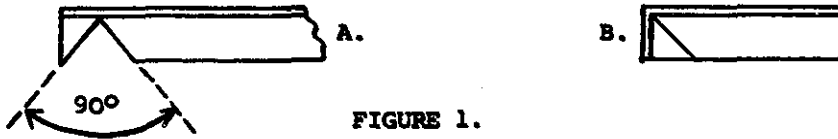
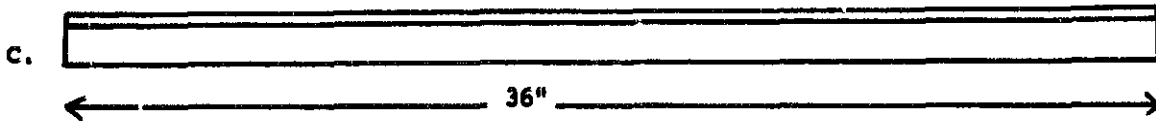
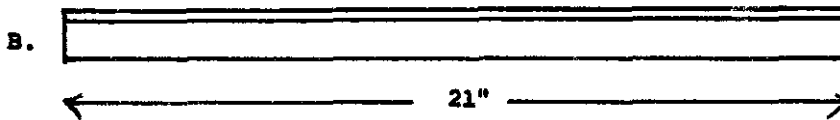
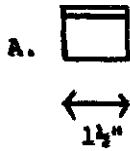


FIGURE 1.

MATERIAL : 1½" x 1½" x ¼" MILD STEEL ANGLE

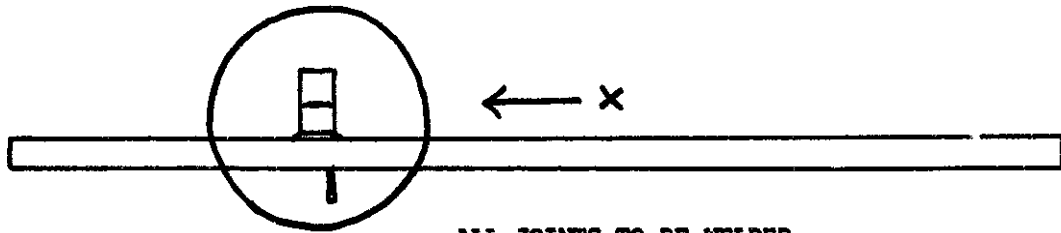
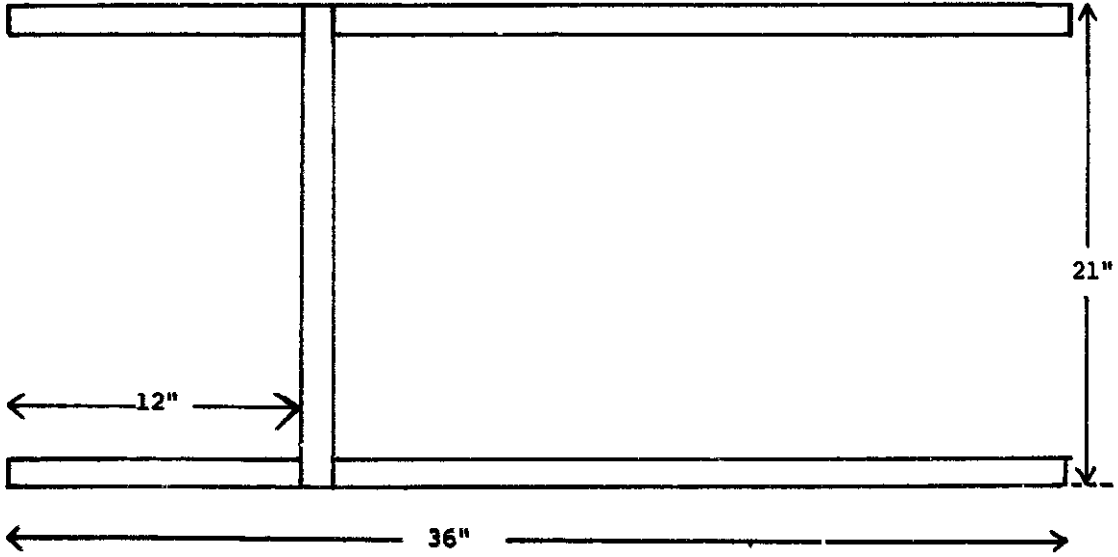
NO. OFF : ONE COMPLETE FRAME



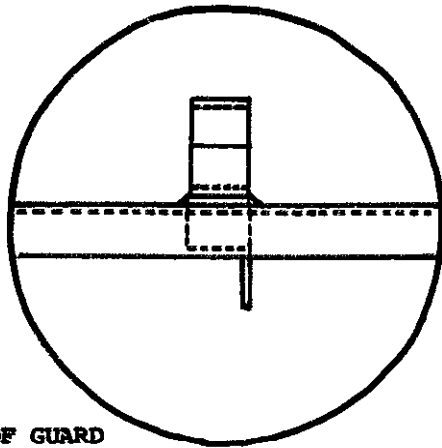
MATERIAL : 1½" : 1½" x ¼" MILD STEEL ANGLE

NO. OFF : A : 2; B : 1; C : 2.

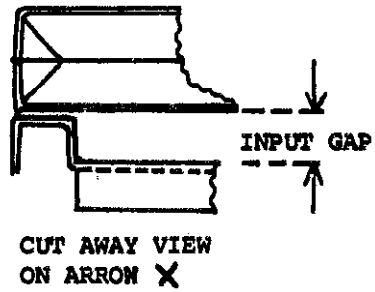
STAGE 2. ASSEMBLY OF TOP FRAME AND GUARD



ALL JOINTS TO BE WELDED



DETAIL OF GUARD
AND INPUT GAP FABRICATION



CUT AWAY VIEW
ON ARROW X

STAGE 3. ROTOR THRESHER

A. THE BLADES OF THE ROTOR NEED TO BE OF SUCH DESIGN AS TO GIVE A THRESHING ACTION. IN THE PROTOTYPE MODEL, THE ROTOR BLADES WERE COMBINE HARVESTER BLADES (FIGURE 1).

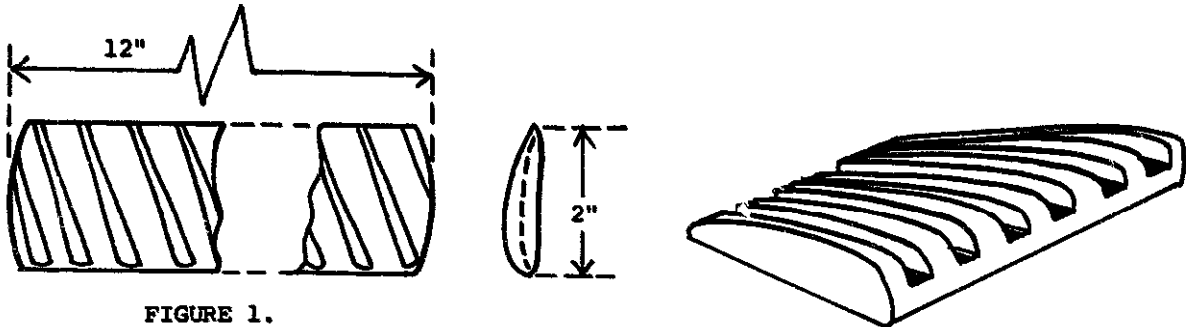


FIGURE 1.

HOWEVER, IT IS NOT ESSENTIAL THAT THE BLADES BE OF THE DESIGN IN FIG. 1. FIGURE 2. SHOWS A METHOD OF FABRICATING BLADES TO GIVE A THRESHING ACTION. MATERIALS WERE : $\frac{1}{4}$ " x 2" MILD STEEL PLATE AND $\frac{1}{4}$ " ϕ MILD STEEL ROD.

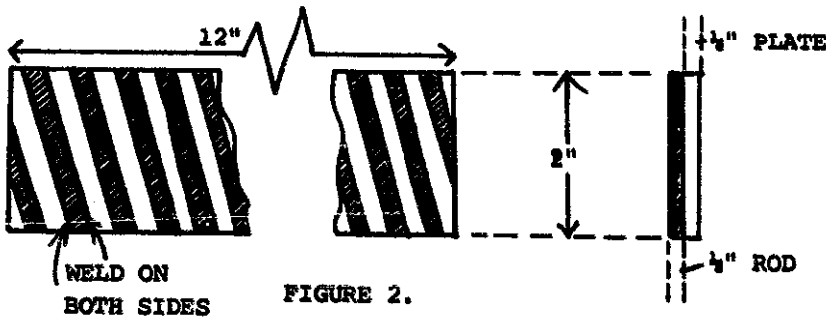
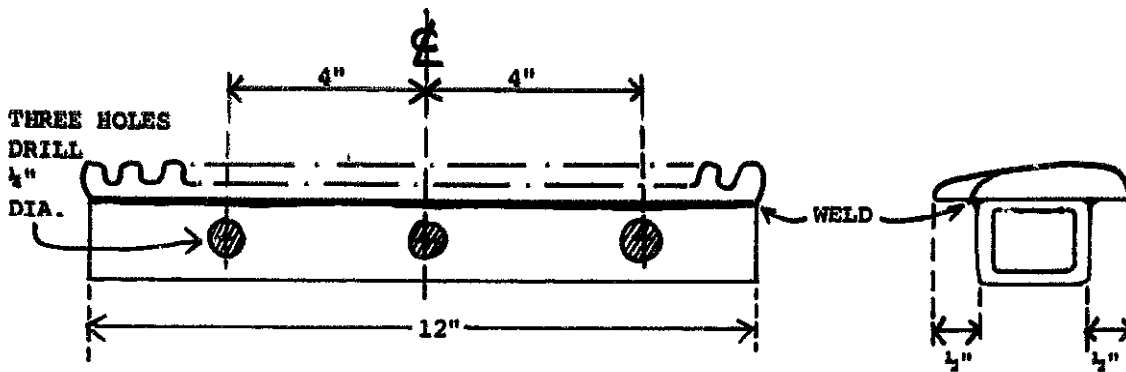


FIGURE 2.

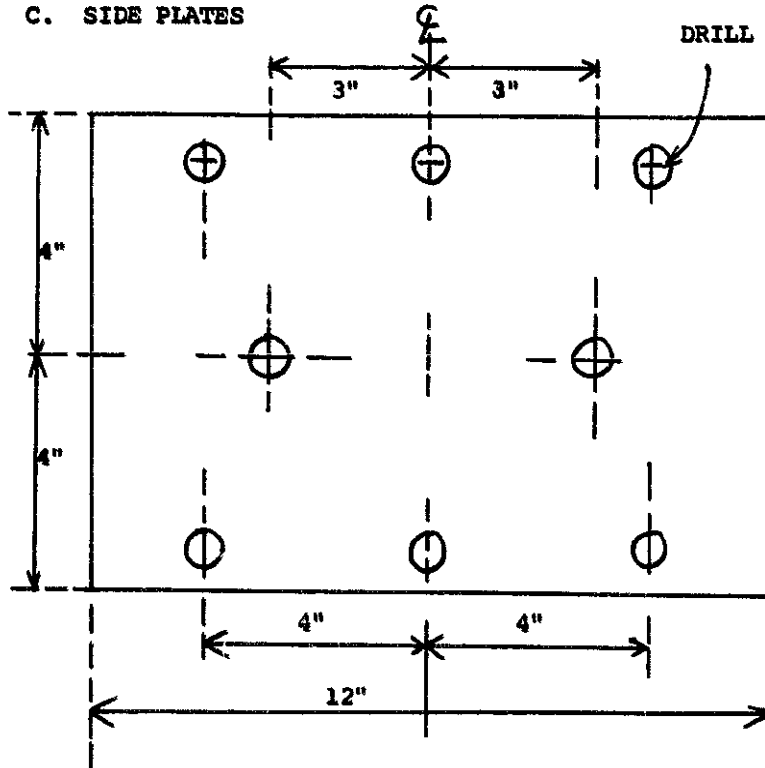
NOTE: RODS MUST BE SPACED AT $\frac{1}{4}$ " INTERVALS AND WELDED AT A SLIGHT ANGLE, AS SHOWN.
 NO. OFF : 2 BLADES,
 ONE RIGHT HAND ,
 ONE LEFT HAND

B. BLADES : WELD ROTOR BLADES TO SQUARE SECTION, ONE LEFT HAND AND ONE RIGHT HAND.

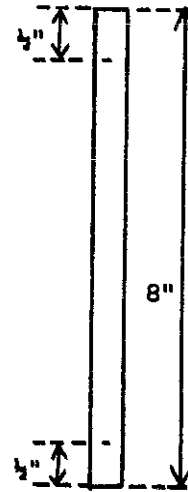


MATERIAL : 1" x 1" MILD STEEL SQUARE SECTION
 NO. OFF : TWO

C. SIDE PLATES

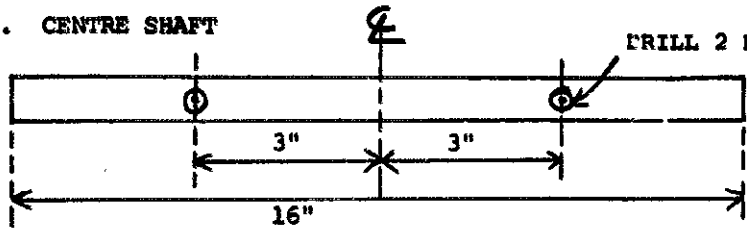


DRILL 6 HOLES $\frac{1}{4}$ " DIA.



MATERIAL : $\frac{1}{4}$ " THICK PLYWOOD
NO. OFF : 2.

D. CENTRE SHAFT



DRILL 2 HOLES $\frac{1}{4}$ " DIA.



MATERIAL : 1" x 1" MILD
STEEL SQUARE SECTION
NO. OFF : 1.

THE BEARINGS FOR THE ABOVE CENTRE SHAFT ARE TWO STANDARD BICYCLE PEDALS, AS SHOWN BELOW IN FIGURE 3.

NOTE : THE PEDALS MUST BE A TIGHT FIT IN THE SQUARE SECTION ENDS. THE SPROCKET (SEE FIG. 4 NEXT PAGE) MUST BE FITTED TO ONE SIDE OF SHAFT BEARING BEFORE ASSEMBLY OF BEARING.

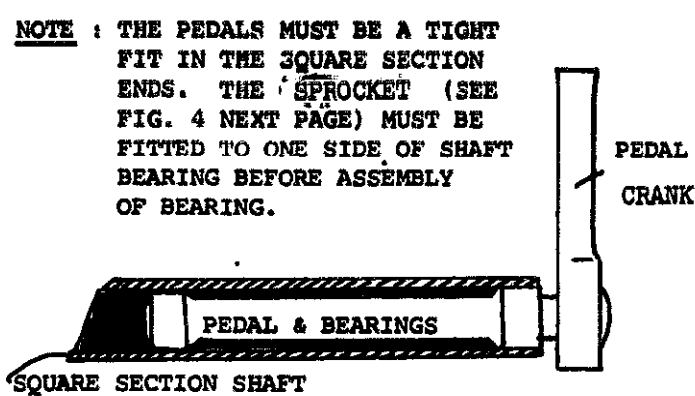


FIGURE 3. (SECTION ON AA)

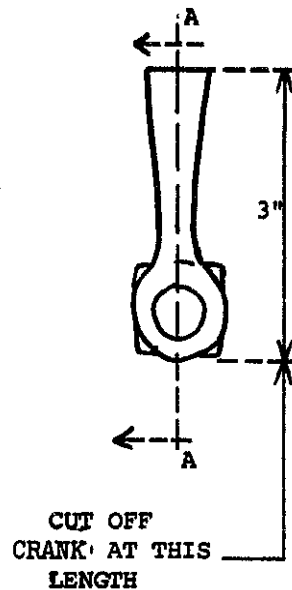
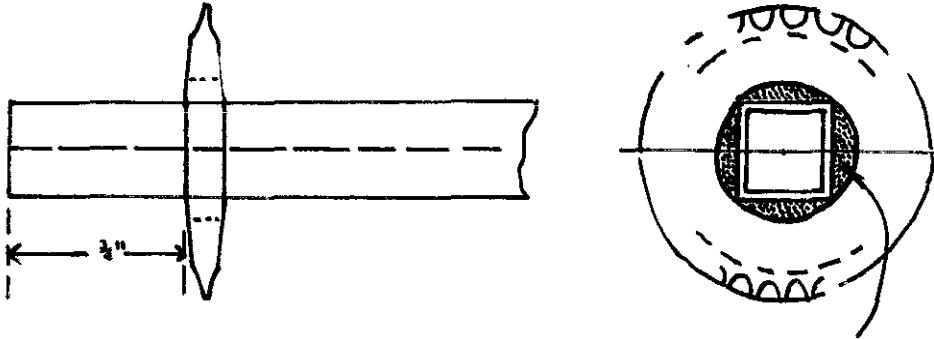


FIGURE 3.
(PEDAL
CRANK)

CUT OFF
CRANK AT THIS
LENGTH

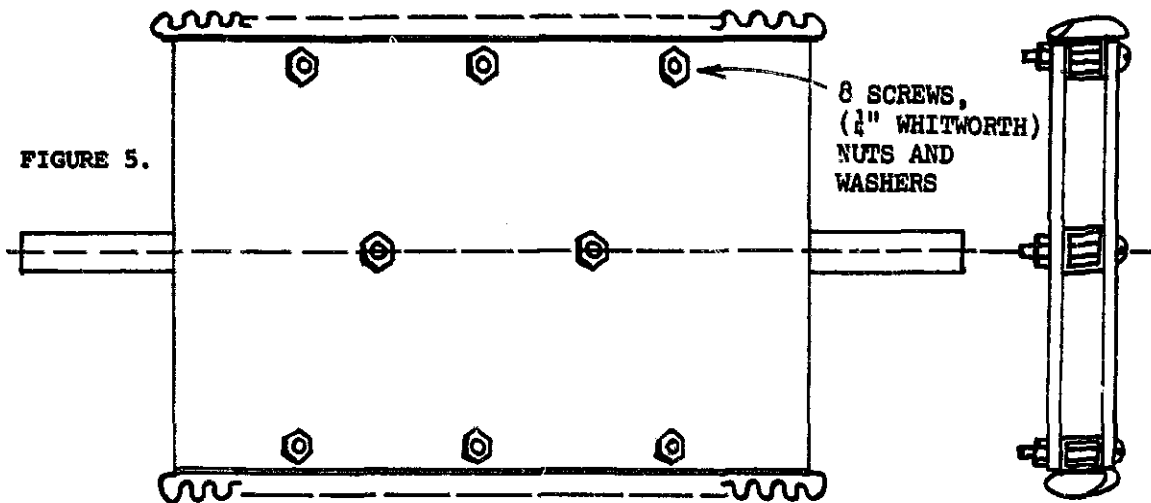
FIGURE 4.



THE SPROCKET FOR THE CENTRE SHAFT IS OF THE "FREE WHEEL" TYPE WITH A 3" OUTSIDE DIAMETER AND 1½" INSIDE DIAMETER. FITTING IS SHOWN IN FIGURE 4.

APERTURES TO BE FILLED WITH A MIXTURE OF EPOXY RESIN AND SAND.

FIGURE 5.



E. ASSEMBLY OF ROTOR THRESHER BEFORE FITTING OF CENTRE SHAFT BEARINGS

STAGE 4. ROTOR THRESHER ADJUSTING PLATES

MATERIAL : 1½" x 1½" x ¼" MILD STEEL ANGLE
NUMBER OFF : 2.

DRILL 5/16" DIA. HOLES ELONGATED 1½"

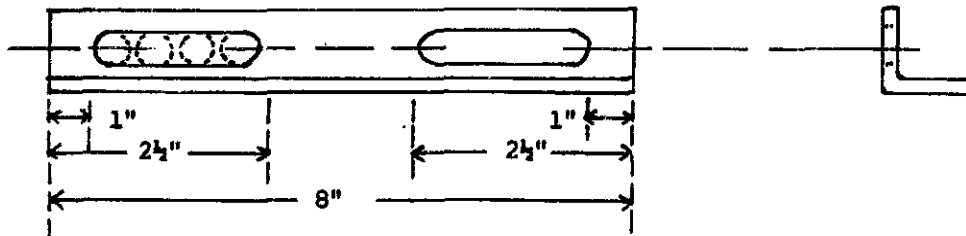
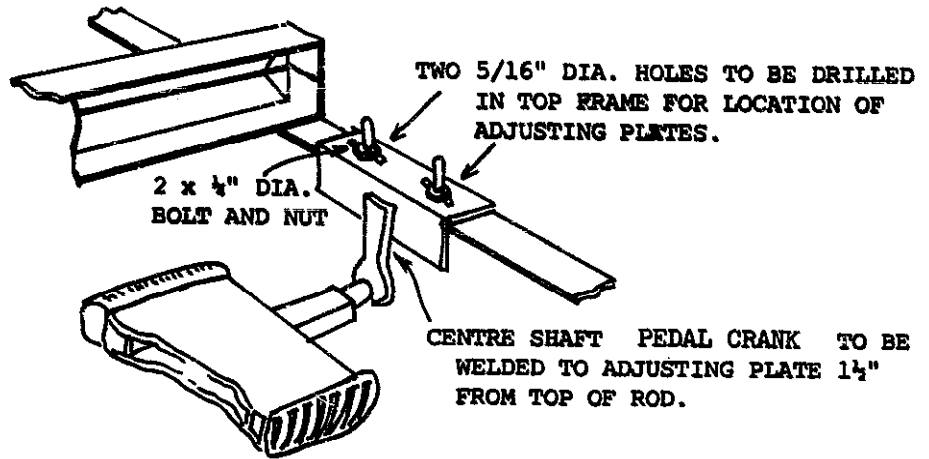


FIGURE 6. ASSEMBLY OF CONNECTING ROD AND ADJUSTING PLATES

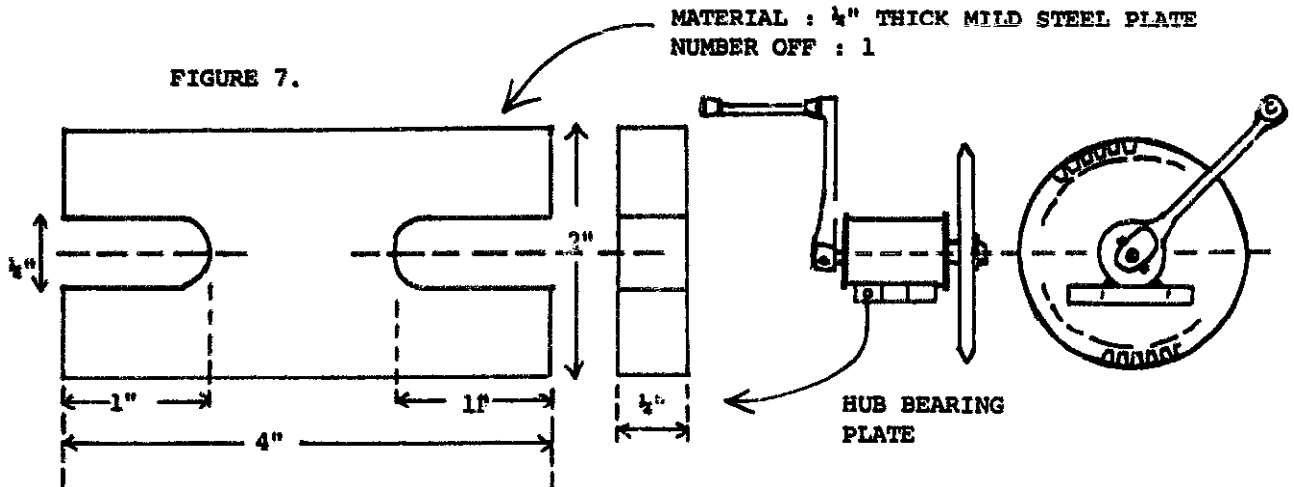


STAGE 5. DRIVE

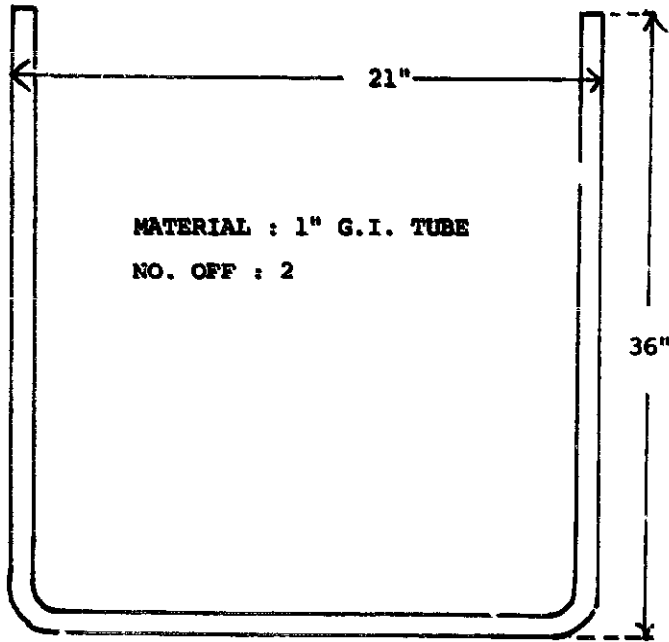
DRIVE IS OBTAINED FROM A BICYCLE PEDAL CONNECTED THROUGH A HUB BEARING TO A 7" Ø SPROCKET. A STANDARD BICYCLE CHAIN CONNECTS THE SPROCKET TO SPROCKET ON CENTRE SHAFT.

THE DRIVE ASSEMBLY IS BOLTED TO THE LEFT HAND SIDE OF TOP FRAME APPROX. 10" FROM GUARD. ENSURE THAT THE TWO SPROCKETS ARE IN LINE BEFORE FITTING CORRECT LENGTH OF CHAIN.

FIGURE 7 SHOWS ASSEMBLY WITH DETAIL OF HUB BEARING FIXING PLATE.



STAGE 6. STAND



MATERIAL : 1" G.I. TUBE
NO. OFF : 2

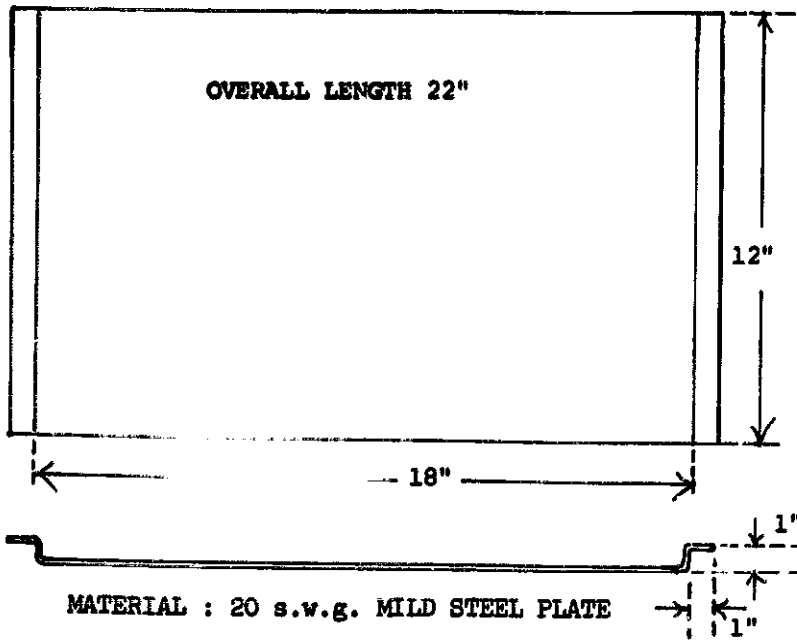
STAGE 7.
DELIVERY
FRAME



MATERIAL : 1 1/2" x 1 1/2" x 1/4"
MILD STEEL ANGLE

NO. OFF : 2

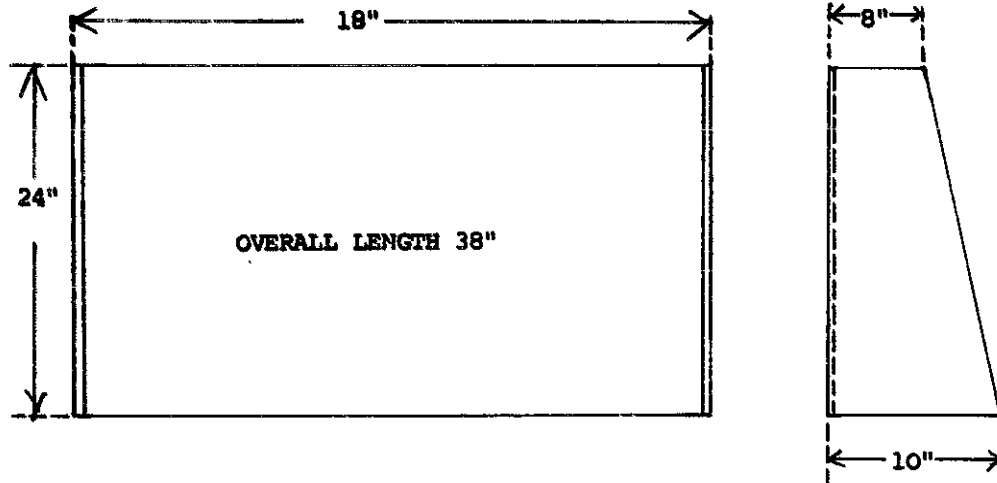
STAGE 8. INPUT TABLE



MATERIAL : 20 s.w.g. MILD STEEL PLATE

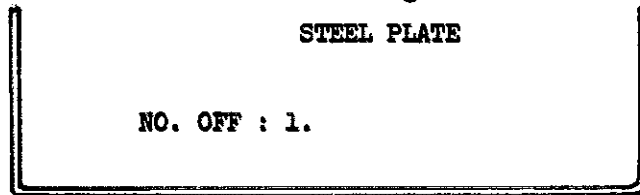
NO. OFF : 1.

STAGE 9. DELIVERY TABLE

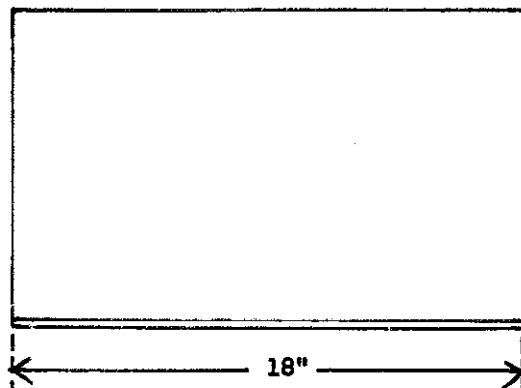


MATERIAL : 20 s.w.g. MILD
STEEL PLATE

NO. OFF : 1.

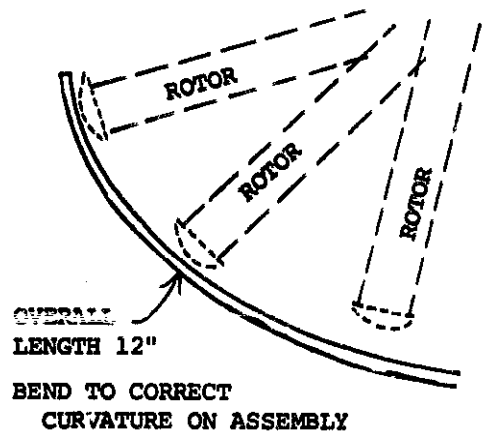


STAGE 10. THRESHER PLATE



MATERIAL : 16 s.w.g. MILD STEEL PLATE

NO. OFF : 1.



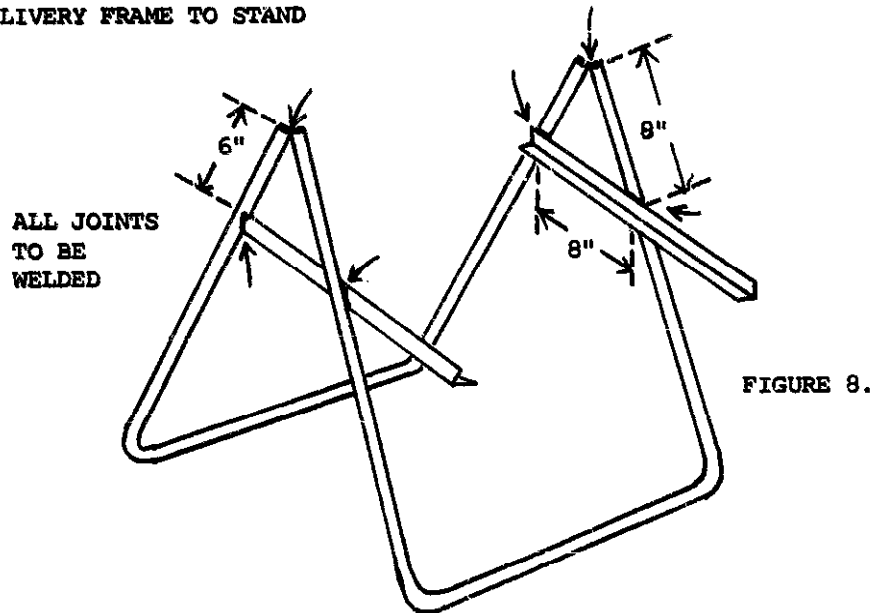
NOTE: ON ASSEMBLY THE THRESHER PLATE IS WELDED BETWEEN THE INPUT GAP AND THE DELIVERY TABLE.

THE GAP BETWEEN THE ROTOR AND THRESHER PLATE CAN BE ADJUSTED BY MOVING THE ROTOR THRESHER ADJUSTING PLATES.

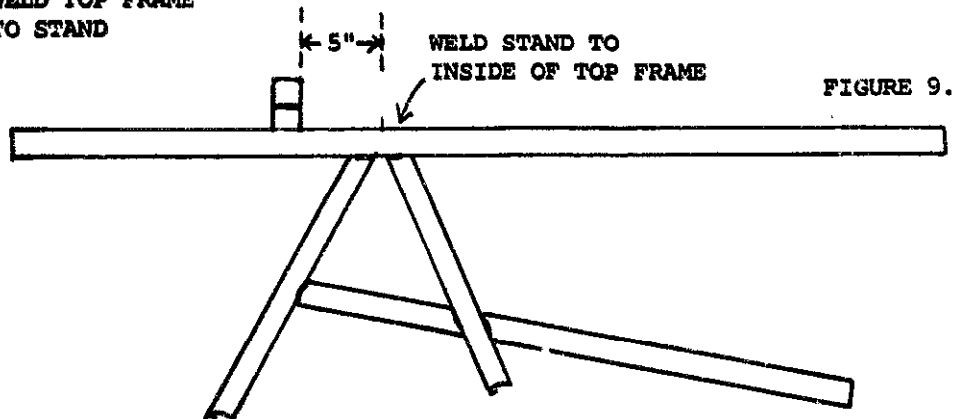
THE CORRECT GAP IS APPROX $\frac{1}{4}$ ". FOR GUINEACORN (SORGHUM).

STAGE 11. FINAL ASSEMBLY

1. WELD DELIVERY FRAME TO STAND



2. WELD TOP FRAME TO STAND



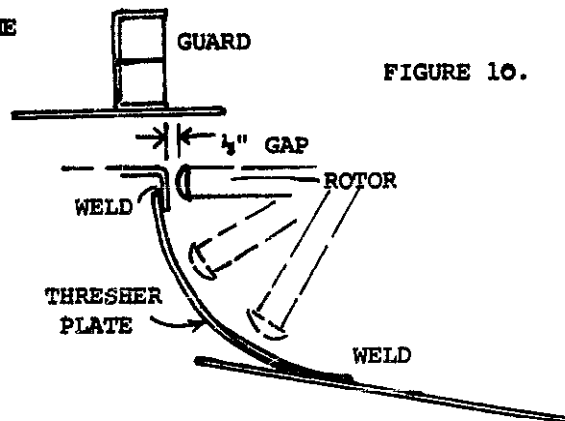
3. LOCATE INPUT TABLE IN POSITION ON TOP FRAME (SEE COVER DRAWING)

4. LOCATE DELIVERY TABLE IN POSITION IN DELIVERY FRAME (SEE COVER DRAWING)

5. WELD THRESHER PLATE IN POSITION AND ADJUST GAP (FIG. 10).

6. CLEAN WELDED AREAS

7. LUBRICATE AND PAINT



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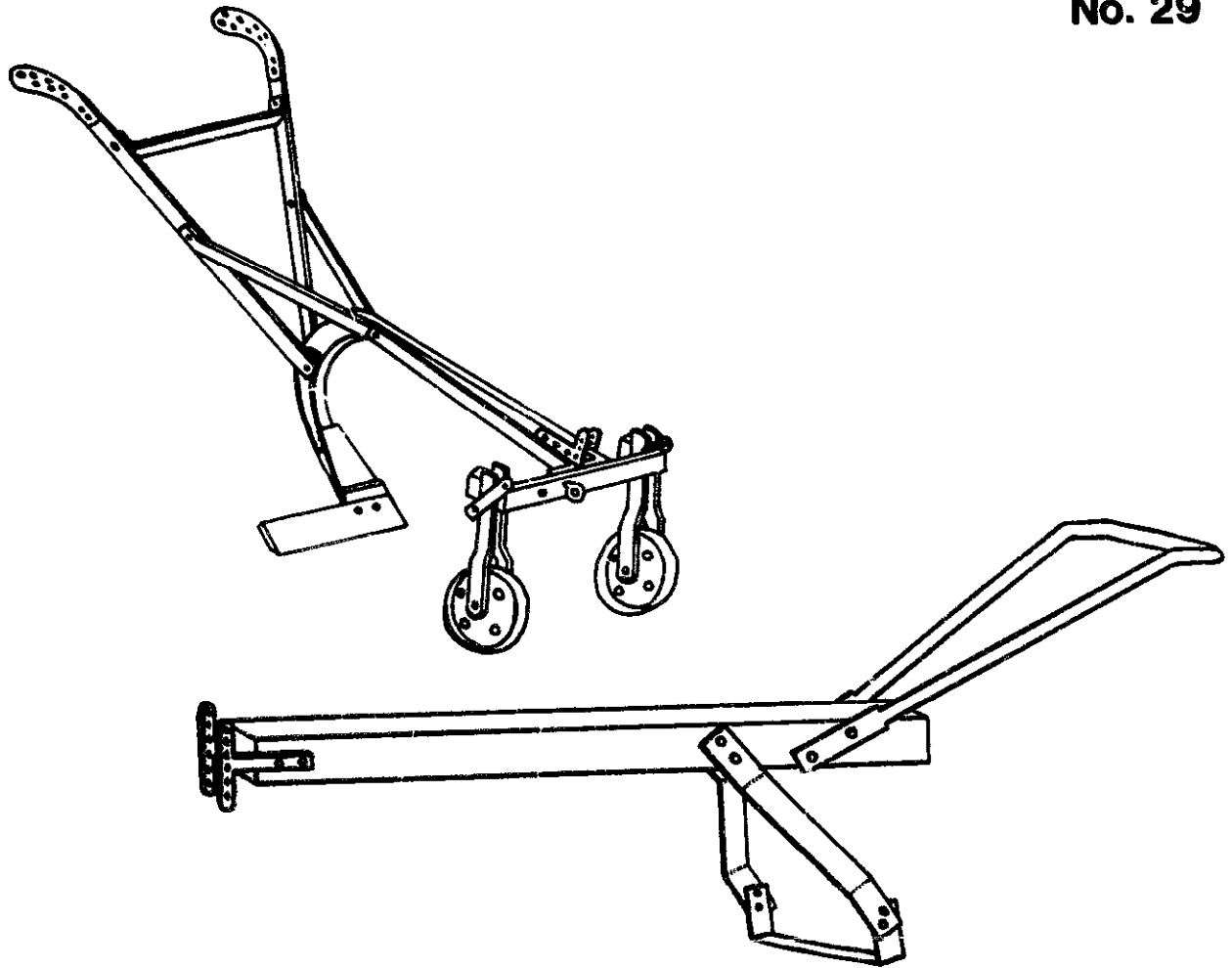
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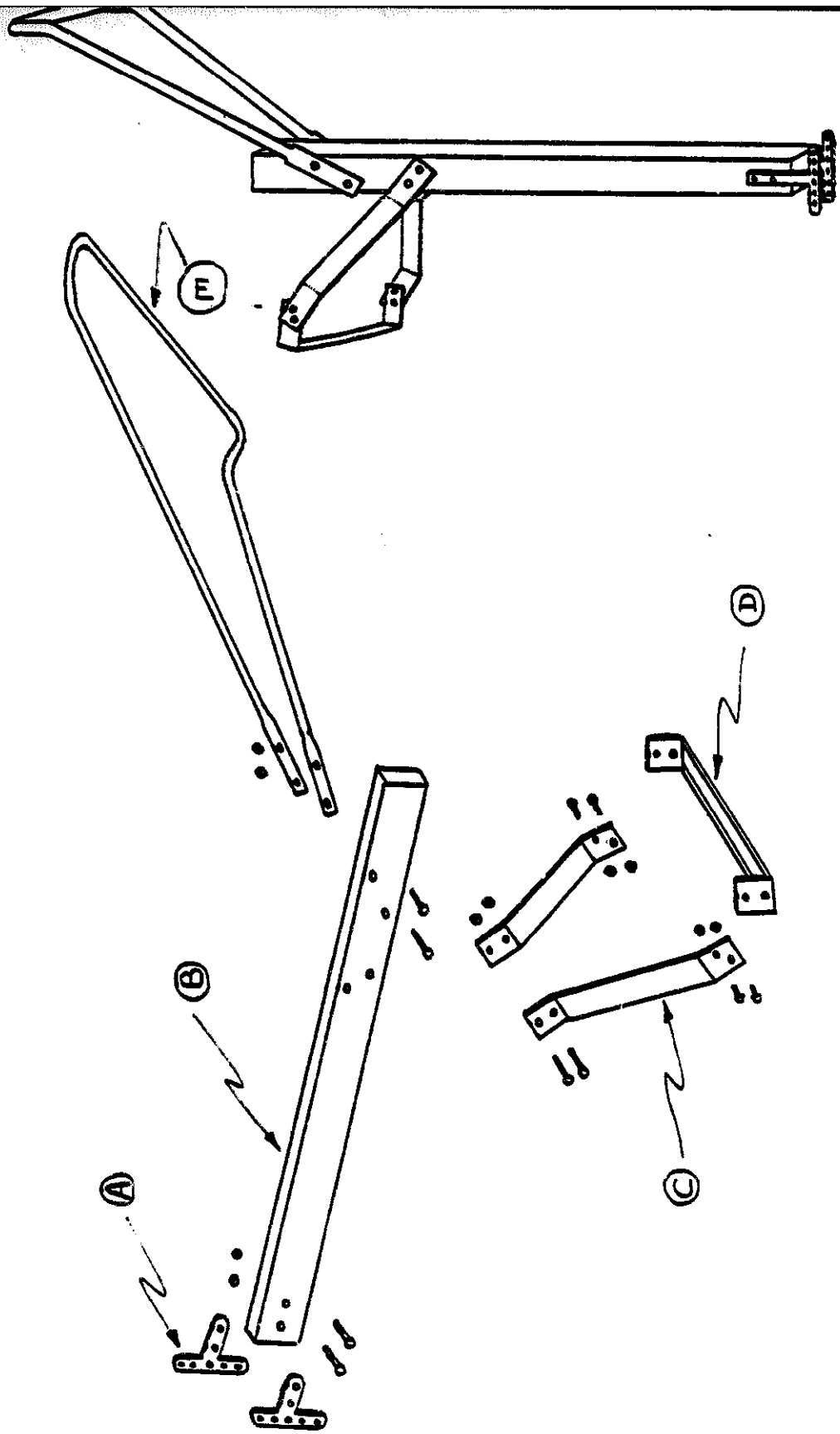


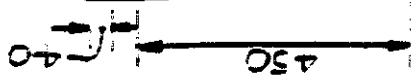
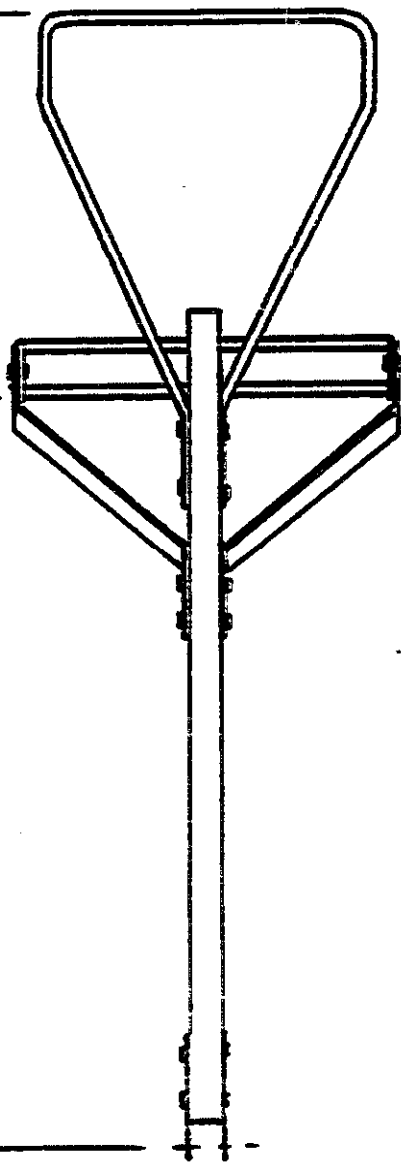
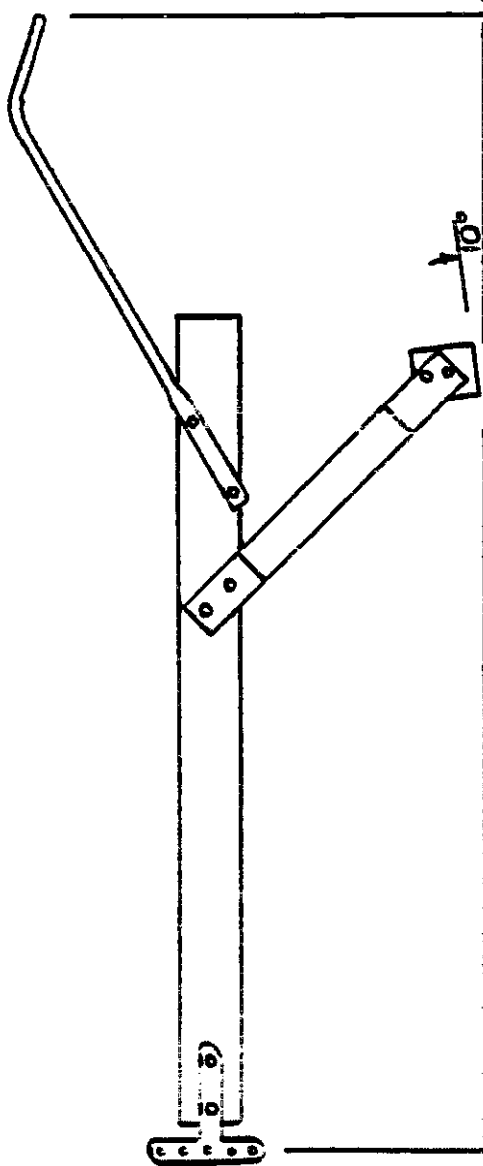
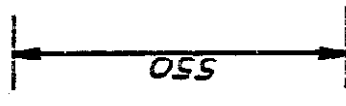
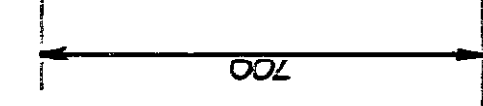
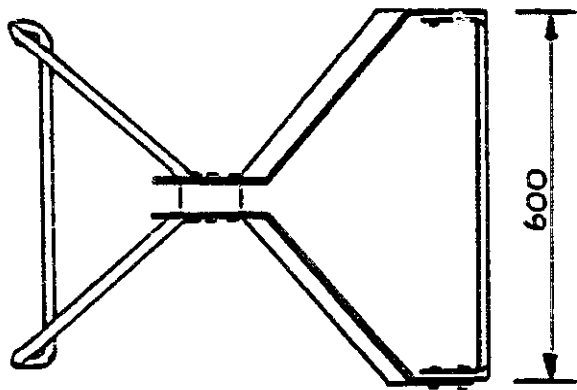
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I.T. GROUNDNUT LIFTER

DESIGN: JOHN BOYD

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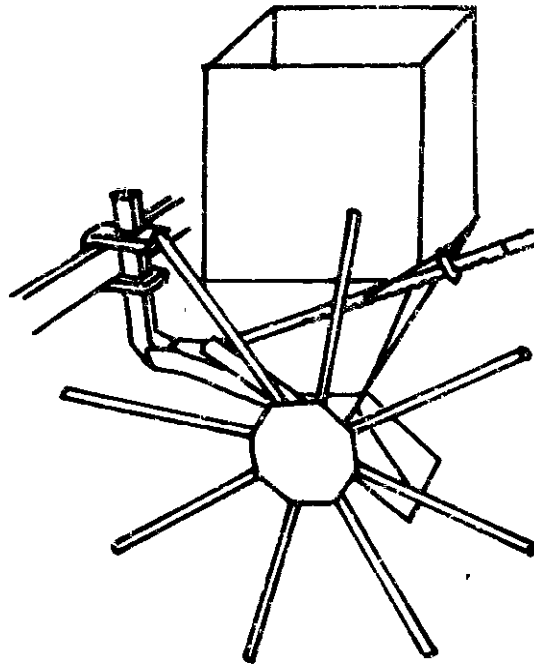
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I.T. GRANULE APPLICATOR
(DAUDAWA, N.C.S. NIGERIA)

DESIGN: JOHN BOYD

DRAWING: BERNARD WINLO

I.T. GRANULE APPLICATOR

Developed by : Intermediate Technology Project, Daudawa,
North Central Nigeria.

Introduction : The granule applicator was developed as part of the I.T. Farm Equipment Development Project work programme attached to the Institute of Agricultural Research of Ahmadu Bello University.

The I.A.R. Agronomy Department requested development of an applicator for fertiliser granules into which herbicide had been incorporated, the granules to be spread in a 15 cm wide band on top of the ridges to control weeds in the crop rows while the inter-rows were mechanically weeded.

A Planet Junior hand-pushed seeder was modified to spread a band of granules by replacing its seed tube with a fan-shaped outlet.

A similar Planet Junior-based applicator was fitted to an Ariana toolbar and a simple direct drive from a spiked wheel was used to replace the original bevel gears and shaft drive to the metering mechanism. Standard Ariana soil moving components were added to enable a ridge to be built and granules to be applied, either on the surface or incorporated into the soil, simultaneously.

A simpler, more robust applicator with a larger hopper capacity was built from locally available mild steel sheet, water pipe and reinforcing rod, using normal hand tools and welding equipment, and fitted to an Ariana toolbar. It was found to be capable of spreading superphosphate granules in a 15 cm wide band at rates between 10 kg and 500 kg per total hectare on the 75 cm spaced rows used in the Daudawa area.

Description :

In the drawings which follow, dimensions are given in inches with millimetre equivalents in brackets.

- Page 1. Pictorial views of assembled granule applicator.
- Page 2. Hopper unit, side view.
- Page 3. Hopper unit, rear view.
- Page 4. Hopper unit, plan view.
- Page 5. Metering mechanism.
- Page 6. Granule aperture flow adjuster.
- Page 7. Ratchet lever for flow adjustment.
- Page 8. Granule-flow drive, front view.
- Page 9. Granule-flow drive, side view.
- Page 10. Granule distribution spout, plan and side views.
- Page 11. Granule distribution spout in position, side view.
- Page 12. Calibration chart for I.T. granule applicator.

The applicator hopper A is made of 3/32" (2.4) thick mild steel sheet, and to increase its capacity it was extended vertically by 9" (229) using 1/16" (1.5) mild steel sheet as indicated by B.

The hopper support frame pieces C of 1" x 1/8" (25 x 3) mild steel, are welded to the attachment stalk D which is fabricated from 1" x 1" (25 x 25) angle iron and allows the applicator to be clamped firmly to an Ariana toolbar E.

The first part of the metering mechanism is made of 1 1/8" (28) internal diameter pipe F welded to the bottom of the hopper. The granule flow adjuster G of 1 1/16" (27) outer diameter pipe, which fits inside the pipe F, is provided with bearings of hardwood at both ends as indicated by H.

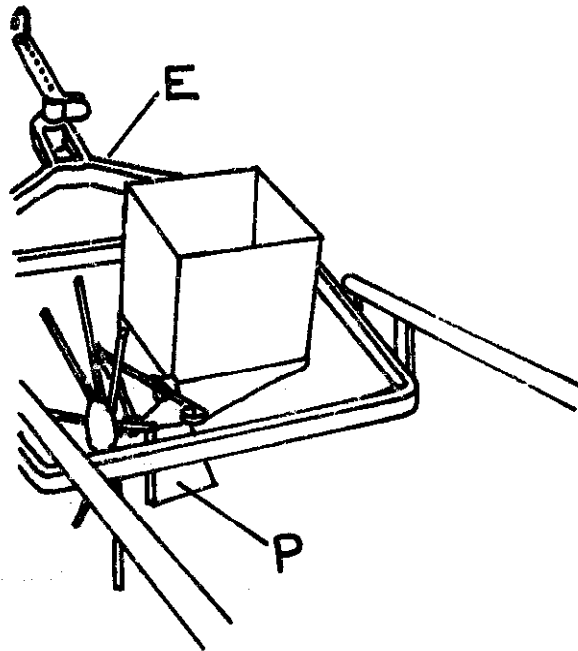
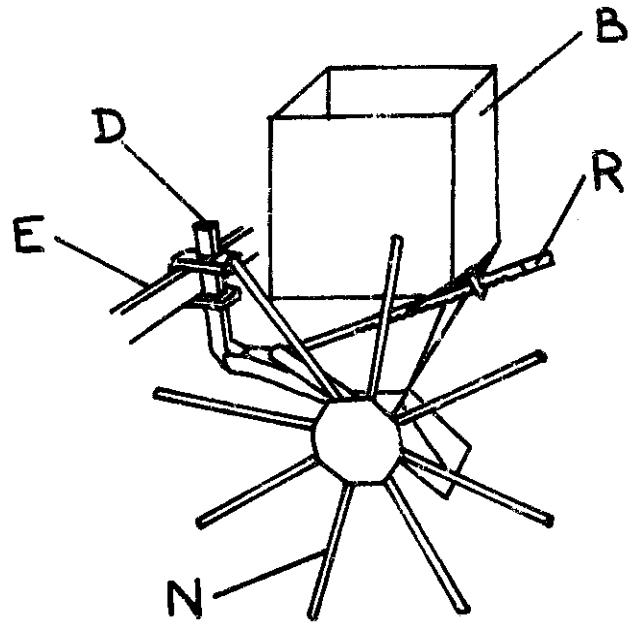
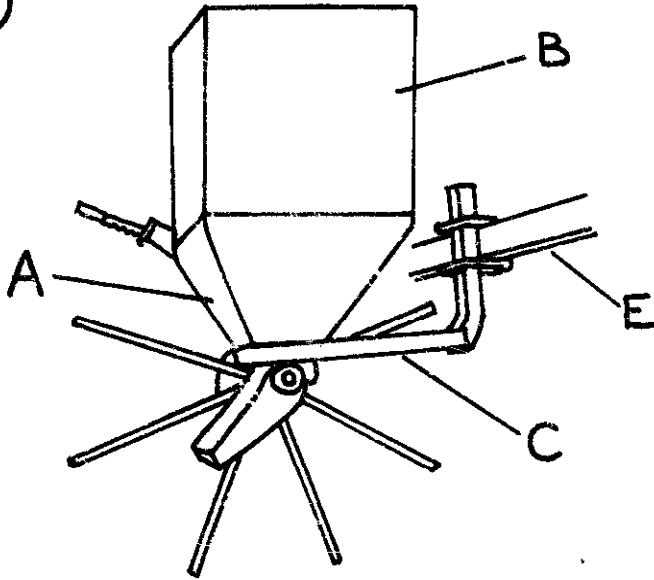
Even granule flow is maintained by the rotating movement of the agitator J which, when passed through the wooden bearings within pipe G, is provided with a distance piece K of 1/2" (12.5) bore pipe, washers L, and a split pin M. The integral agitator J and granule flow drive N is made from 7/16" (11) mild steel bar, rotation being by ground-drive from the "spiked-wheel" N.

The granule spout P is made from 1/8" (3) thick mild steel, and even granule spread is accomplished by the provision of diverter pegs made of wire and positioned within the spout as shown at Q.

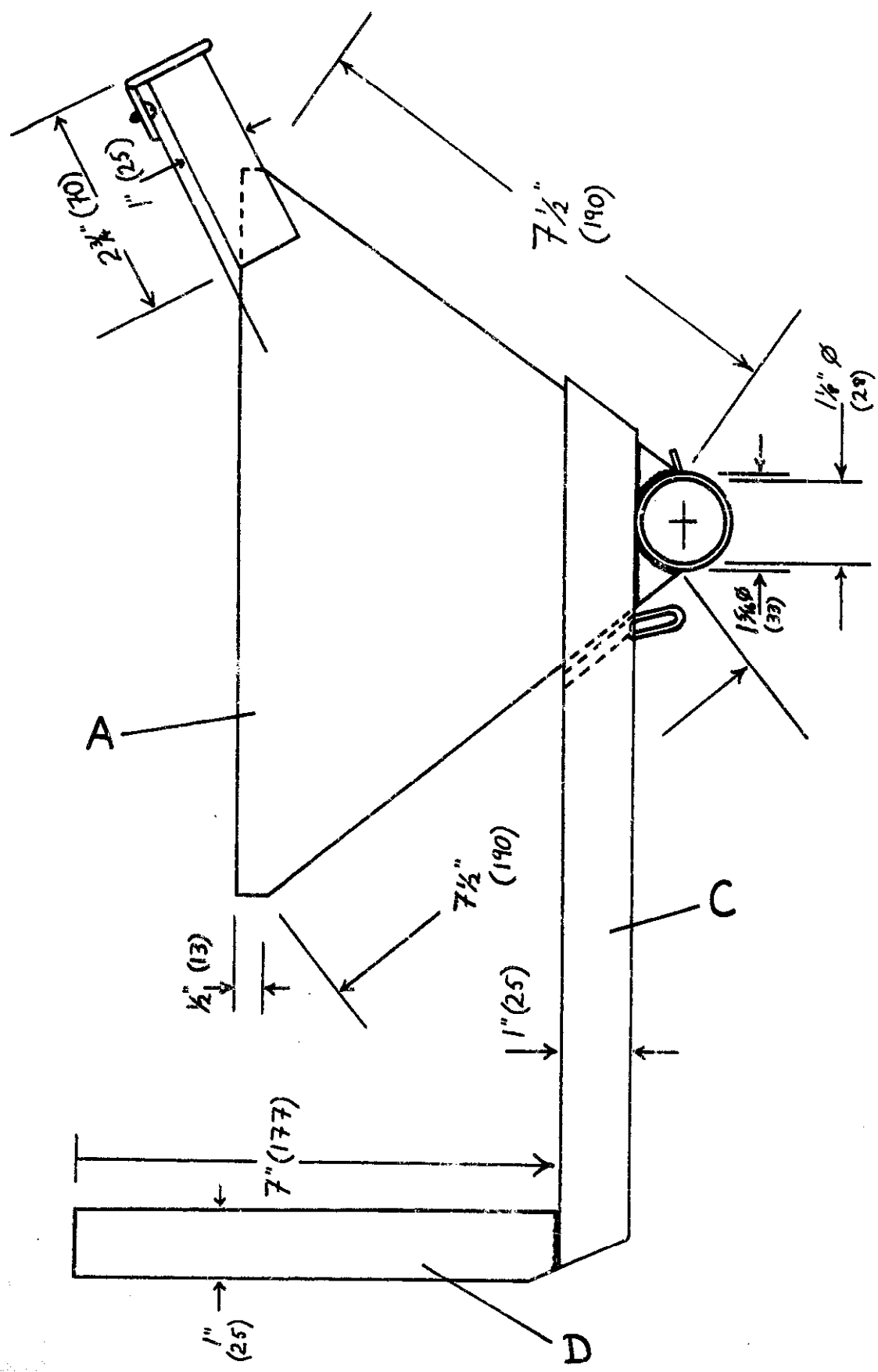
With reference to pages 7 and 12, the rate of application of granules per unit area is controlled by the position of the flow adjustment ratchet lever R. The ratchet teeth are at 1/4" (6.3) spacing, and to provide finer adjustment two holes are provided ("A" and "B") on the lever at the point where it joins the metering sleeve arm S. To keep the ratchet engaged during field operation, a small coil spring is fitted through 3/8" (3) diameter holes between the metering sleeve arm and the ratchet lever.

These drawings and description should be sufficient to enable the recipient to construct an applicator. However, materials used will depend on what is available and the constructor is advised to determine availability and alter dimensions accordingly. He is also welcome to alter the design to suit local conditions.

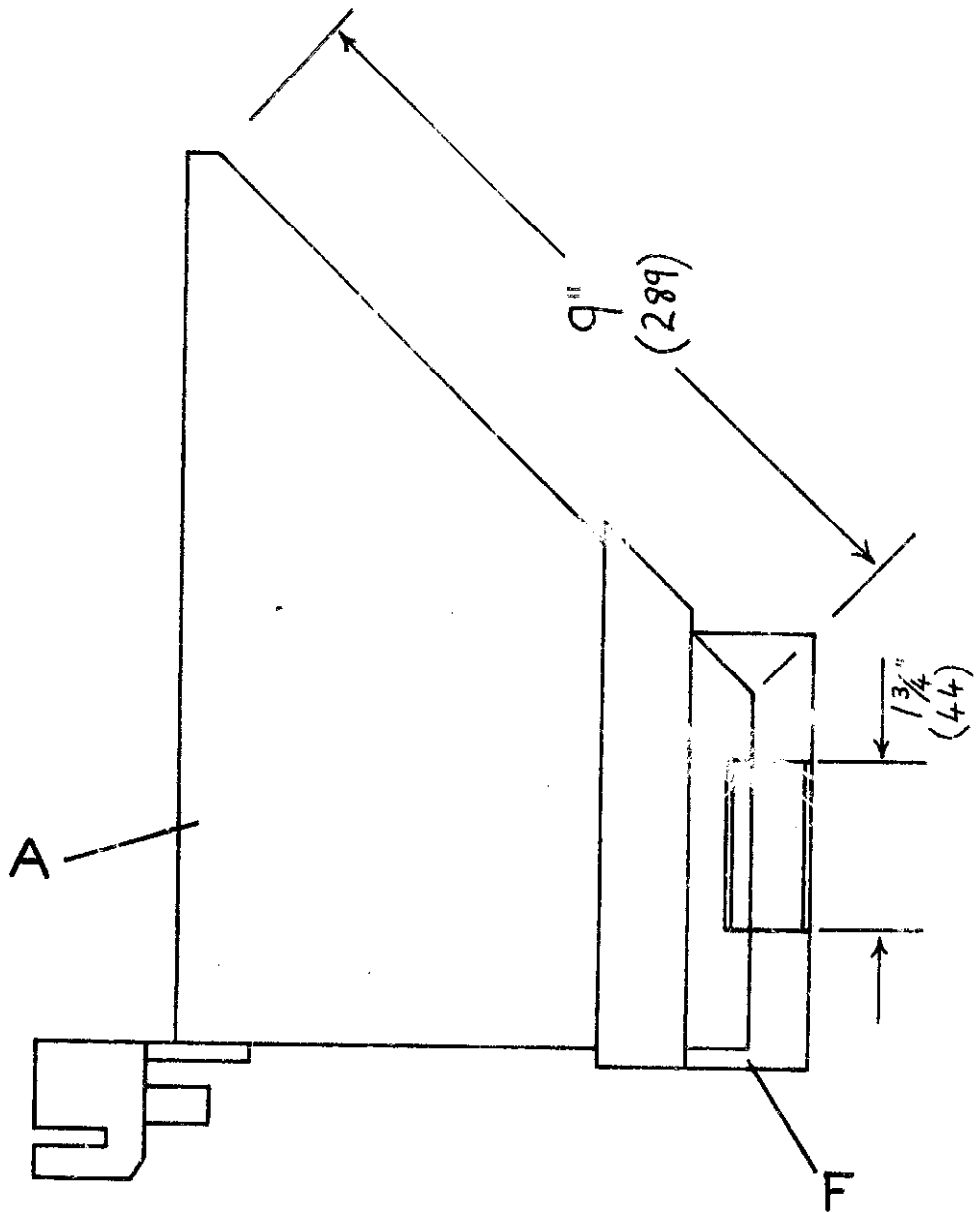
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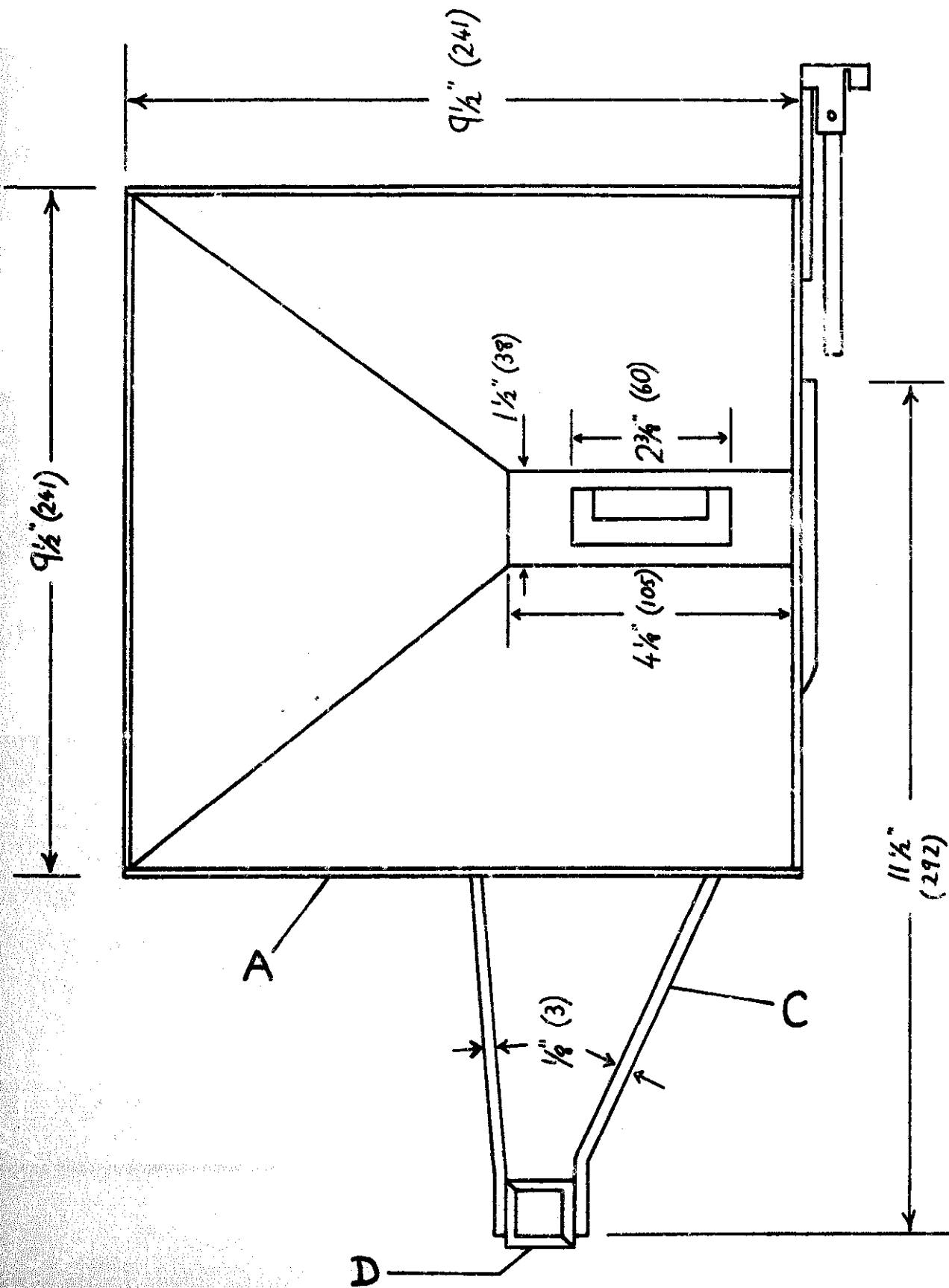
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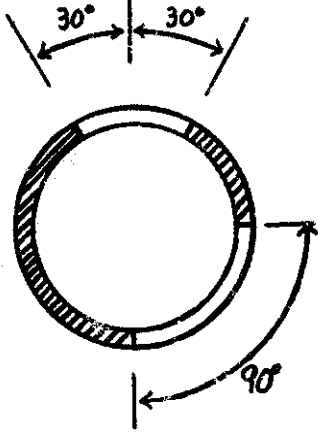
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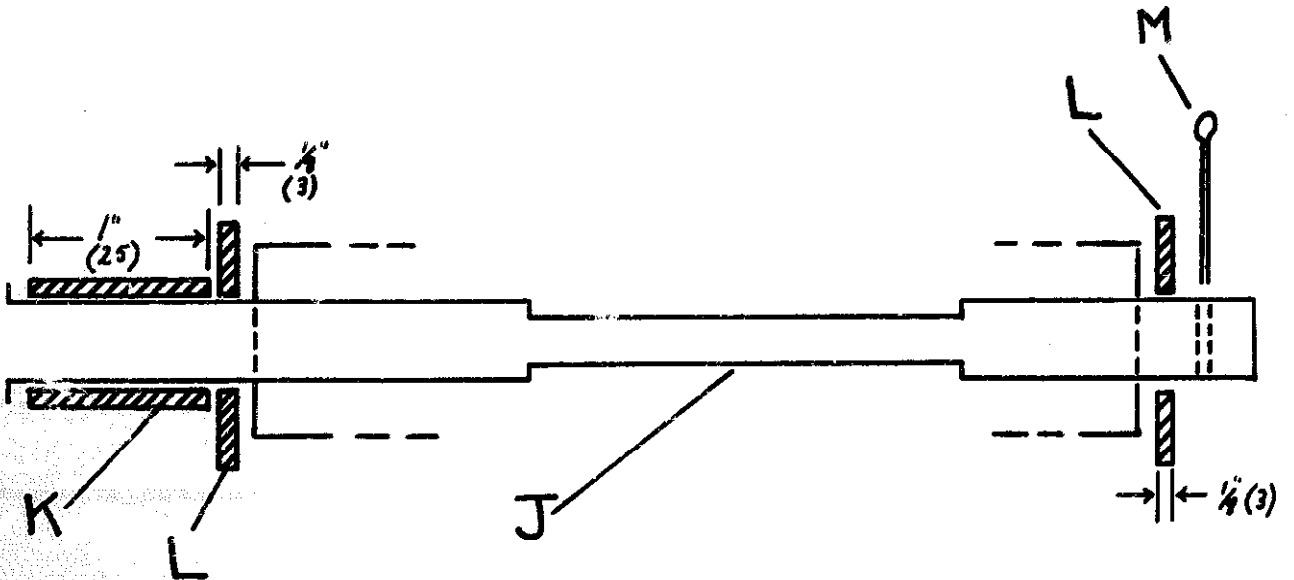
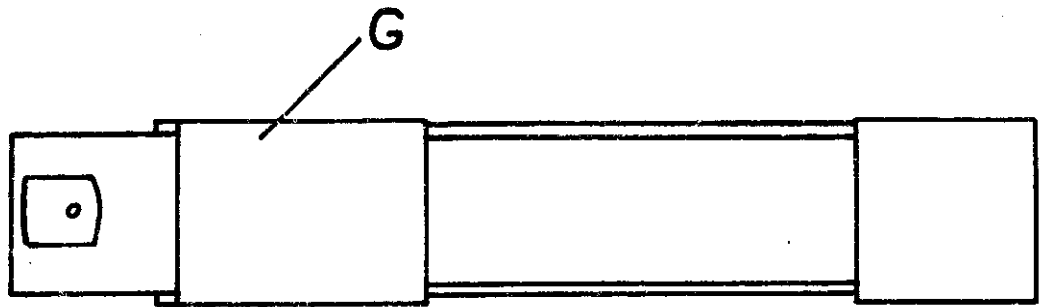
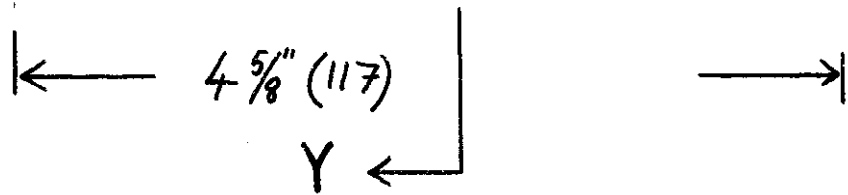
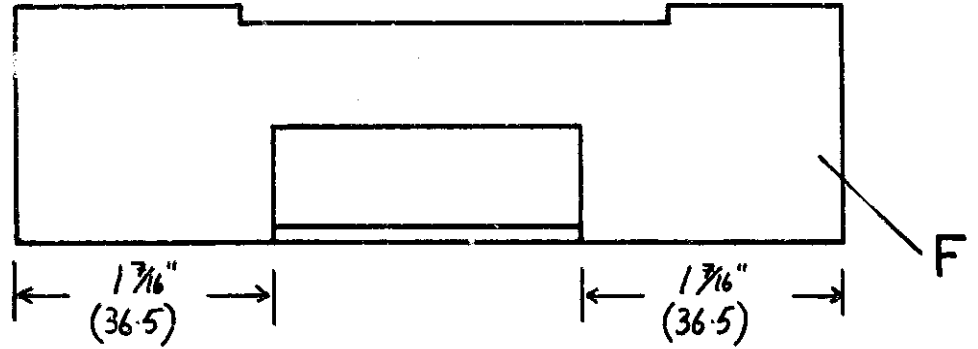
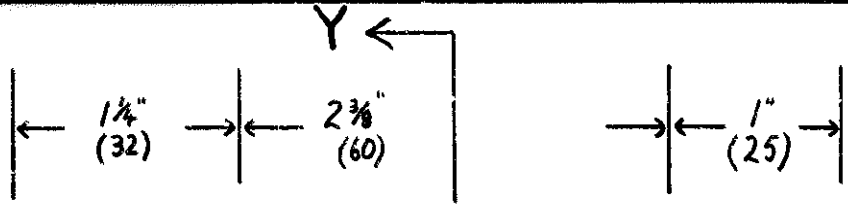
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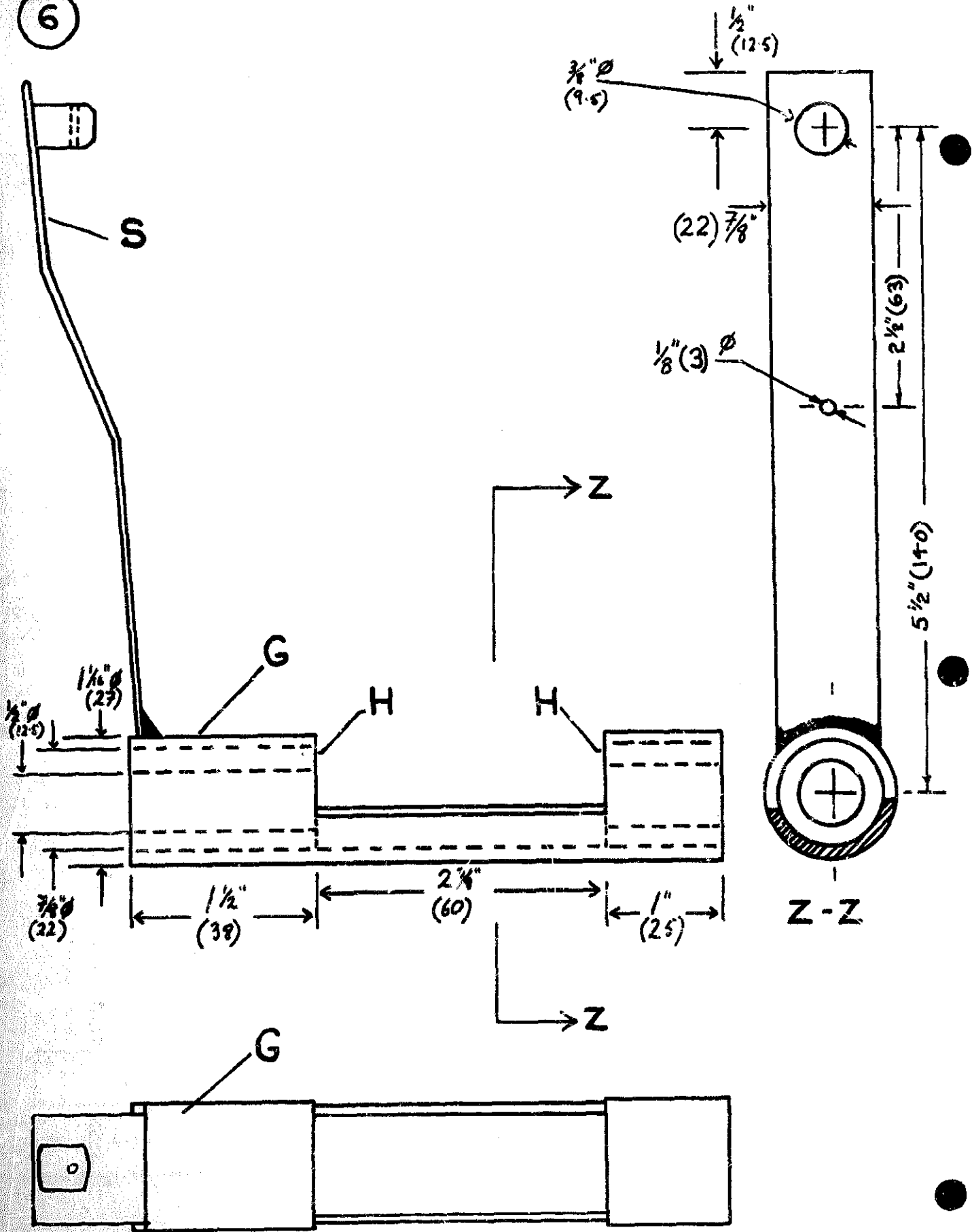
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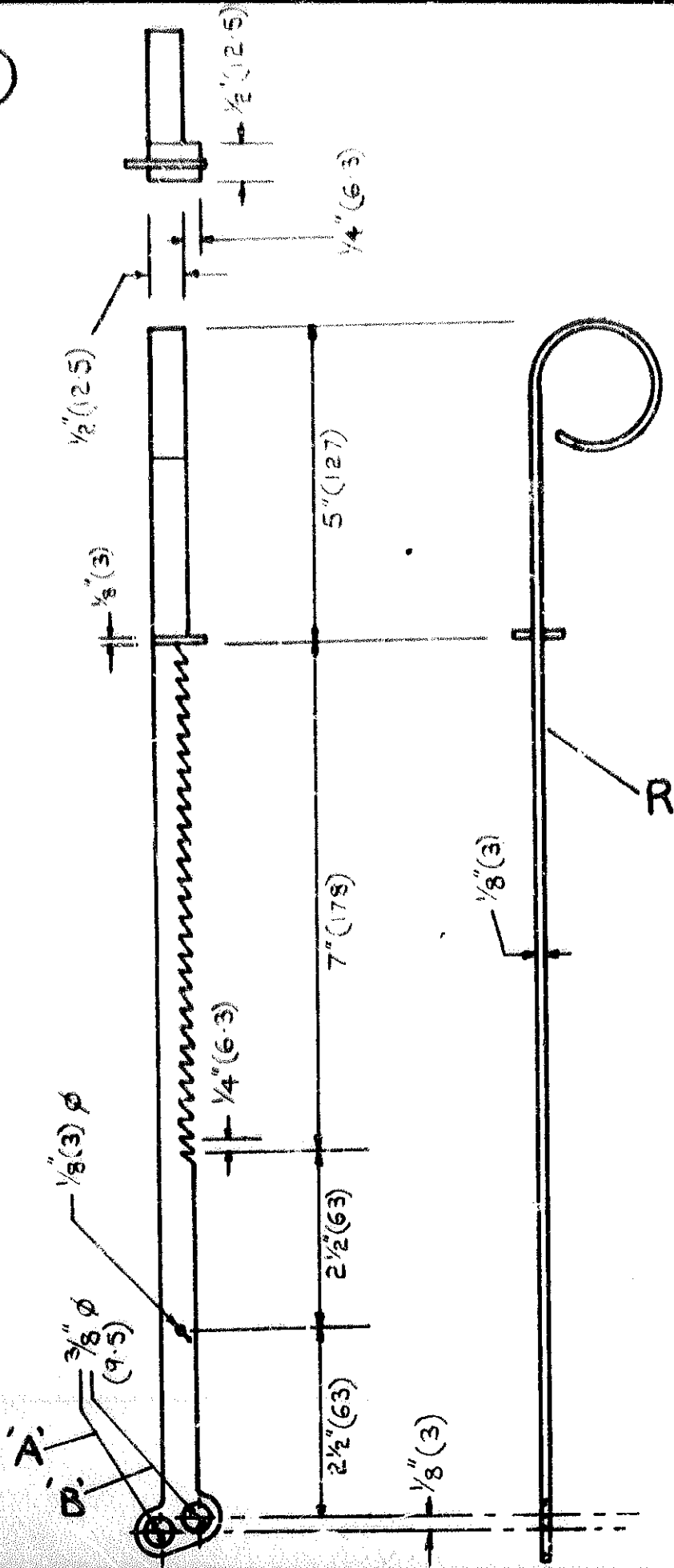
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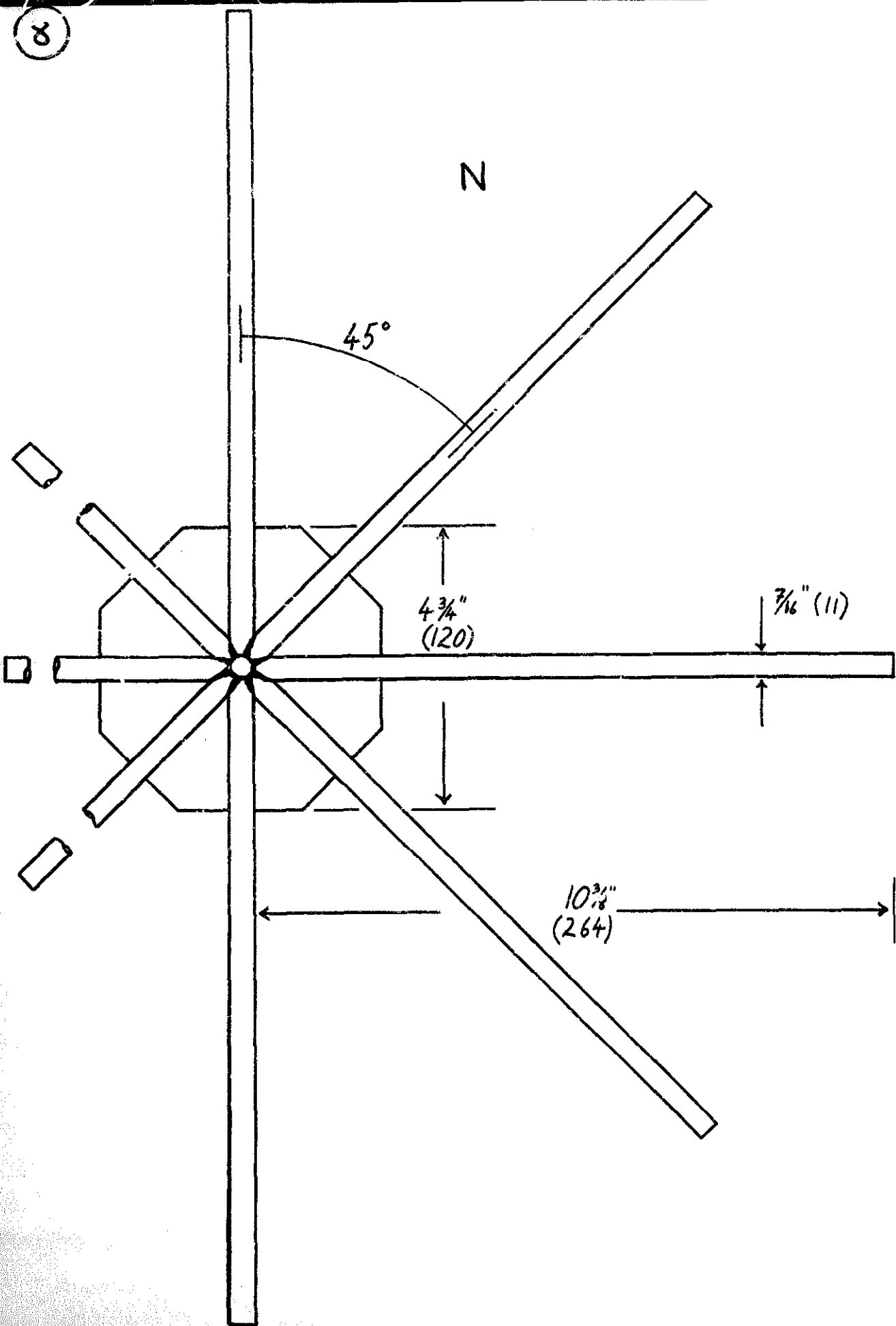
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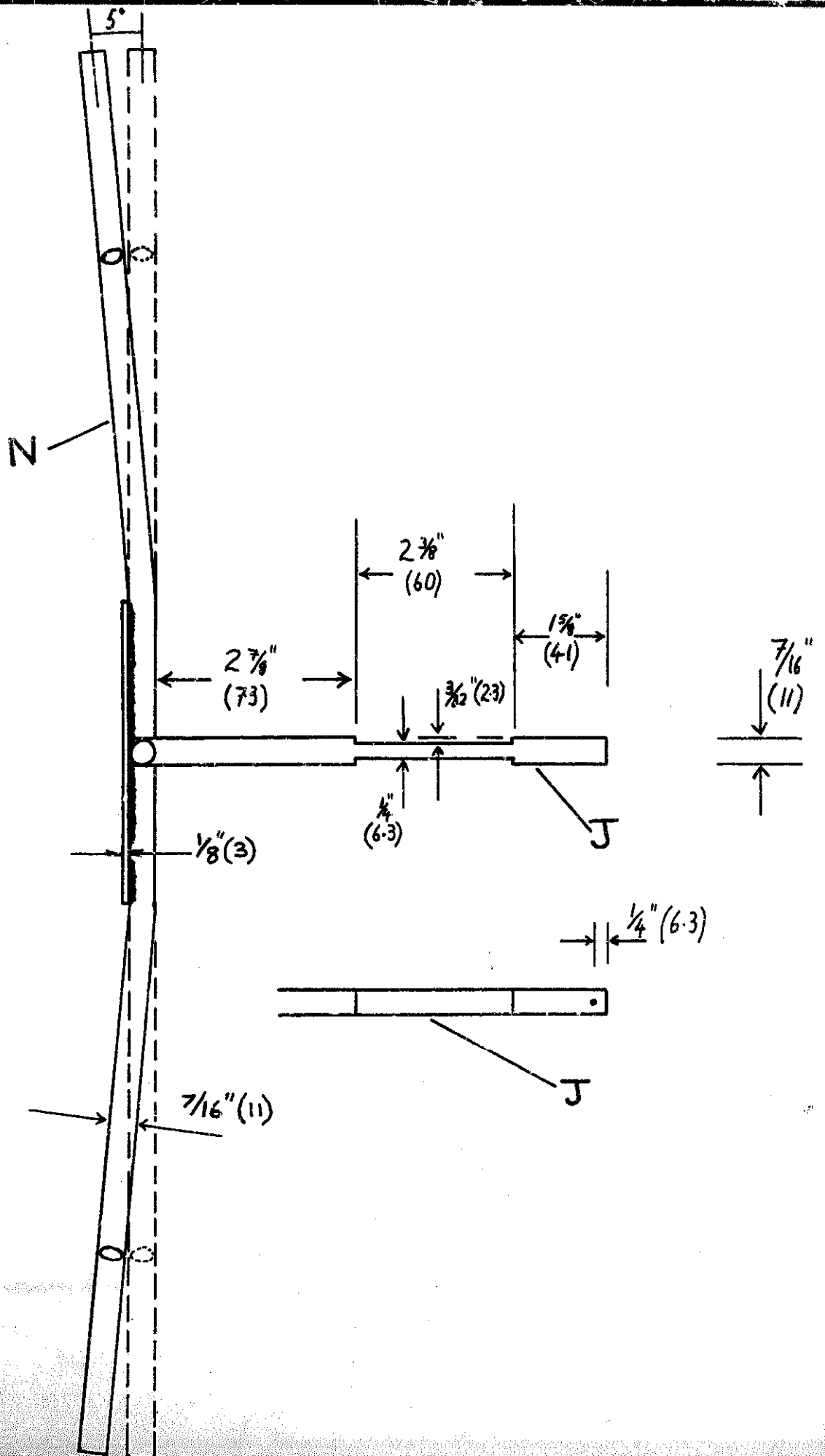
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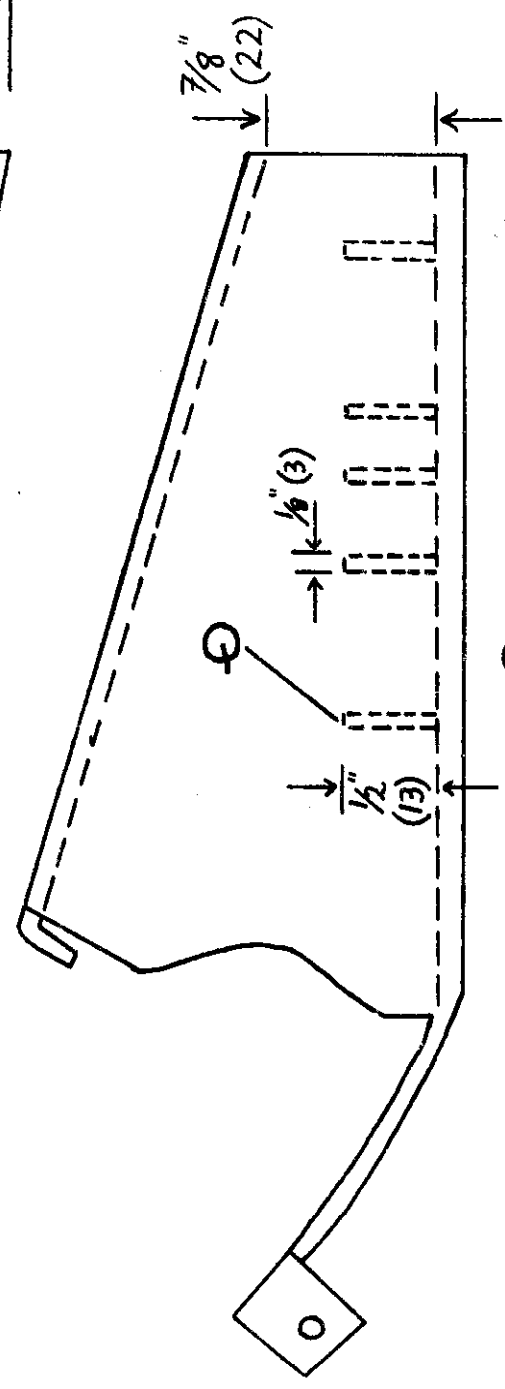
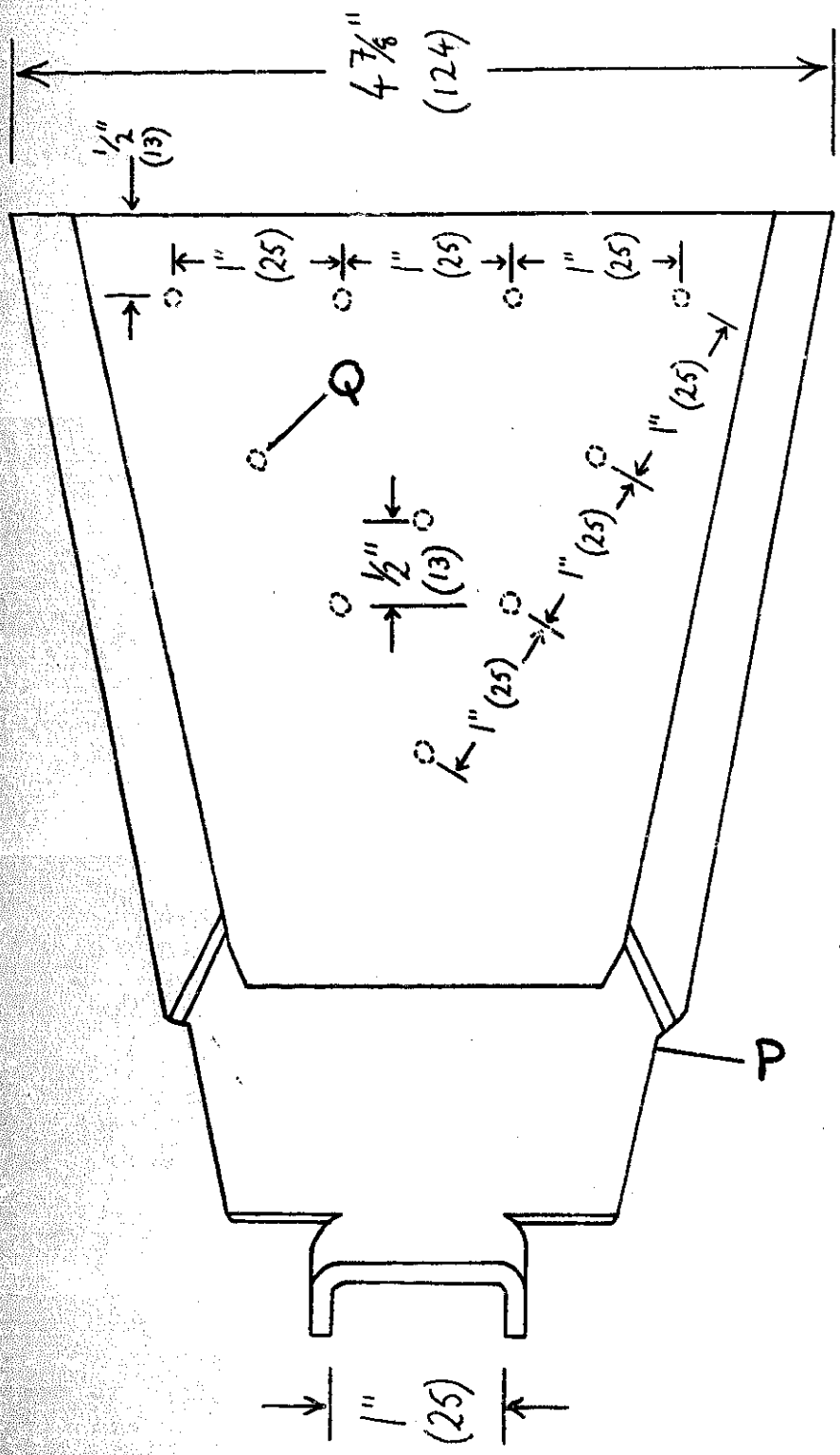
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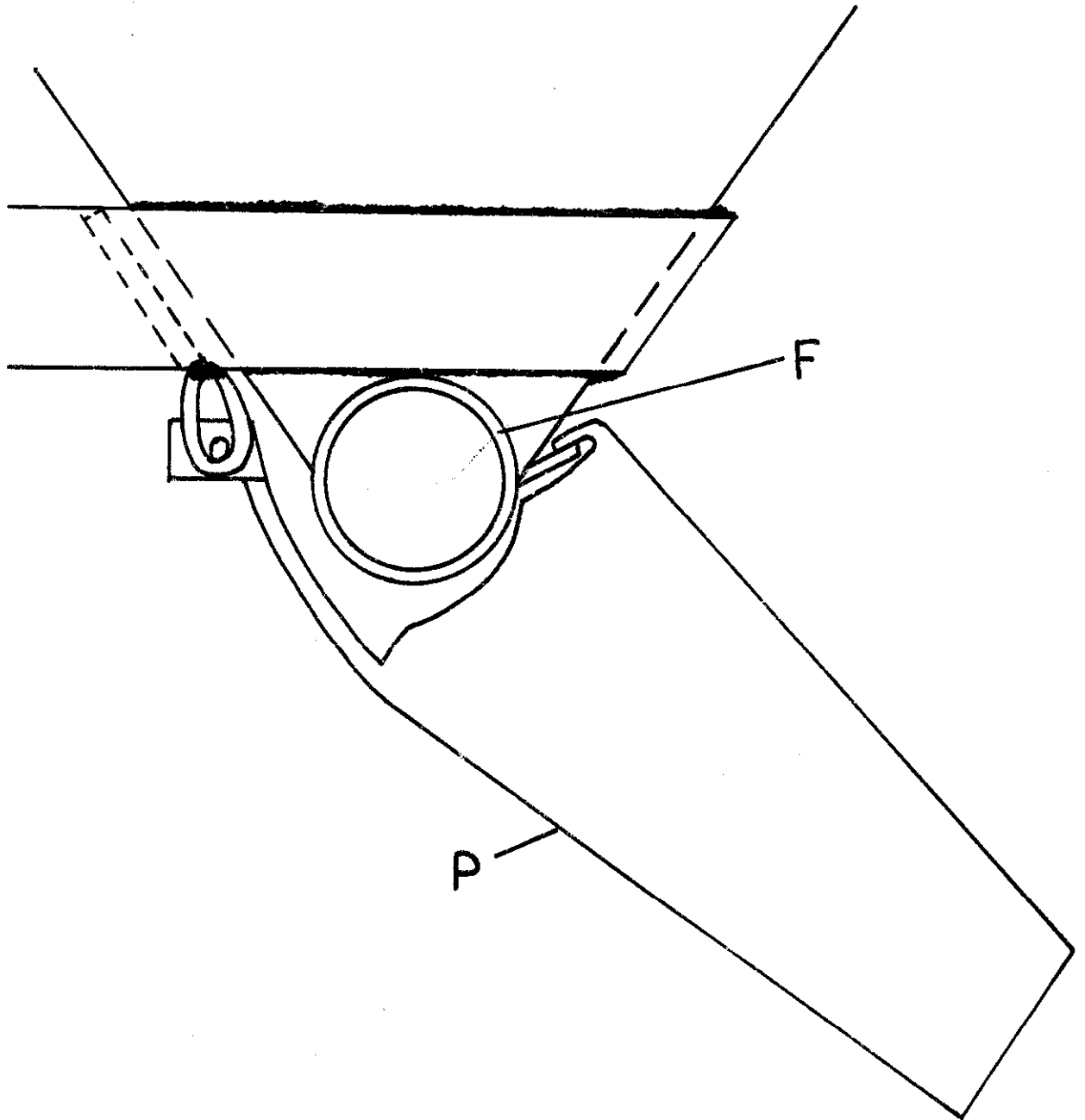
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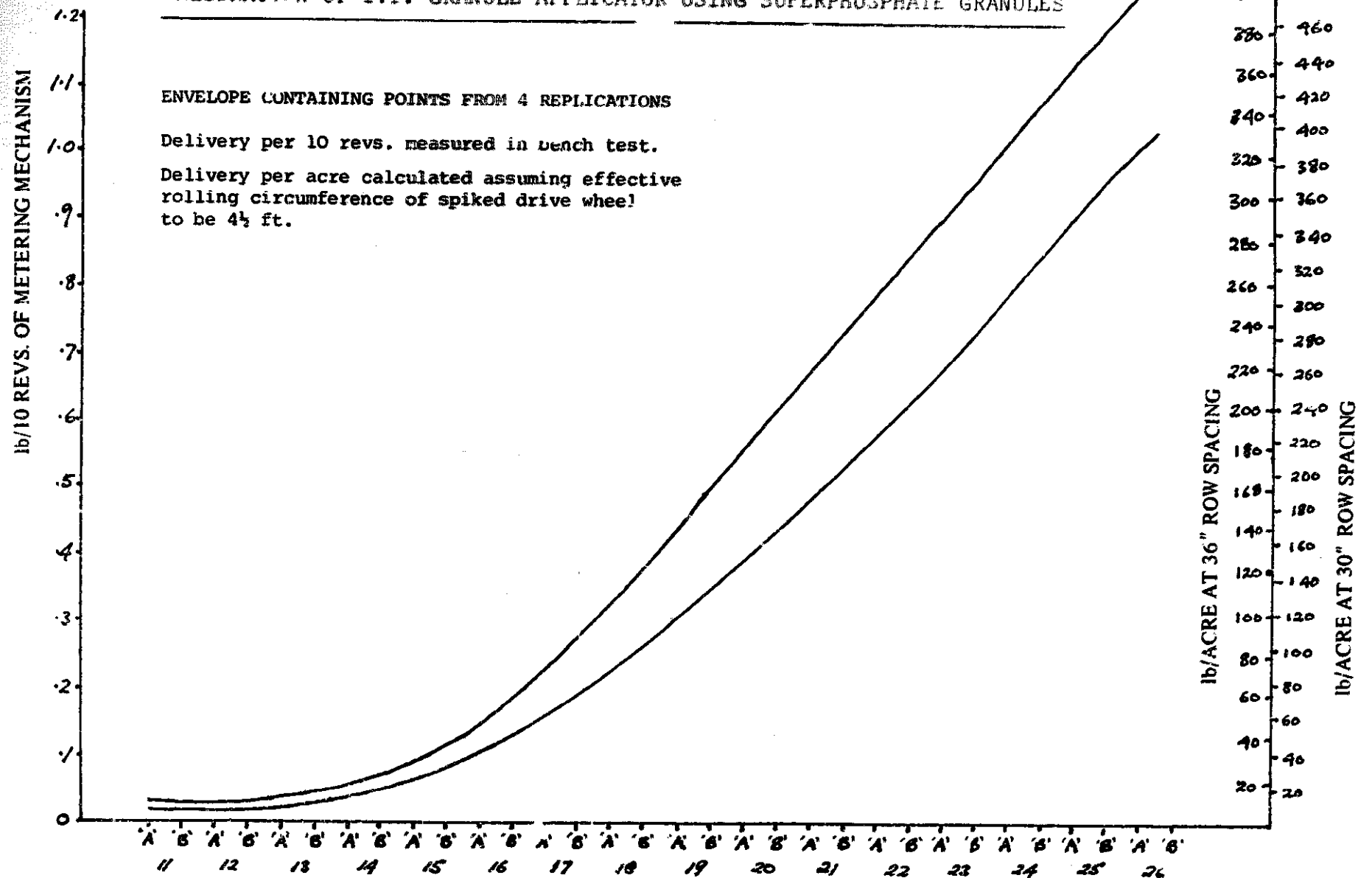
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11



CALIBRATION OF I.T. GRANULE APPLICATOR USING SUPERPHOSPHATE GRANULES



"A" and "B" ARE ALTERNATIVE HOLES IN RATCHET CONTROL LEVER;
 NUMBERS ARE RATCHET LEVER NOTCHES (ZERO = FULLY CLOSED POSITION)

3

1

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A project of Volunteers in Asia

IT Expandable Cultivator

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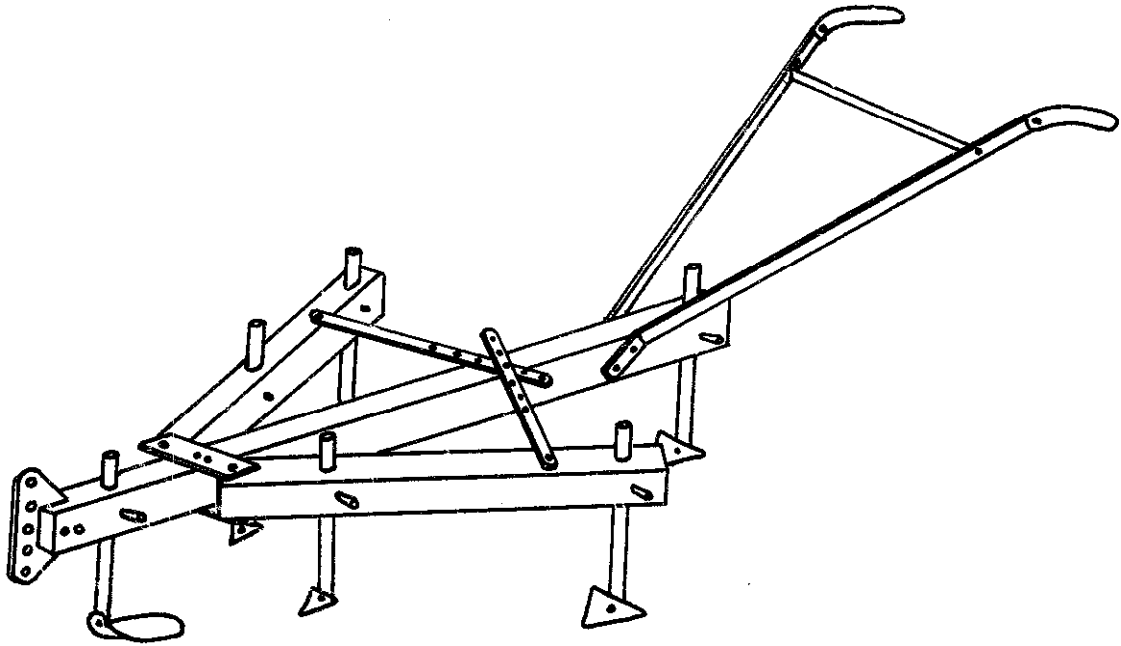
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I.T. EXPANDABLE CULTIVATOR
(DAUDAWA, N.C.S. NIGERIA)

DESIGN: JOHN BOYD

DRAWING: BERNARD WINLO

I.T. EXPANDABLE CULTIVATOR

Developed by : Intermediate Technology Project, Daudawa, North Central State, Nigeria

Description :

A lightweight cultivator designed for weeding of crops planted in 70-90 cm spaced rows in sandy soils, to be pulled by one or two oxen or donkeys.

Tines are individually adjustable for depth, making the implement suitable for flat or ridge cultivation. Taper pins engage with notches in the tool standards and are hammered into the wooden beams to lock the tines at the required depth.

The cultivator is suitable for manufacture by village blacksmiths, minimum equipment for manufacture being :

Forge
Anvil
Hammer
Tongs
Punch
Chisel

Orthographic drawings use first angle projection. Dimensions are in mm.

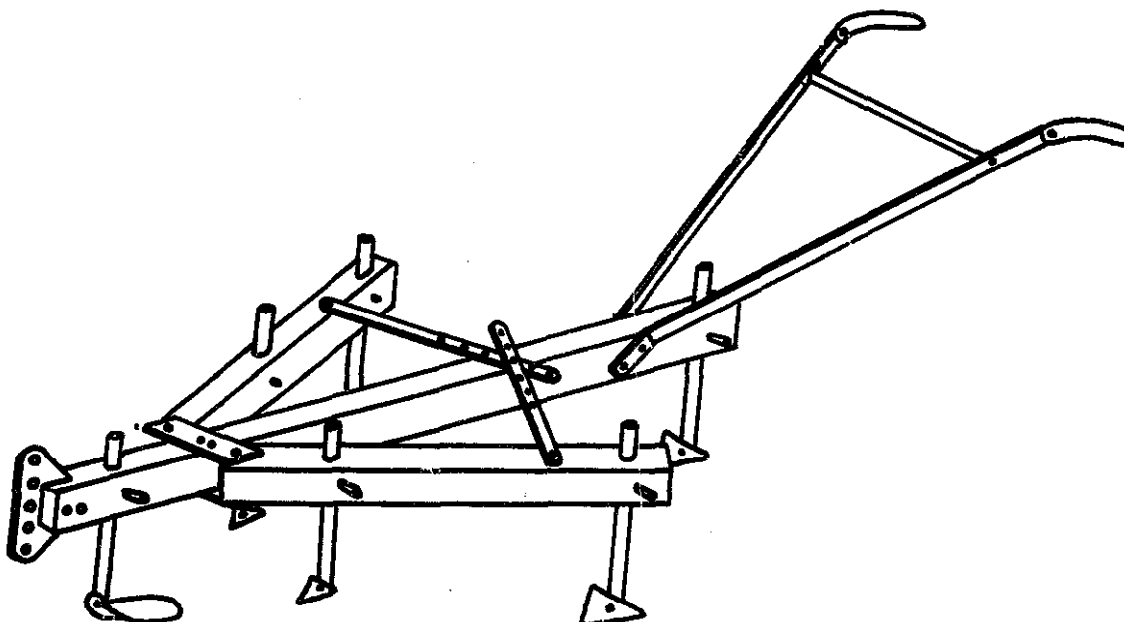
<u>ITEM NAME</u>	<u>QTY</u>	<u>MATERIAL PER ITEM</u>	<u>MANUFACTURING NOTES</u>
A Centre beam	1	1200 x 75 x 50 hardwood	Holes for taper pins drilled or burnt 9 ϕ and burnt out to form using hot taper pin.
B RHS Beam	1	700 x 75 x 50 hardwood	
C LHS Beam	1	700 x 75 x 50 hardwood	
D Hake plate	1	10 mm M.S. plate	Holes drilled or punched.
E Pivot plate	2	155 x 40 x 10 M.S.	
F Pivot bush	2	75 mm length pipe	O.D. press-fit in 20 ϕ holes in B and C. I.D. turns on 15 ϕ bolt.
G Adjustor	2	270 x 20 x 6 M.S.	
H Adjustor pin	1	150 x 10 ϕ M.S.	
J Handle	2	1000 x 30 x 10 M.S.	
K Handle tie bar	1	500 x 20 x 6 M.S.	
L Handle grip	2	200 x 25 bore water pipe	

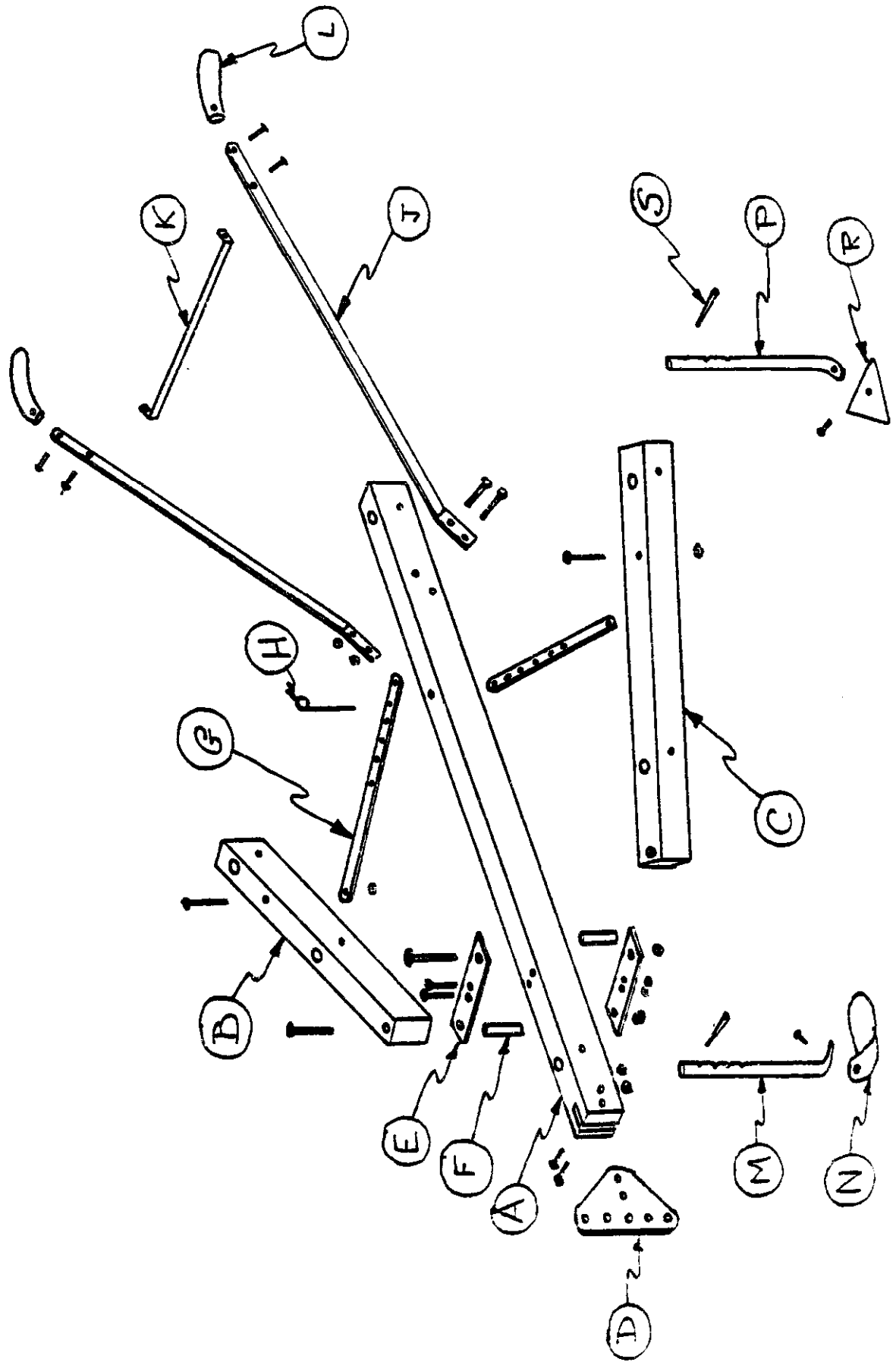
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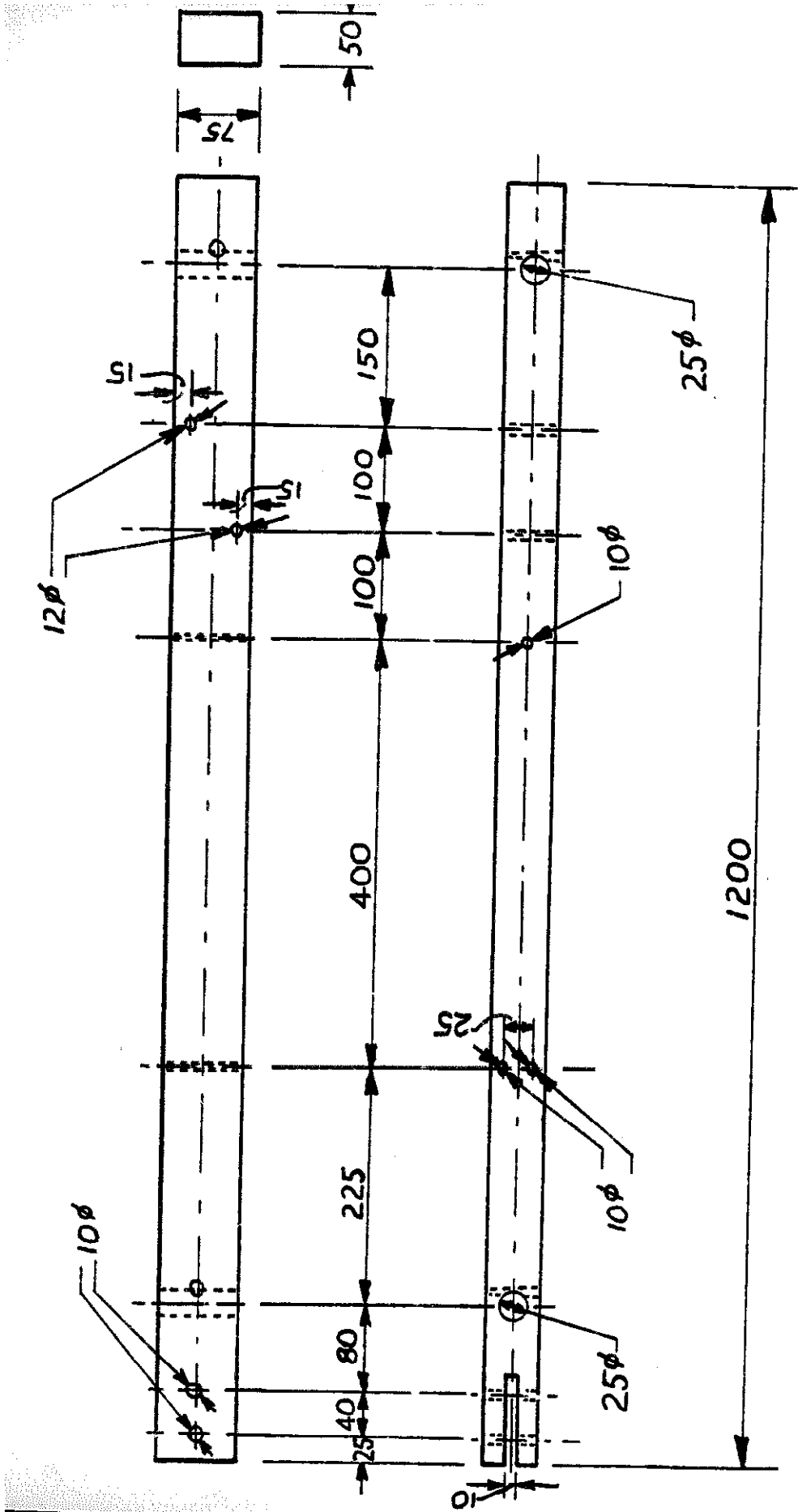
<u>ITEM</u>	<u>NAME</u>	<u>QTY</u>	<u>MATERIAL PER ITEM</u>	<u>MANUFACTURING NOTES</u>
M	Skid standard	1	300 x 25 ϕ M.S.	Notches made with 6 ϕ round file.
N	Skid	1	200 x 40 x 10 M.S.	
P	Tool standard	5	300 x 25 ϕ M.S.	
Q	Narrow tine	2	6 mm lorry spring leaf	Fitted to front tool standards.
R	Sweep tine	3	ditto.	Fitted to rear tool standards.
S	Taper pin	6	90 x 12 ϕ M.S.	Forged to taper.

Nuts and bolts on which side beams and adjustors pivot should be done up hand tight and the ends of the bolts peened over the nuts.

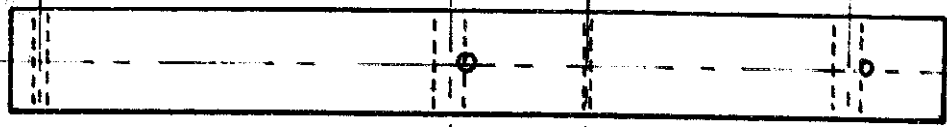
Rivets may be used instead of bolts.



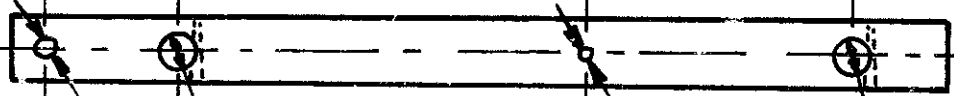
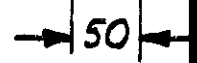




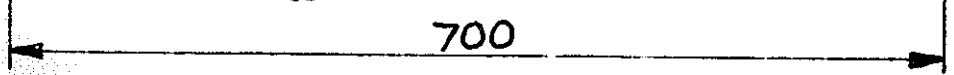
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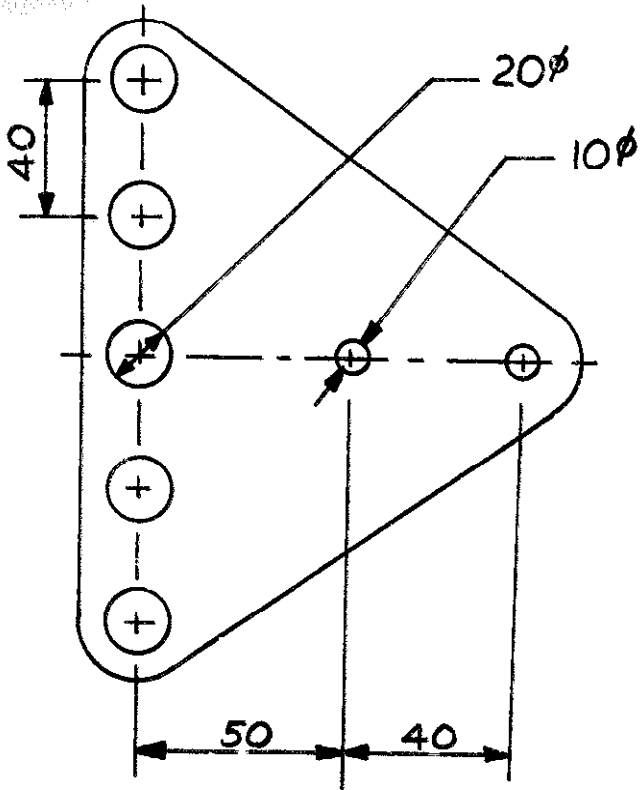


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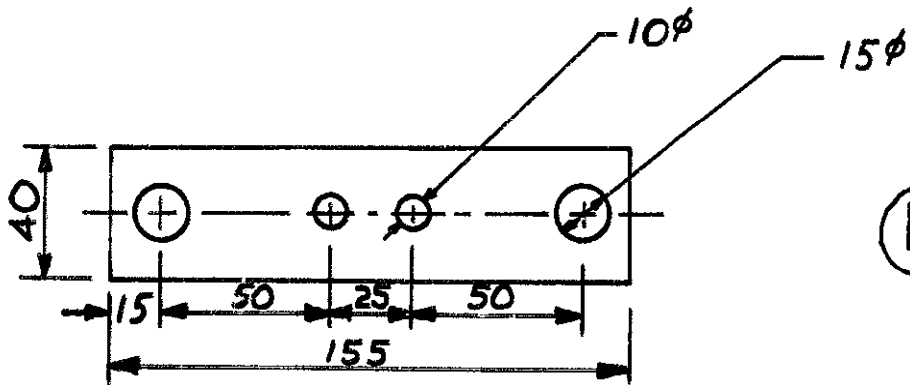


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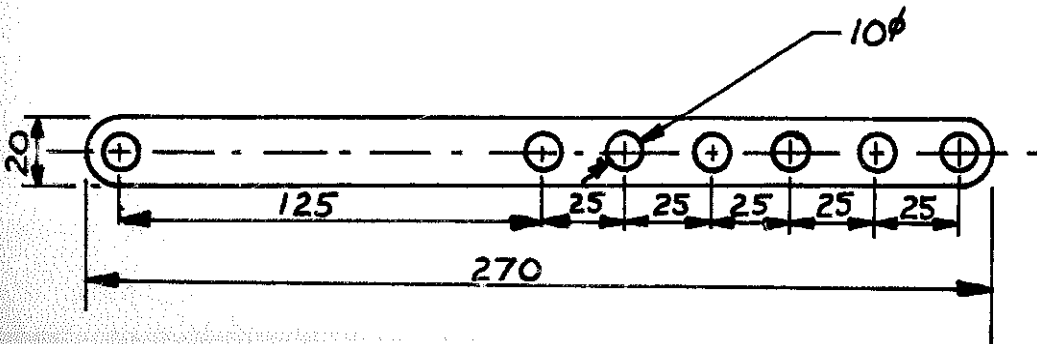




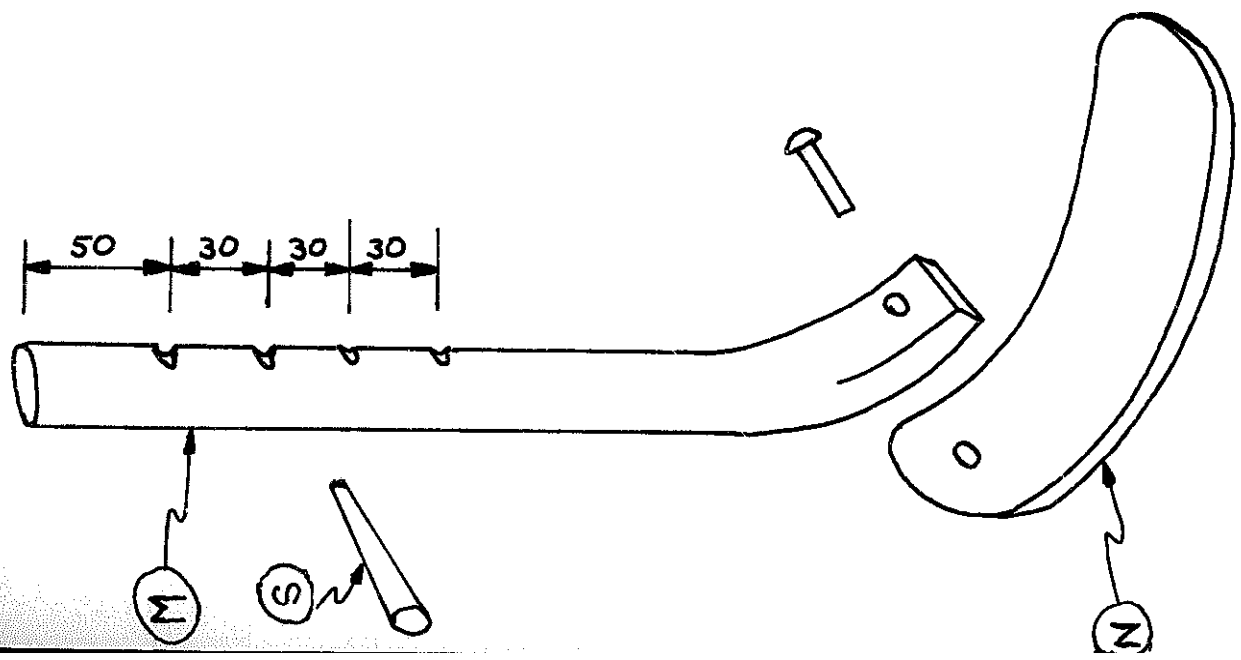
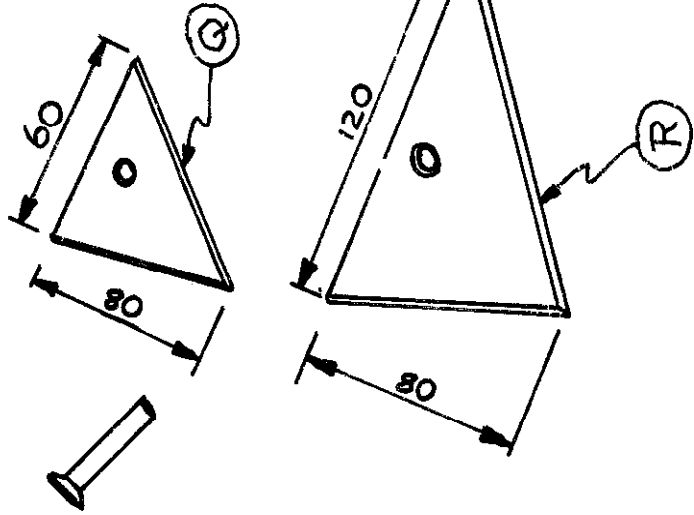
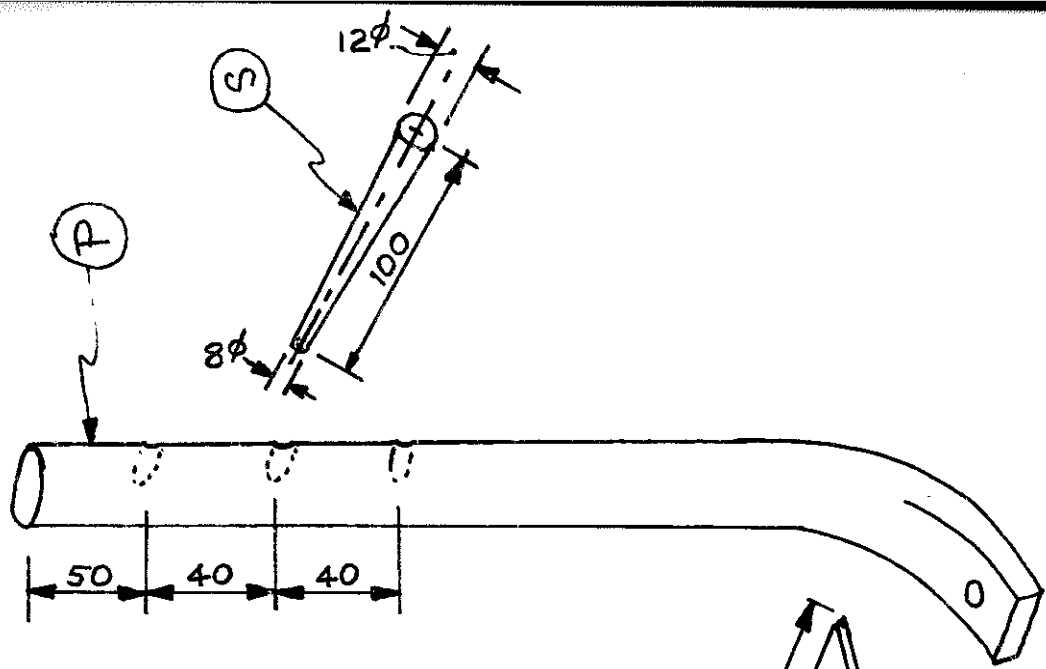
(D)



(E)



(G)



32

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Seed Dressing Drum (Hand-Operated)

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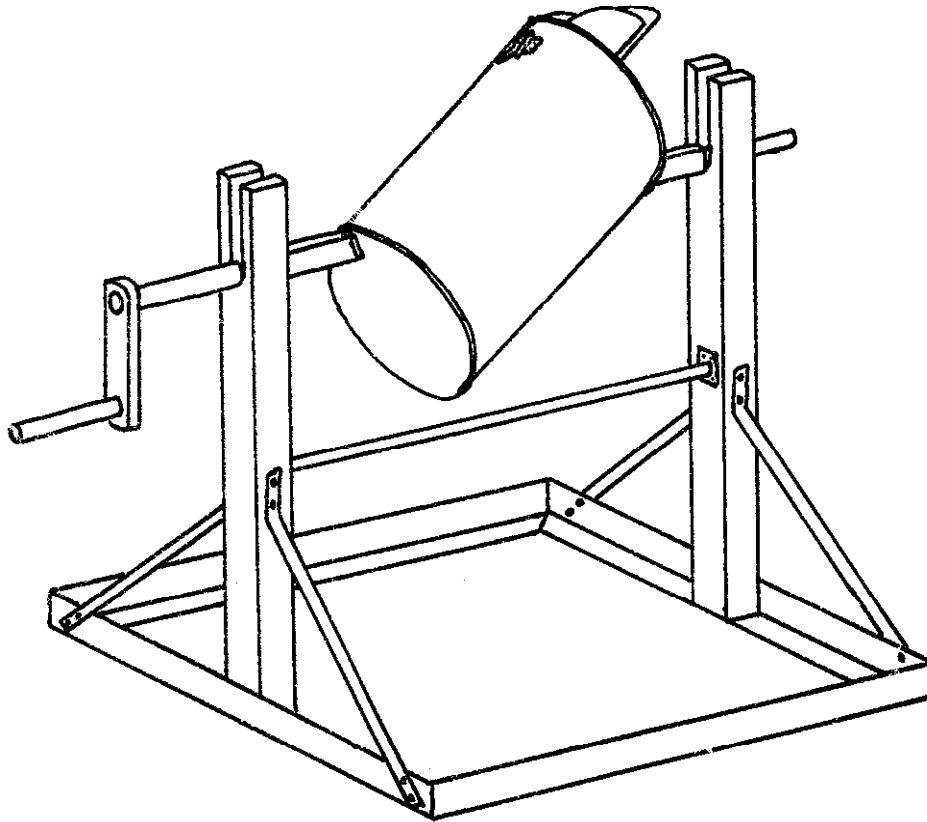
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HAND-OPERATED SEED DRESSING DRUM

(CHITEDZE, MALAWI)

DESIGN: JOHN BOYD

DRAWING: BERNARD WINLO

HAND-OPERATED SEED DRESSING DRUM

Developed by : G. D. Horspool, Chitedze Agricultural Research Station, Malawi.

Introduction :

The object was to build a seed dressing device for village use, the design to be of fairly simple construction so that it could be made by local craftsmen.

The test drum used was an ordinary water tin of approximately 13" (330) diameter and 15" (382) in height.

It was found that this drum had a capacity of 30 lb. (13.6 kg) of Chalimbana groundnuts, 35 (15.9 kg) of soya beans or maize, and 38 lb. (17.2 kg) of fertiliser when filled correctly. In a durability test, a total of 1½ tons of fertiliser was mixed without signs of damage. The drum was also used for seed-dressing of groundnuts and maize with satisfactory coverage performance and no apparent adverse effect on germination.

Description :

With reference to the attached drawings, dimensions are given in inches with millimetre equivalents in brackets.

The handle A is free to revolve on a ¾" (10) diameter bolt which is fitted to the crank arm B. A bolt of ¼" (6) diameter is used to secure the crank arm to the horizontal beam C. The handle, crank and beam are all made of wood, the rectangular part of the beam being 30" (562) in length. The beam ends are supported by timber poles D at a height of 42" (767) from ground level.

Where an open-top container is used, the drum top E should be cut to a diameter of 1" - 1½" (25-38) larger than that of the drum F to allow for bending over (as indicated by the dash line G) and soldering to the sides.

The drum top E, lid H and lid side plates J are made from sheet metal of about 0.5 millimetre thickness.

Cuts are made in the bottom and top of the drum as indicated by Ka, the sheet metal bent up as shown in Kb and tacked to the horizontal beam at Kc.

The outer edge L of the lid is bent down along the line M, and the lid rear pieces N are folded round to form the hinges P. A wooden block Q is nailed inside the lid to provide additional strength, and a sealing strip of foam rubber fitted at R.

The lid side plates are bent outwards along the line S to hold the lid in position when open for filling.

The body of the over-centre latch T is made from 1/16" (2) steel sheet, the latch plate U being riveted or soldered to the drum side. The catch V and lid loop W are of 1/8" (3) diameter steel wire, and the lid loop strap X is made from a piece of rubber tyre inner tube 7" (178) in length.

To ensure that the lid moves freely, it is advisable to fit the lid and hinges before the lid sides and sealing strips are attached.

Apart from the lid aperture, which should not be less than 6" (152) square, the dimensions are flexible depending on the size of drum chosen.

The operating procedure is as follows :

- a) Seed and dressing are poured into the drum as shown in Fig. 1. It is important not to overfill the drum.
- b) The drum is rotated 20 to 40 times as found necessary, Fig. 2.
- c) The position for emptying the drum is given in Fig. 3.

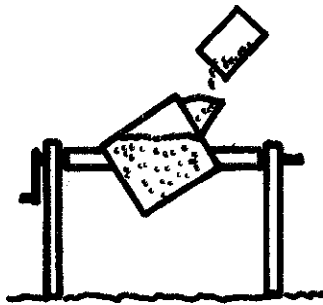


FIG. 1.

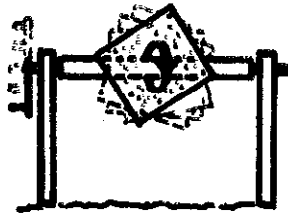


FIG. 2.

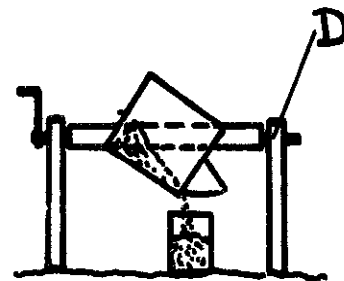
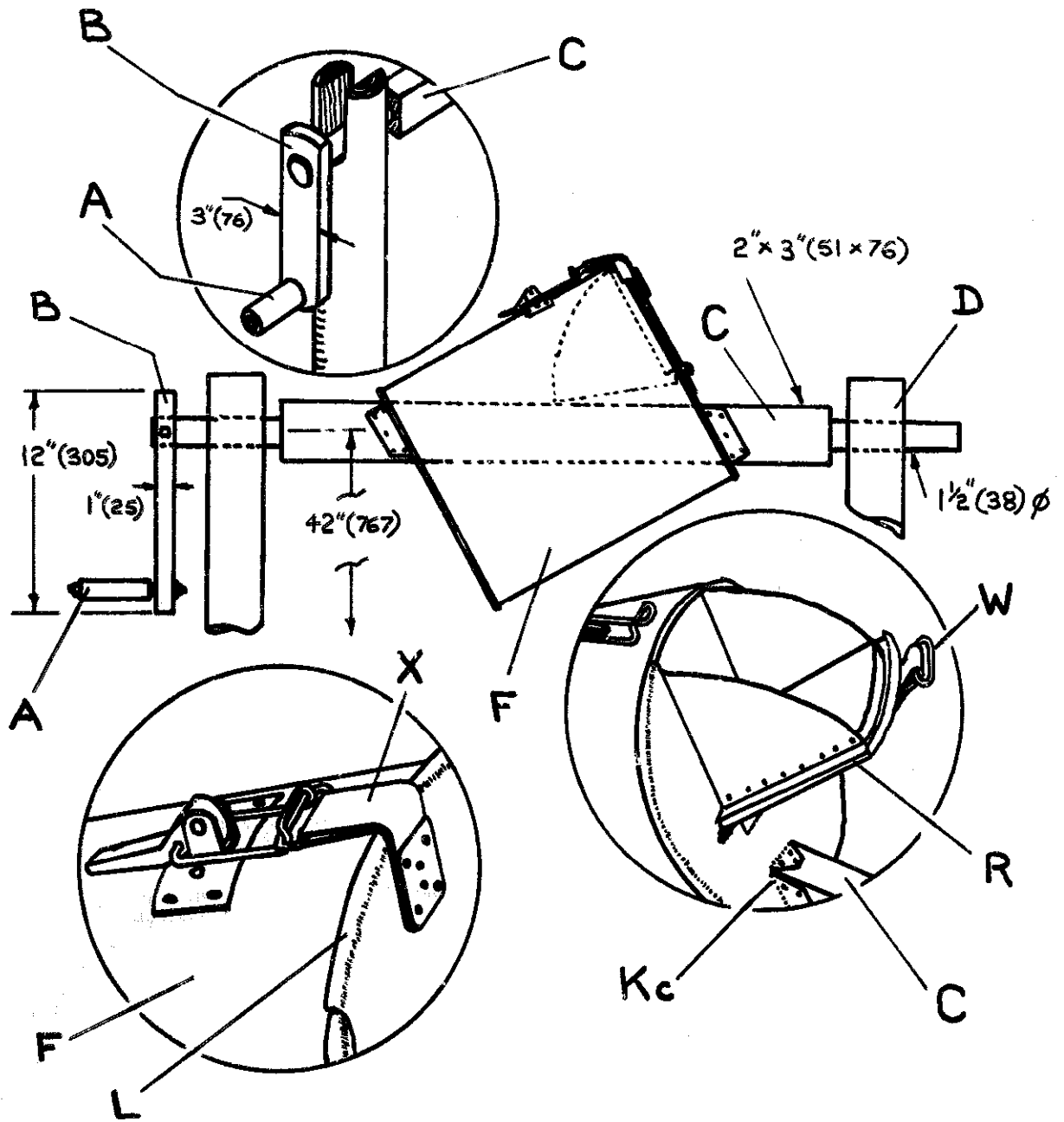
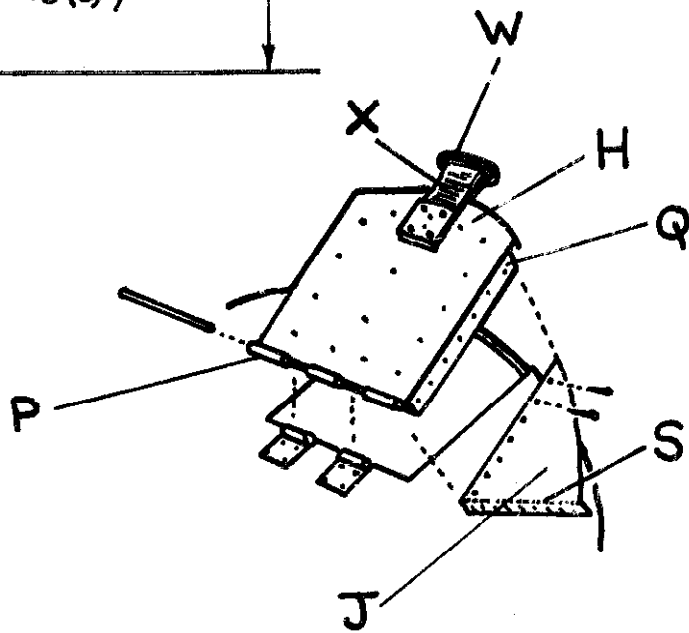
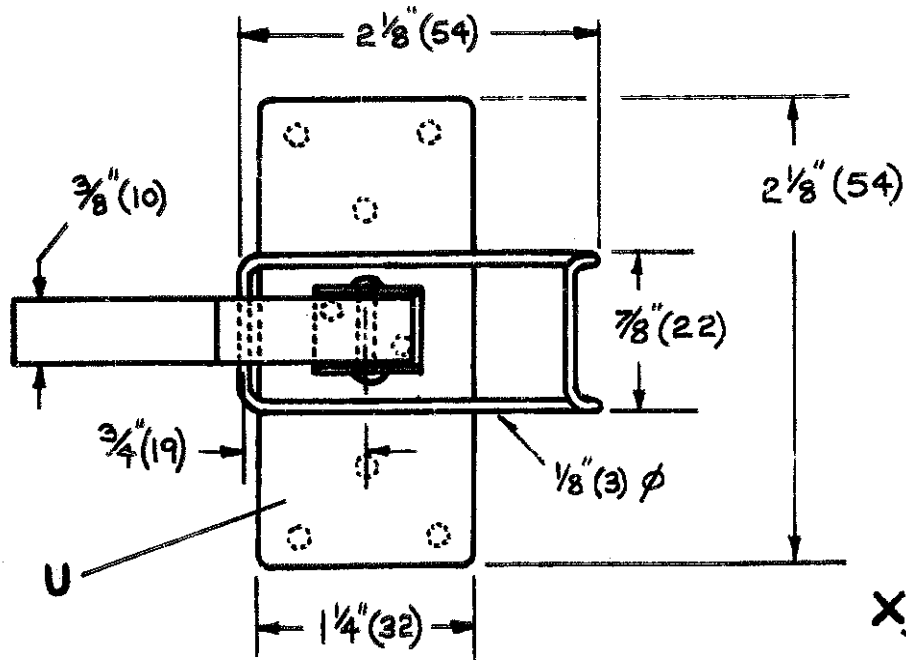
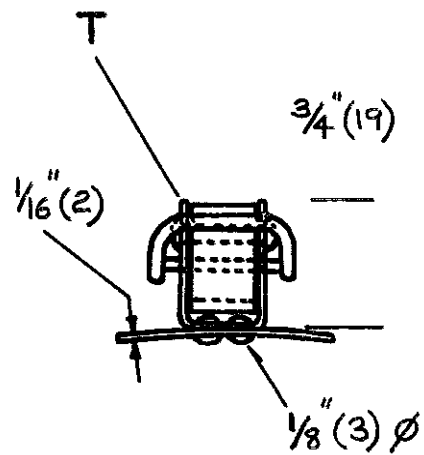
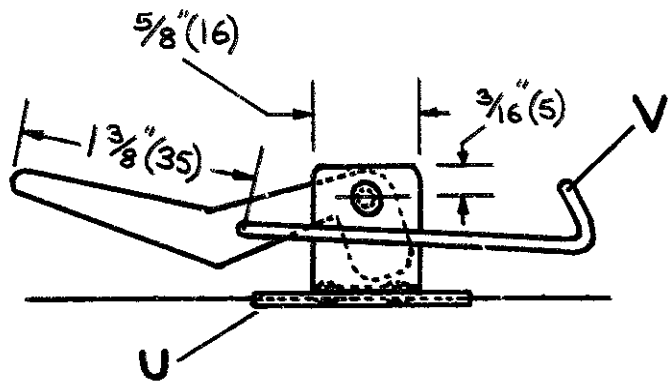
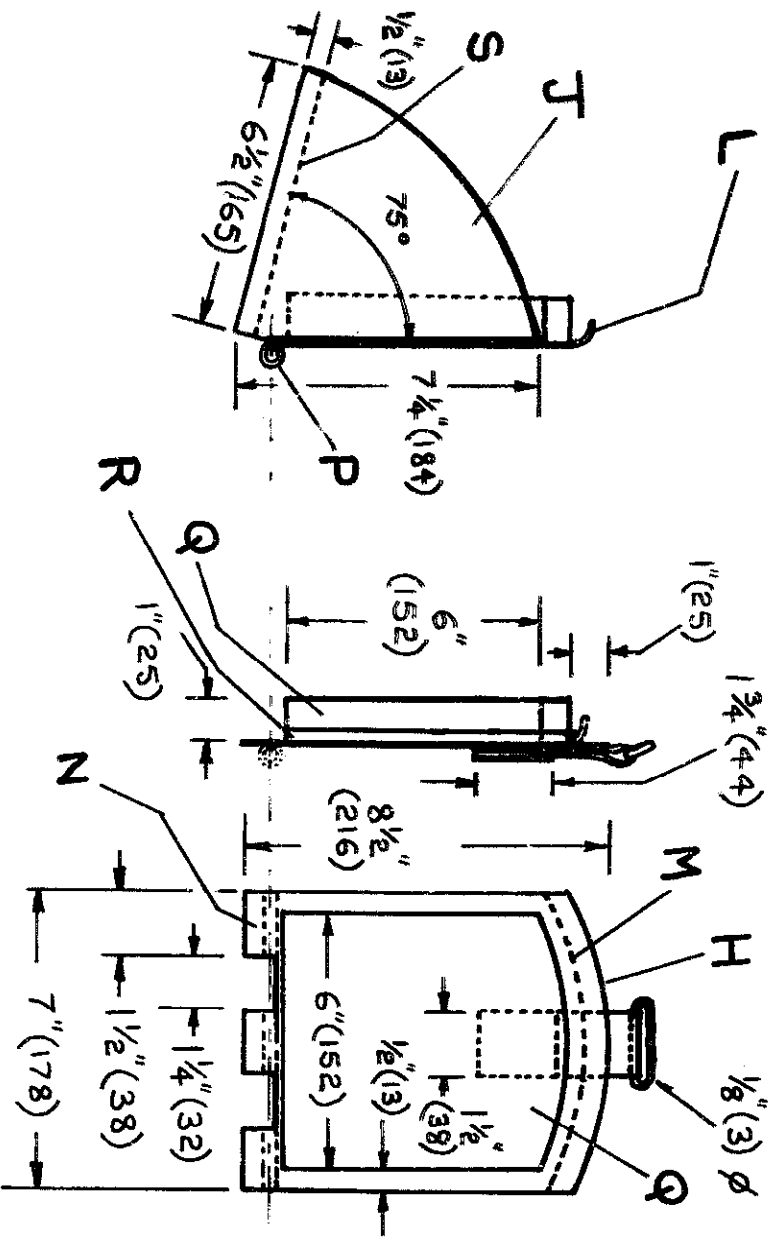
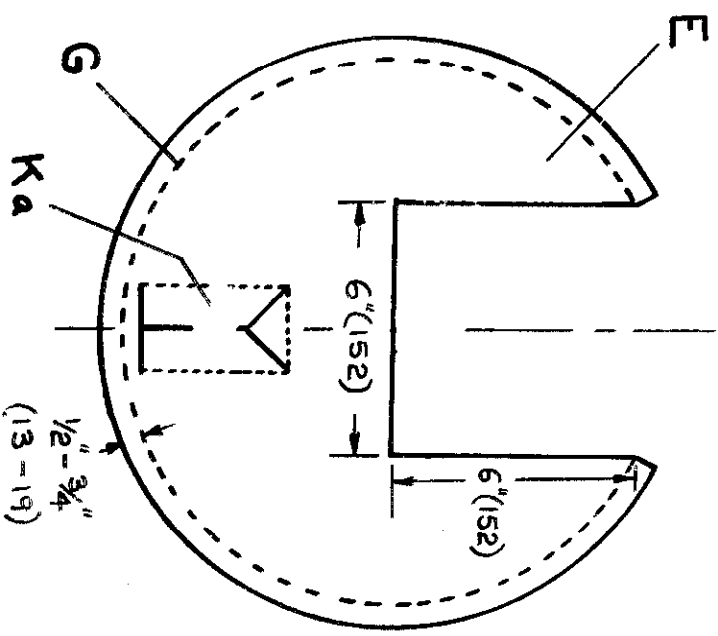
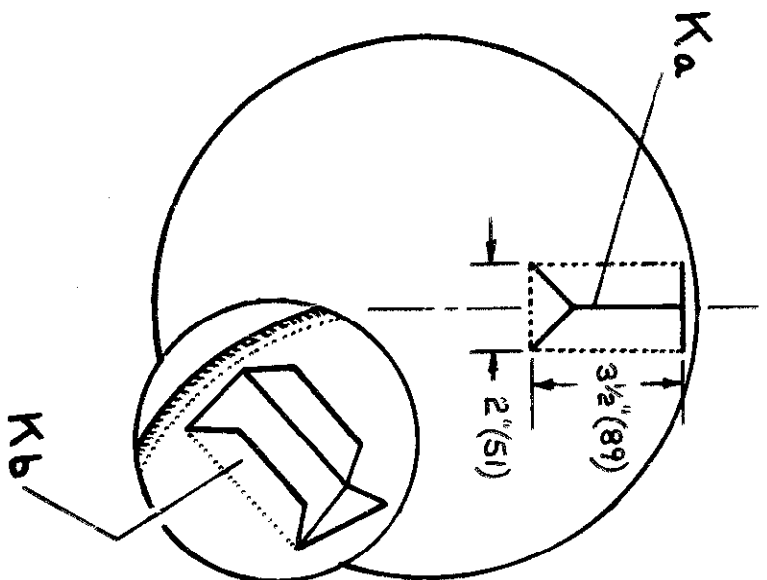


FIG. 3.







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IT High-Clearance Rotary Hoe
ITDG Agricultural Equipment and Tools No. 33

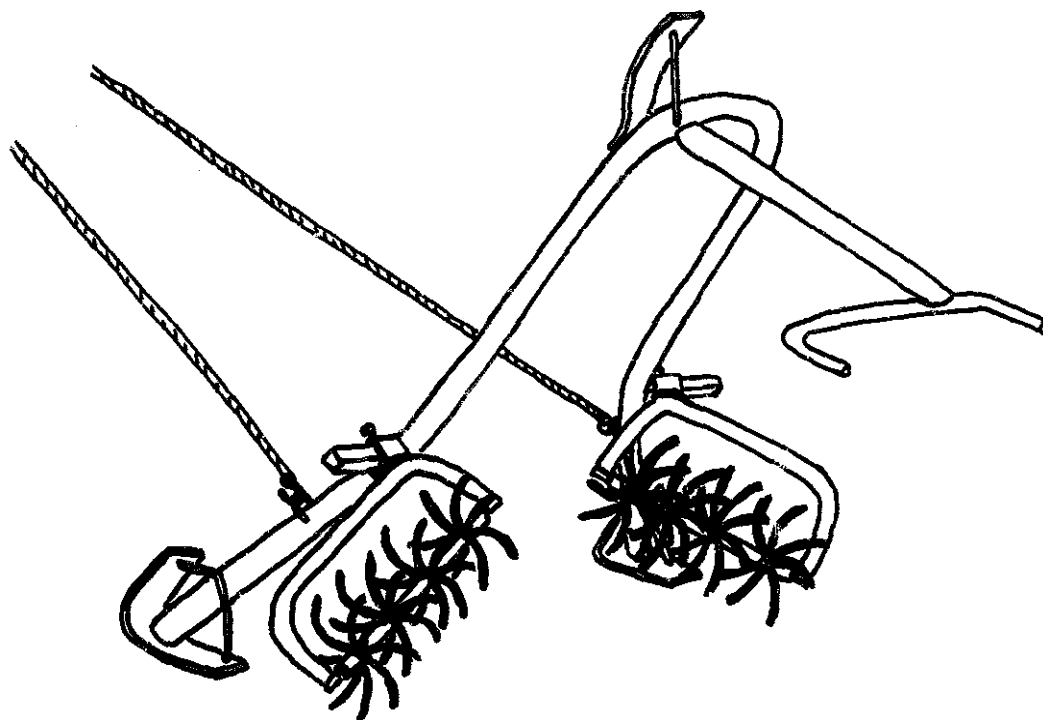
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I.T. HIGH-CLEARANCE ROTARY HOE
(DAUDAWA, N.C.S. NIGERIA)

DESIGN: JOHN BOYD

DRAWING: BERNARD WINLO

I.T. HIGH-CLEARANCE ROTARY HOE

Developed by : Intermediate Technology Project, Daudawa, North Central State, Nigeria.

Description :

This implement is designed for weeding of crops grown on ridges at 75 - 90 cm spacing. It cultivates both sides of one ridge at a time and therefore, unlike cultivators drawn between the ridges, does not require straight and parallel ridges for efficient weeding.

Cultivation is done by two gangs of four spider wheels, each having ten backward curved tines. The gangs are angled to maintain the profile of the ridge and give a slight "earthing up" effect. The width of the uncultivated portion along the crop row can be adjusted from 5 to 20 cm. The rolling action gives light draught and the implement will ride over stumps or other obstructions in improperly cleared land. The rotary hoe can be used for weeding closer to the crop than sweep cultivators without causing apparent crop damage.

An arch frame is used to give 75 cm clearance over the top of the ridge. The frame is pulled by two ropes, one on each side of the crop. The handles are offset to allow the operator to walk in the furrow. Skids for working and transport positions are provided.

Performance is good provided weeding is carried out early, while the weeds are small. The implement is not suitable for use in very hard soil conditions. It can be used in wet soil and has been used successfully for weeding cotton while water was standing in the furrows.

EXPERIMENTAL ADJUSTABLE ANGLE MODIFICATION FOR I.T. ROTARY HOE

Developed by : Intermediate Technology Project, Daudawa, North Central State, Nigeria.

Description :

This modification was designed to allow the I.T. Rotary Hoe to be used on different ridge profiles.

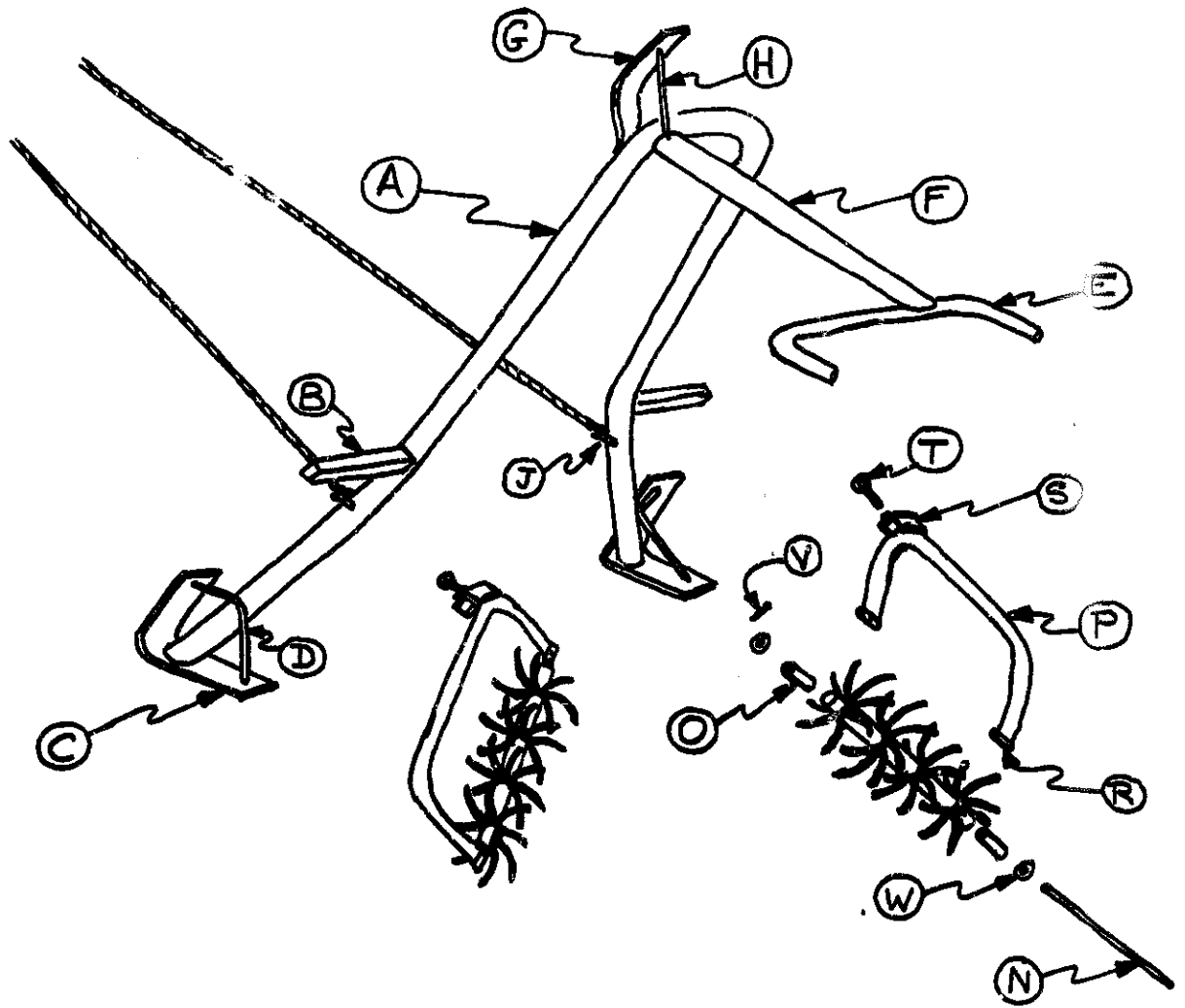
A tube welded onto the U-piece carrying the rotor fits over a round stub Y welded to the clamp and is held in place by a thrust washer and split pin. A plate with a slot is welded to the clamp. A length of angle iron having four holes is welded to the U-piece. Any one of the four holes can be aligned with the slot and a bolt passed through to lock the angle of the U-piece Z.

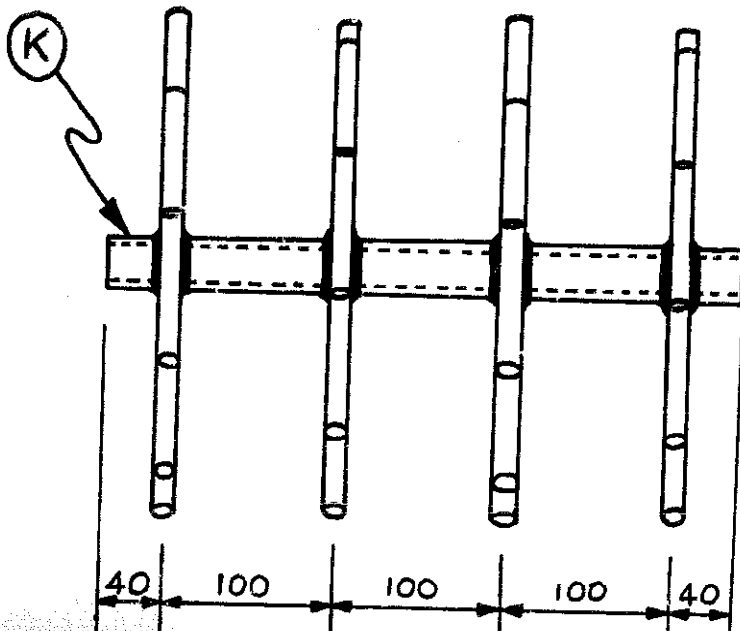
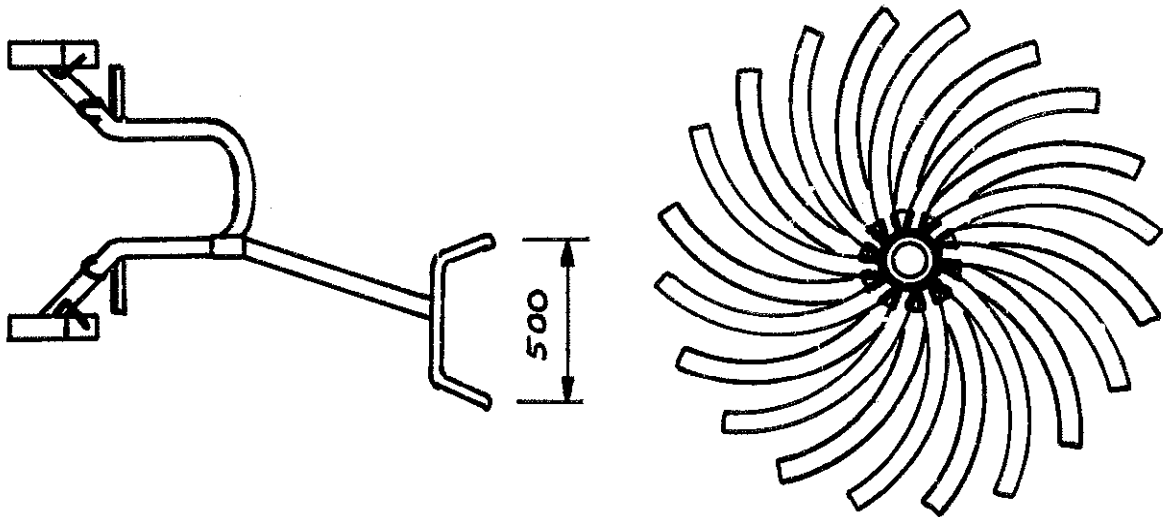
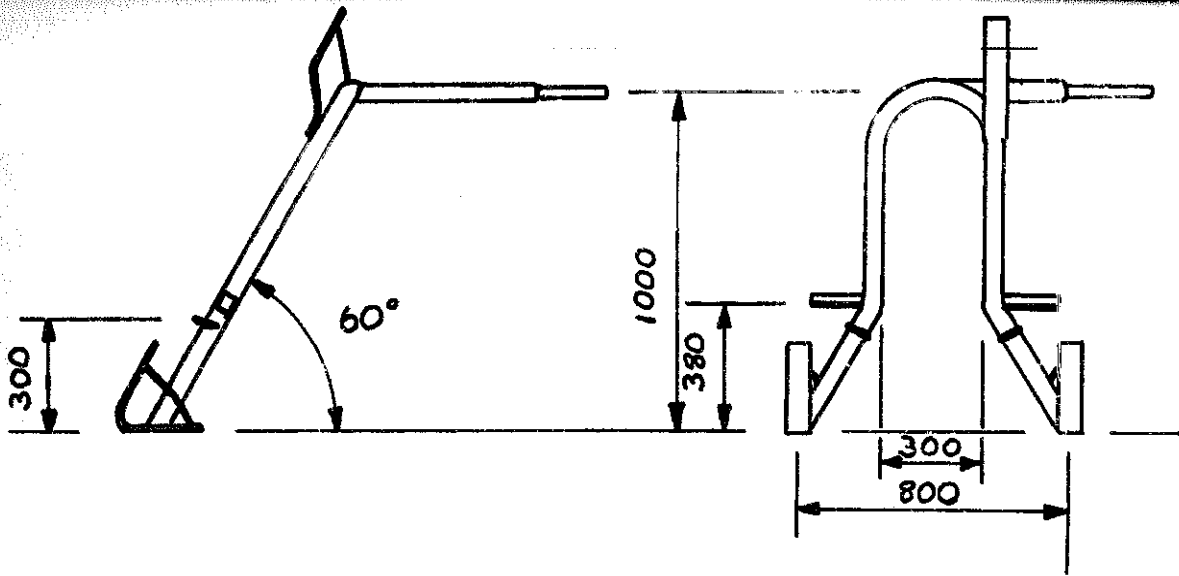
The adjustable angle version would be a useful research tool for finding the appropriate rotor angle for conditions in any locality. This information could then be used to modify the assembly fixture for the farmers' fixed-angle machines.

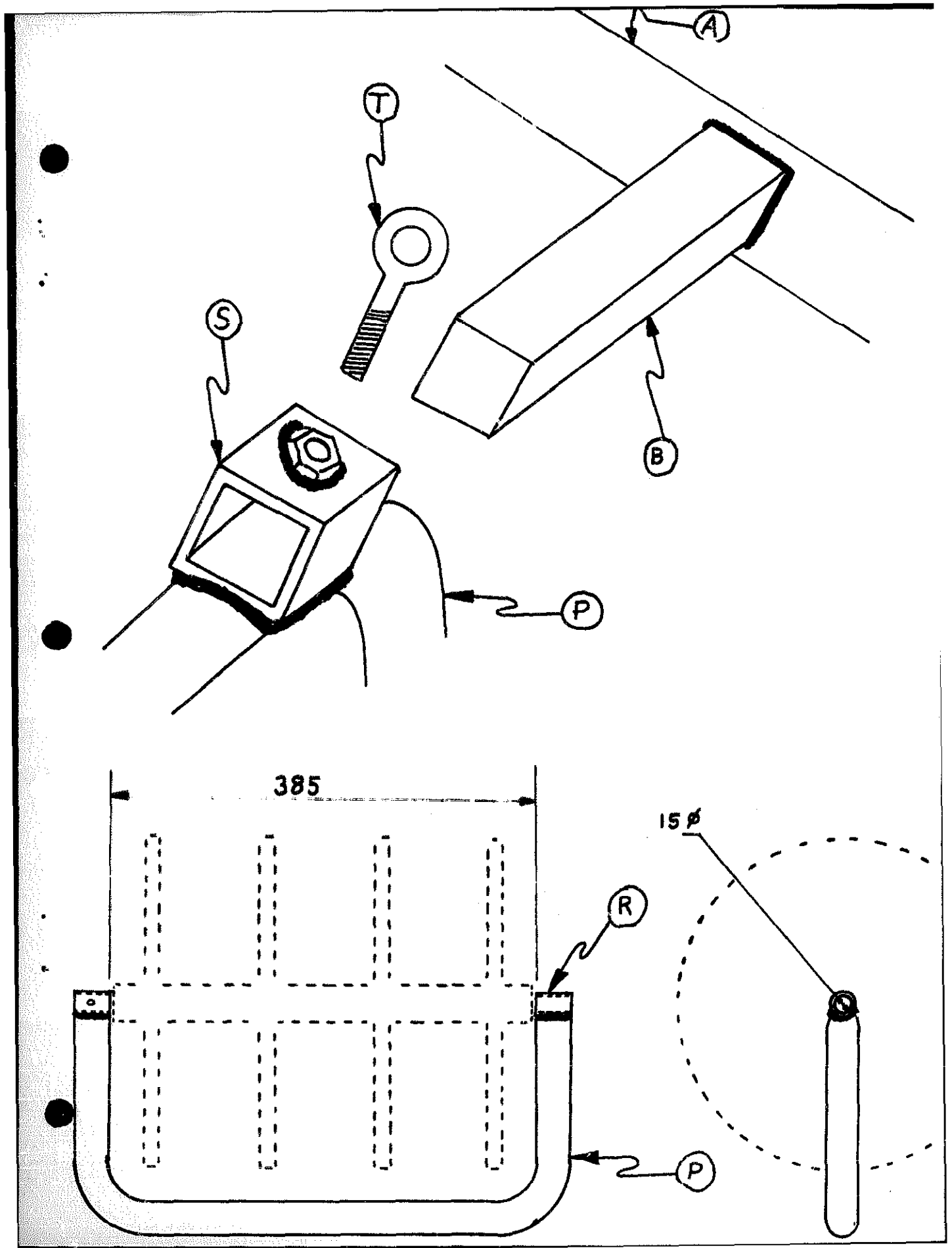
Orthographic drawings use first angle projection.

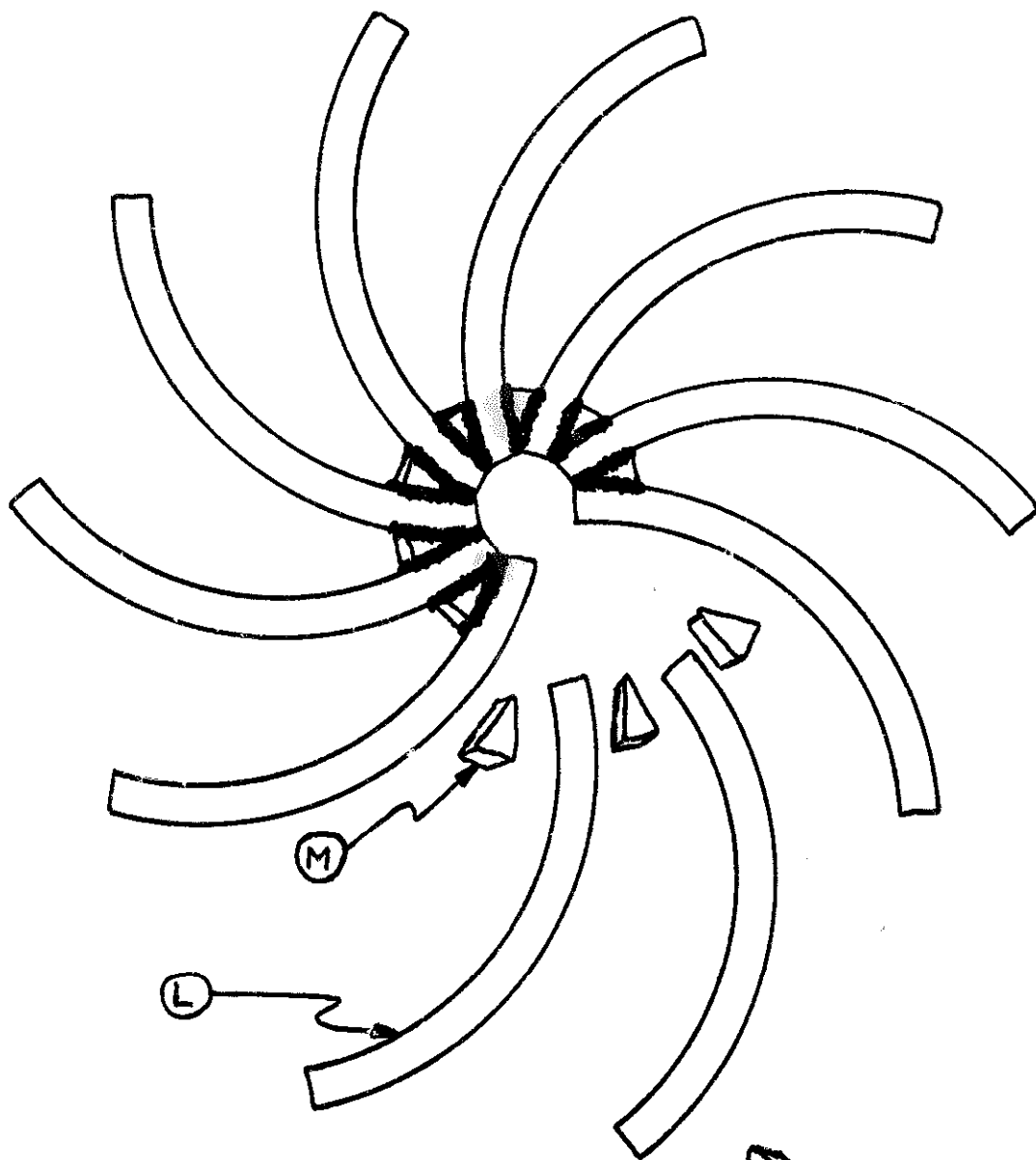
Dimensions given in mm.

ITEM	NAME	QTY	MATERIAL PER ITEM	MANUFACTURING NOTES
A	Arch	1	2400 x 30 bore water pipe	Bend to shape, starting at centre, and saw off ends of pipe level.
B	Stub	2	150 x 30 x 30 M.S.	Square bar or hollow section fabricated from angle iron. Weld to A.
C	Main skid	2	400 x 50 x 10 M.S.	Weld to A.
D	Main skid strut	2	300 x 12 ϕ M.S.	Weld to A and C.
E	Handle	1	750 x 25 water pipe	
F	Handle carrier	1	600 x 30 bore water pipe	Prepare ends by partial crushing and weld to E and A.
G	Transport skid	1	350 x 50 x 10 M.S.	Weld to A.
H	Transport skid strut	1	250 x 12 ϕ M.S.	Weld to F and G.
J	Hitch loop	2	200 x 12 ϕ M.S.	Weld to A.
K	Rotor hub	2	380 x 25 bore water pipe	
L	Tine	80	150 x 12 ϕ M.S.	Bend to approx. 100 mm radius.
M	Reinforcing wedges	80	15 x 12 ϕ M.S.	Forge to shape and cut off from bar. Weld ten each of L and M into each spider wheel so that spider wheels fit over K. Weld spider wheels to K with tine positions staggered.
N	Axle	2	450 x 15 ϕ M.S.	
O	Rotor bearing	4	100 x 30 x 30 hardwood	Wood bearing impregnated with groundnut oil as per IDC Report No. 69-8. O.D. to be press-fit in K, I.D. to be running-fit on N.
P	U-piece	2	745 x 25 bore water pipe	Bend to shape. Partially crush ends for welding to R.
R	Axle supports	4	40 x 15 bore water pipe	Fit R onto N to maintain alignment and weld R to P. Drill 2 ϕ hole through R and N for V.
S	Clamp	2	100 x 40 x 5 M.S.	To be sliding-fit on B. Drill 13 ϕ hole. Weld 12 mm nut over hole.
T	Clamping bolt	2	40 x 12 eye bolt	
V	Axle retaining pin	2	25 x 2 ϕ split pin	
W	Thrust washer	4	2 mm thick washer I.D. 15 mm, O.D. 30 mm	
X	Assembly fixture	1	2050 x 40 x 5 M.S. 760 x 15 bore water pipe	Construct X as shown. Fit (P + R) assemblies onto X using N. Fit S onto B at innermost position. Bring P and S together as shown and weld P to S.



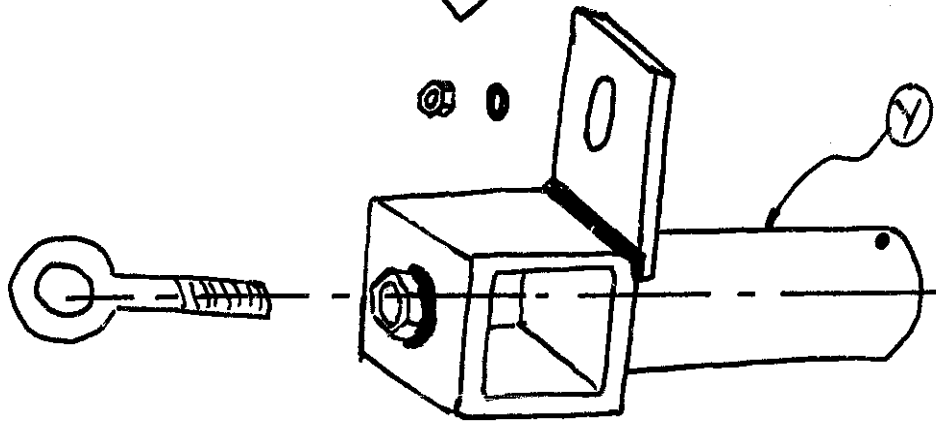




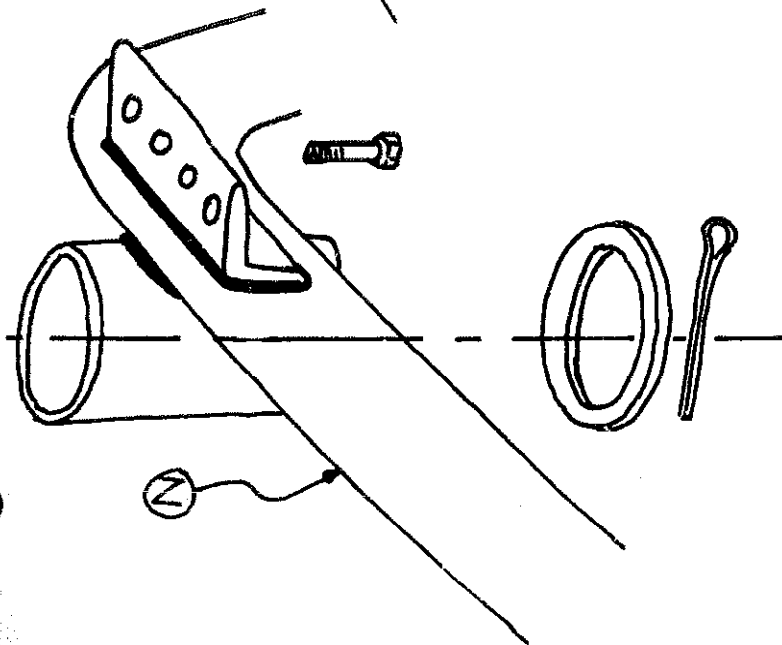
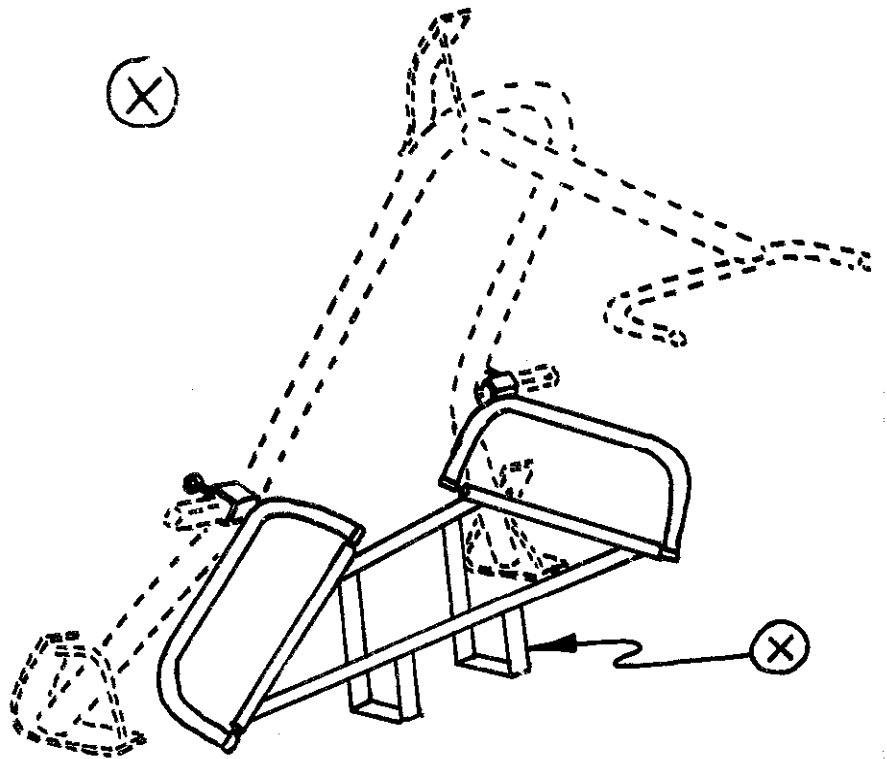
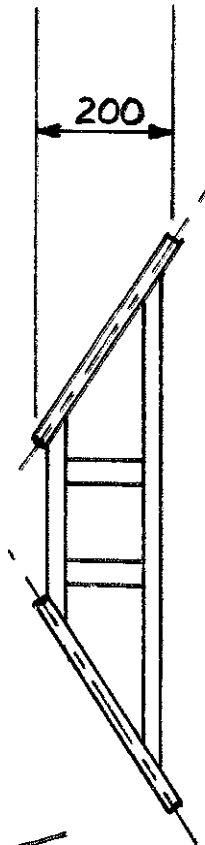
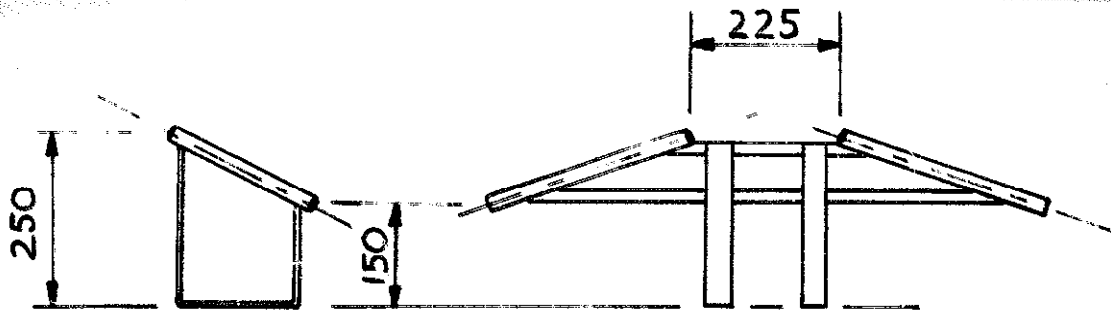


(M)

(L)



(Y)



36

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A project of Volunteers in Asia

The Weeder Mulcher

ITDG Agricultural Equipment and Tools No. 36

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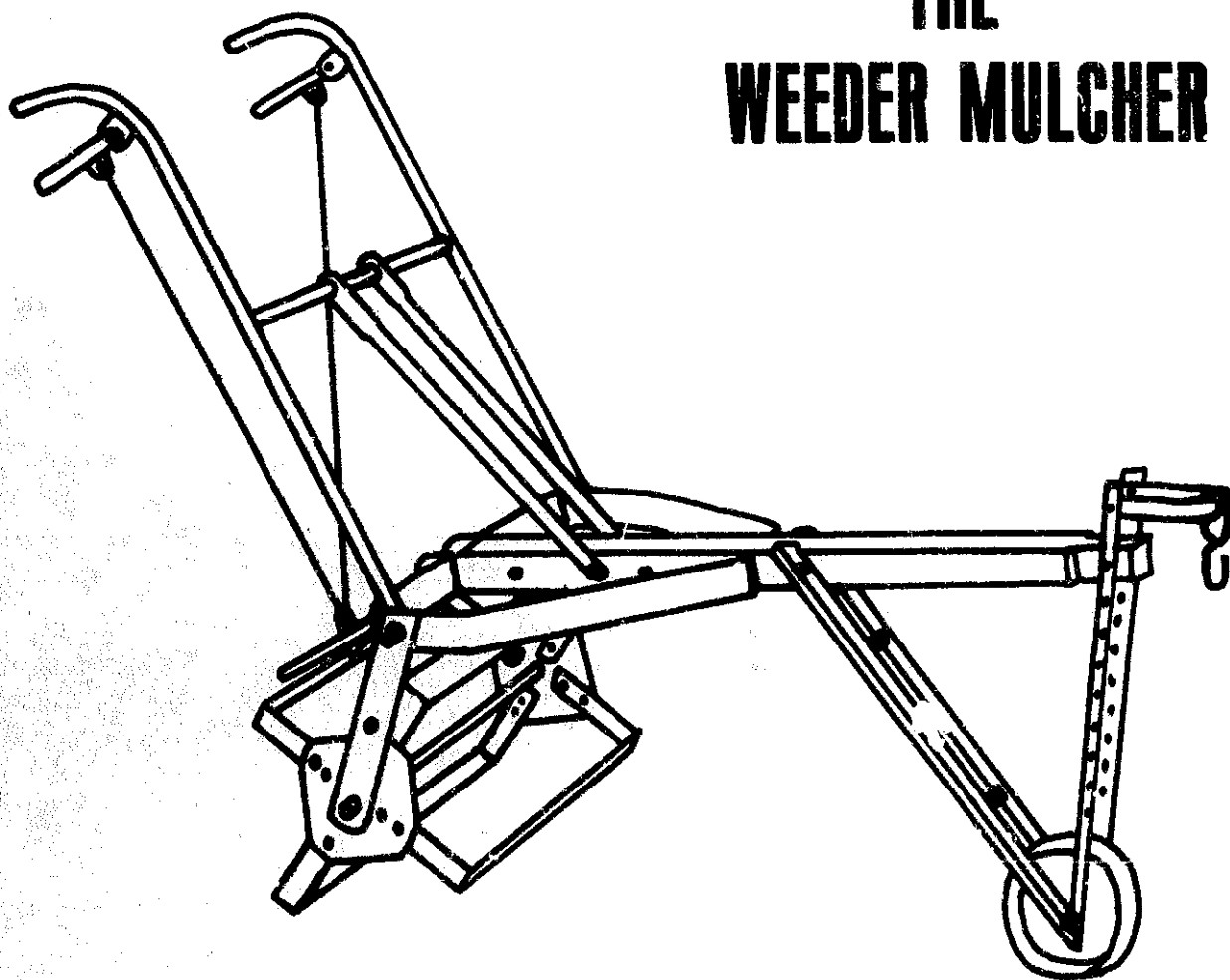
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AGRICULTURAL EQUIPMENT AND TOOLS FOR FARMERS DESIGNED FOR LOCAL CONSTRUCTION

No. 36

THE WEEDER MULCHER



**Intermediate
Technology** Publications Ltd
9 King Street, London WC2E 8HN, England
Telephone 01-836 6379

THE I.I.S.R. WEEDER-MULCHER

Acknowledgment:

Developed by R.R.Panje and R.G.Menon of the Indian Institute of Sugarcane Research, Lucknow.

Copied from the original plans by R.D.Mann and B.P.Winlo

Description:

This animal-drawn self-cleaning weeder was originally developed for use in sugarcane plantations. It is designed to destroy weeds, leave a mulch on the soil surface to conserve moisture and give a high work output per day (up to 5 or 6 acres of row crop work per 8 hour day). It can be used on most row crops with a spacing of 30 inches (75cm) or more.

Operation:

The blade works at a depth of 2 inches (5cm) below the surface. The weed roots are cut or pulled out and the soil layer is lifted slightly, which helps to break any crust present. If the blade clogs it will rise out of work. When this happens the operator flicks the release levers, the rotor moves round 90° and is locked in place by the lever. The weeds drop off the blade and soon dry out. Best results are obtained on tilled soils which have settled down to form a crust.

The implement is light enough to be carried on the yoke of a pair of bullocks yet robust enough to withstand a fair amount of rough handling. The blades can easily be replaced by a village blacksmith and the whole machine can be built in any reasonably well-equipped workshop.

The machine can be used in two forms:

- (1) with a long draught pole and two depth wheels at the rear (as shown in the detailed drawings).
- (2) with a short beam and draught chain and a single depth wheel at the front of the beam (as shown on the cover).

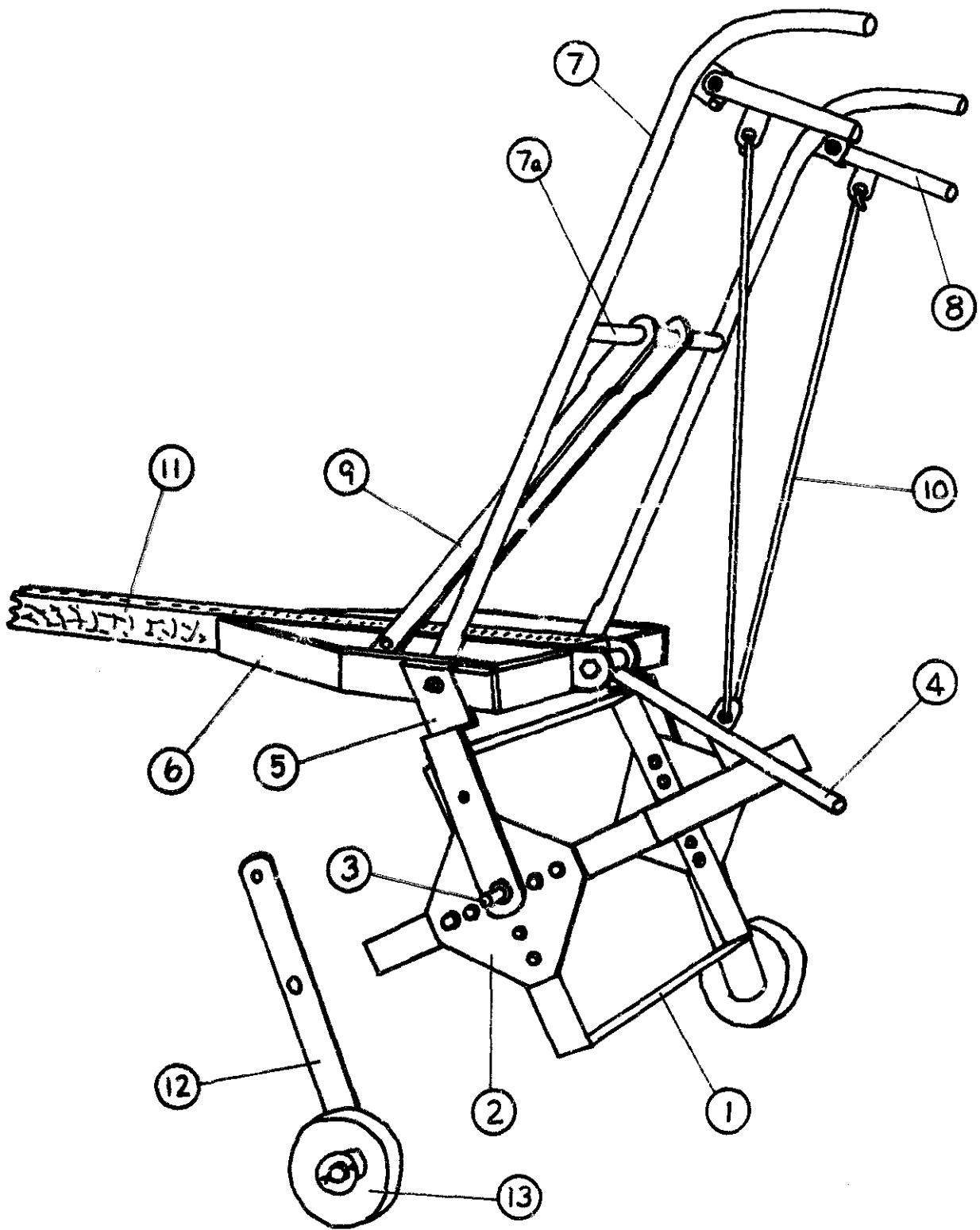
ITDG has not yet had the opportunity to field test this implement. The information above was supplied by the Indian Institute of Sugarcane Research.

It has been suggested that the implement might be improved by splaying out the handle brackets to improve lateral rigidity and that the axle support brackets might need to be strengthened for use in hard soils.

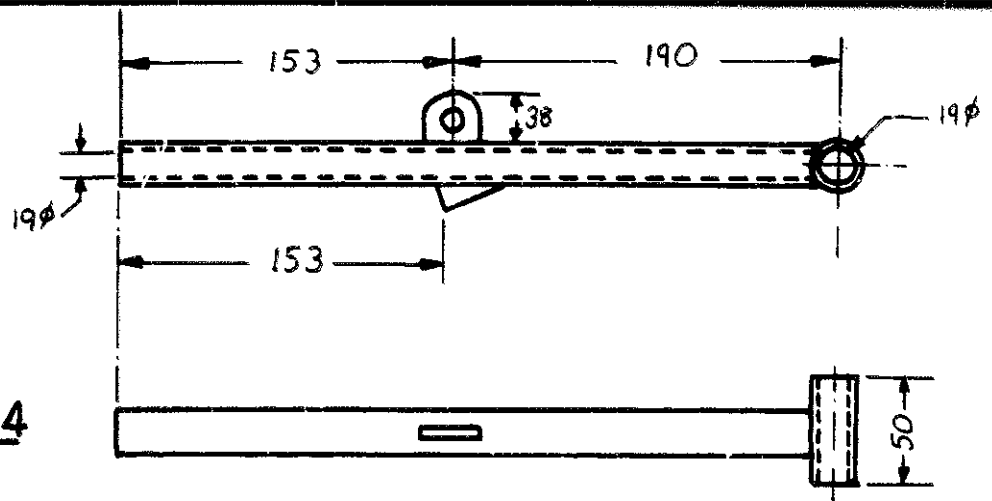
List of materials required for the fabrication of the I.I.S.R. Weeder Mulcher.

Part No.	Description	Specification	Material	Number required.
1	Blade	600mm x 38mm x 6mm	M.S.Flat	4
2	Cutter Assembly Plate	165mm x 165mm x 3mm	M.S.Plate	2
3	Axle	774mm length x 19mm Dia.	M.S.Rod	1
4	Latch	345mm x 19mm Dia. Pipe	M.S.Pipe	1
5	Brackets	330mm x 50mm x 6mm	M.S.Flat	2
6	Frame	1.225m x 50mm x 6mm	M.S.Flat	2
7	Handle	860mm x 19mm Dia. Pipe	M.S.Pipe	2
7a	Handle cross bar	445mm x 19mm Dia. Pipe	M.S.Pipe	1
8	Latch grip	140mm x 19mm Dia. Pipe	M.S.Pipe	2
9	Handle bracket	500mm x 37.5mm x 6mm	M.S.Flat	2
10	Latch rod	1.425m x 6mm Dia.	M.S.Rod	1
11	Wooden beam	2.80m x 75mm x 50mm	Sal wood	1
12	Transport wheel bracket	380mm x 50mm x 60mm	M.S.Flat	2
13	Transport wheel	125mm x 38mm width	C.I.	2

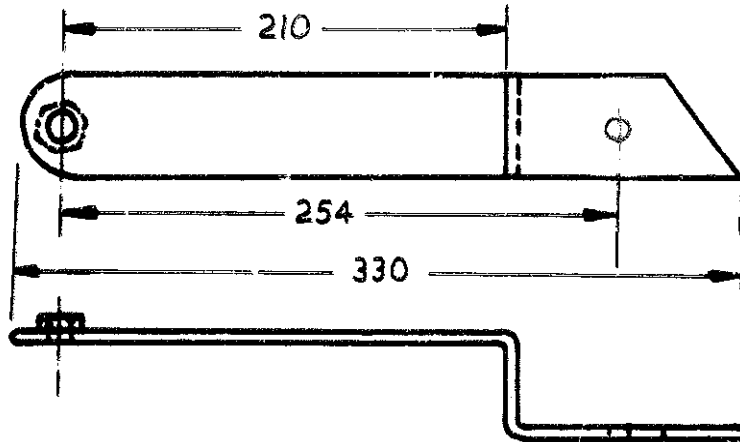
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ALL DIMENSIONS : mm



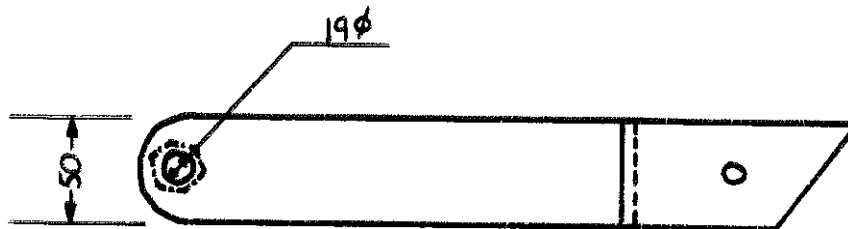
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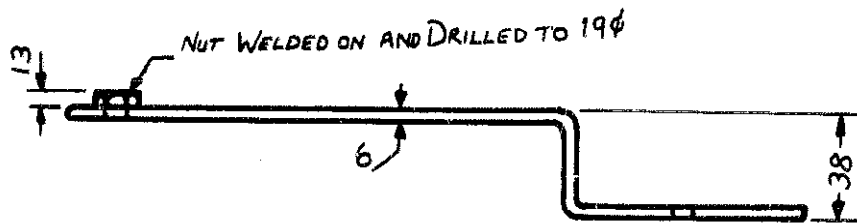
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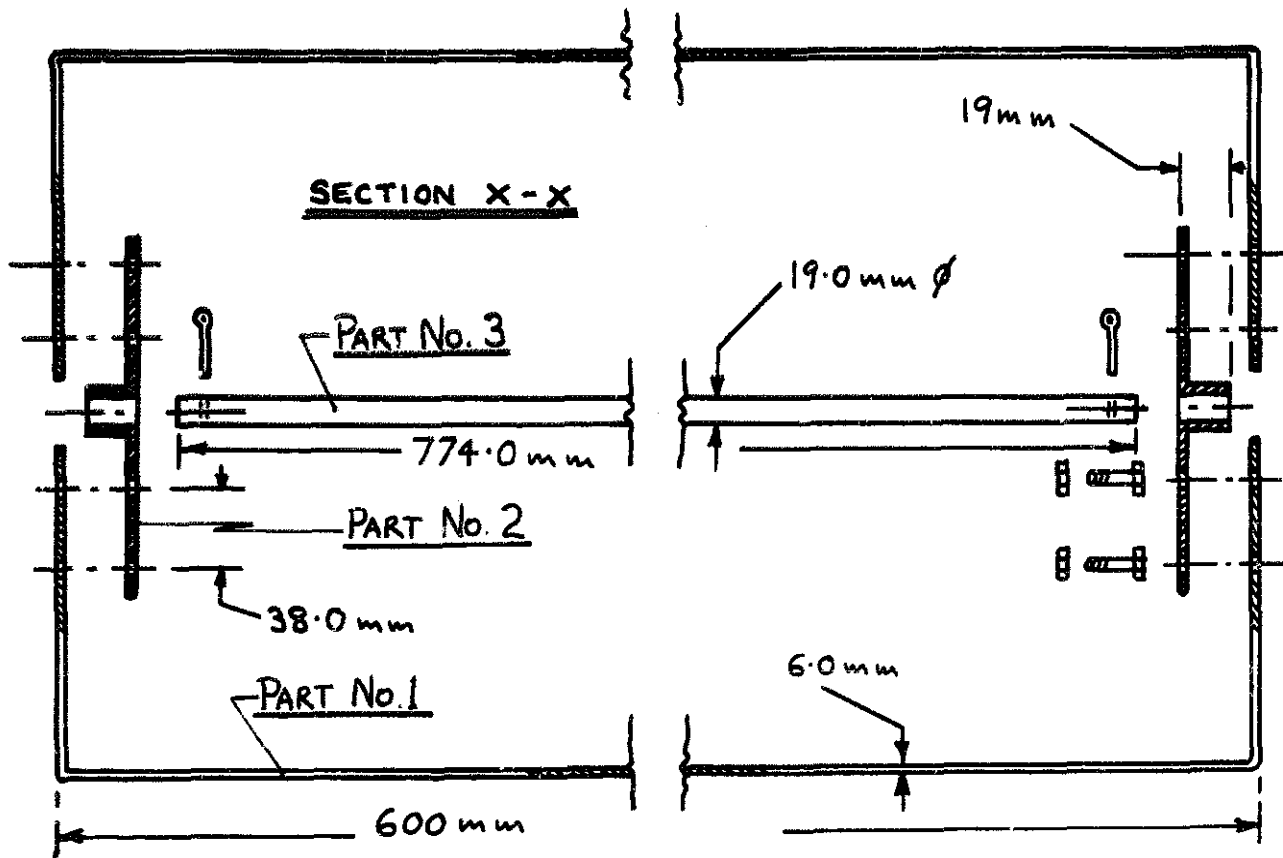
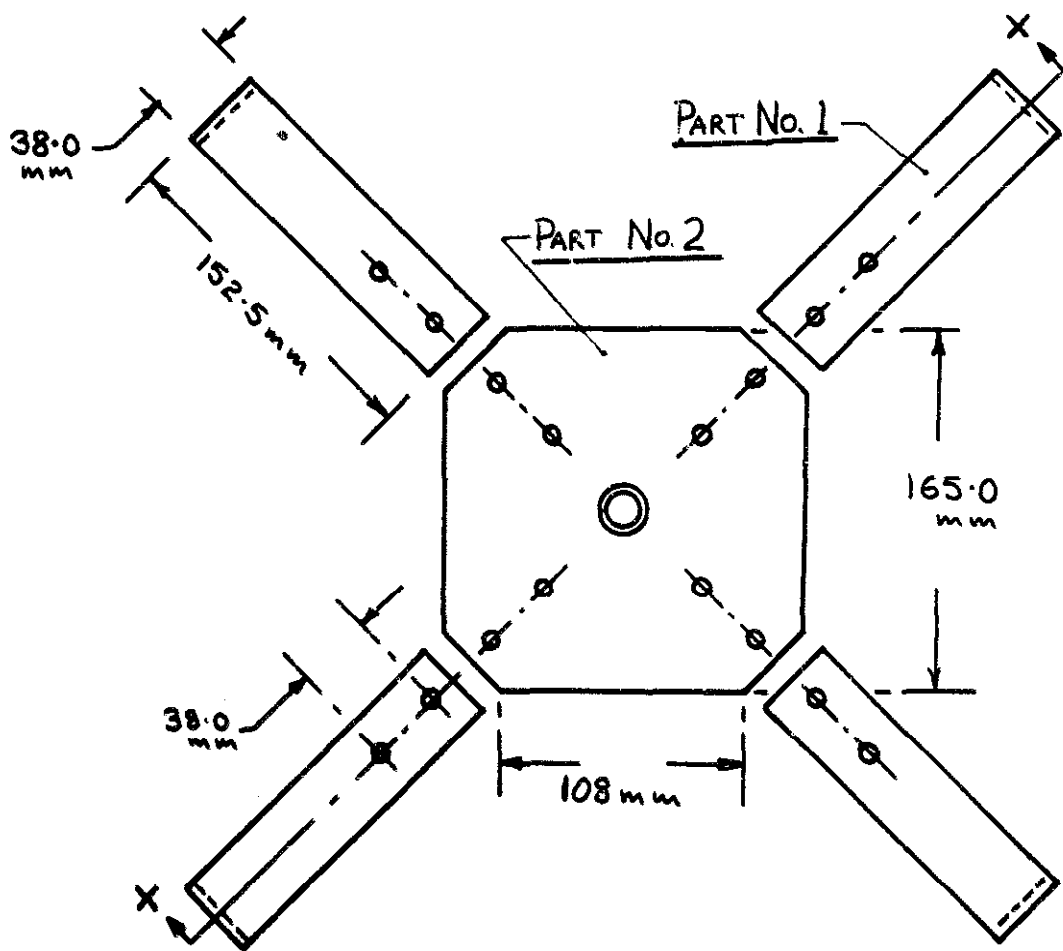


LEFT

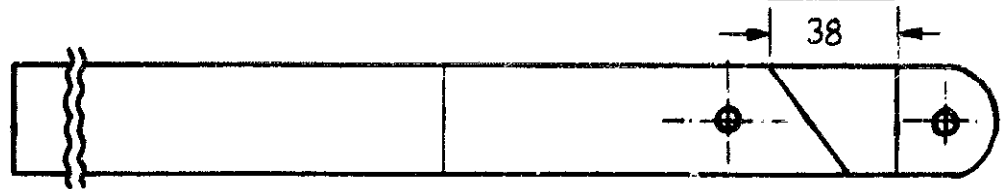
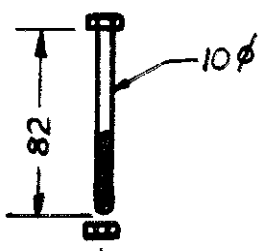
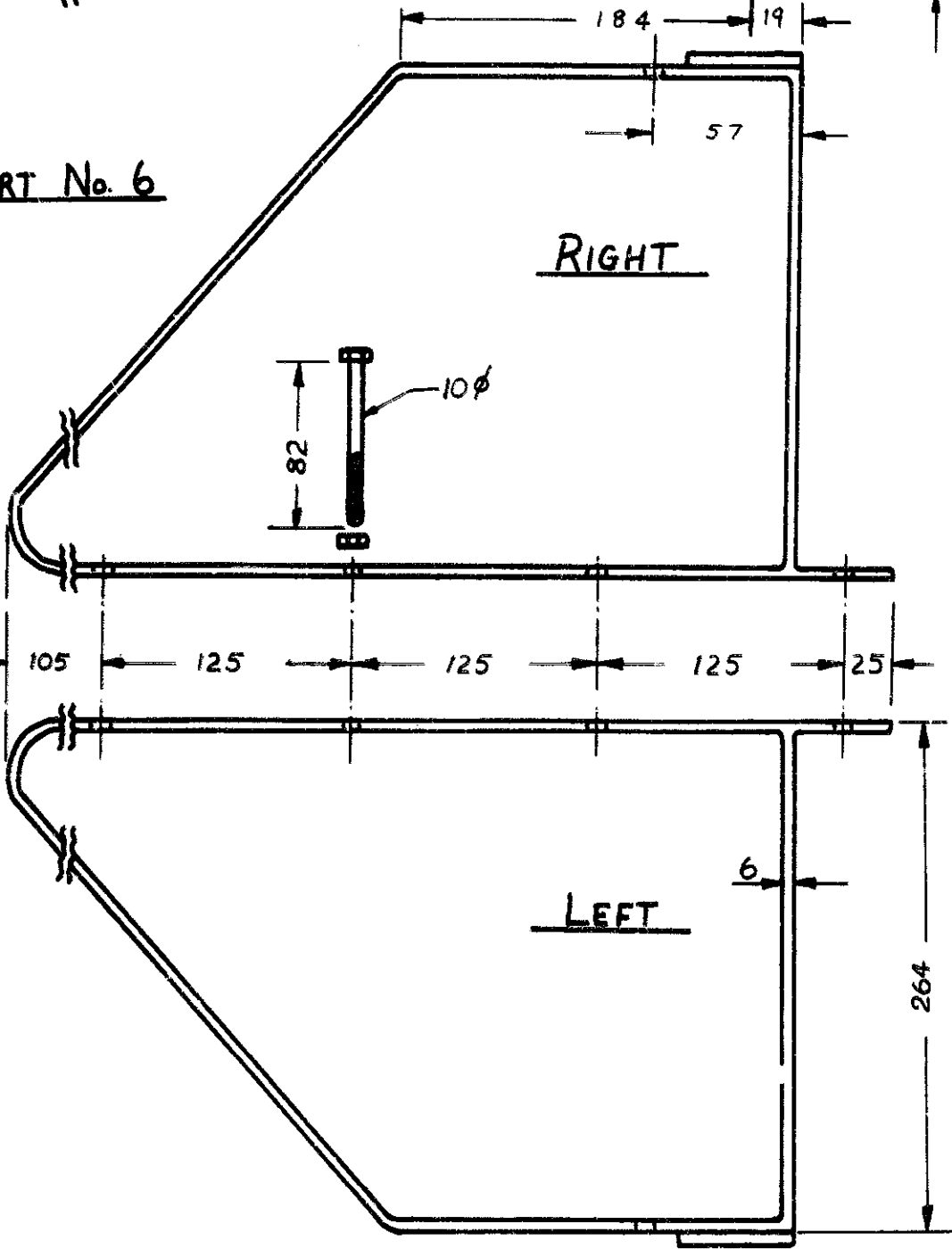
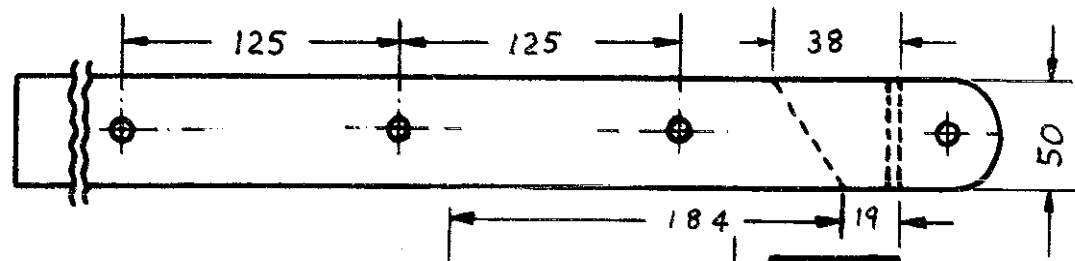


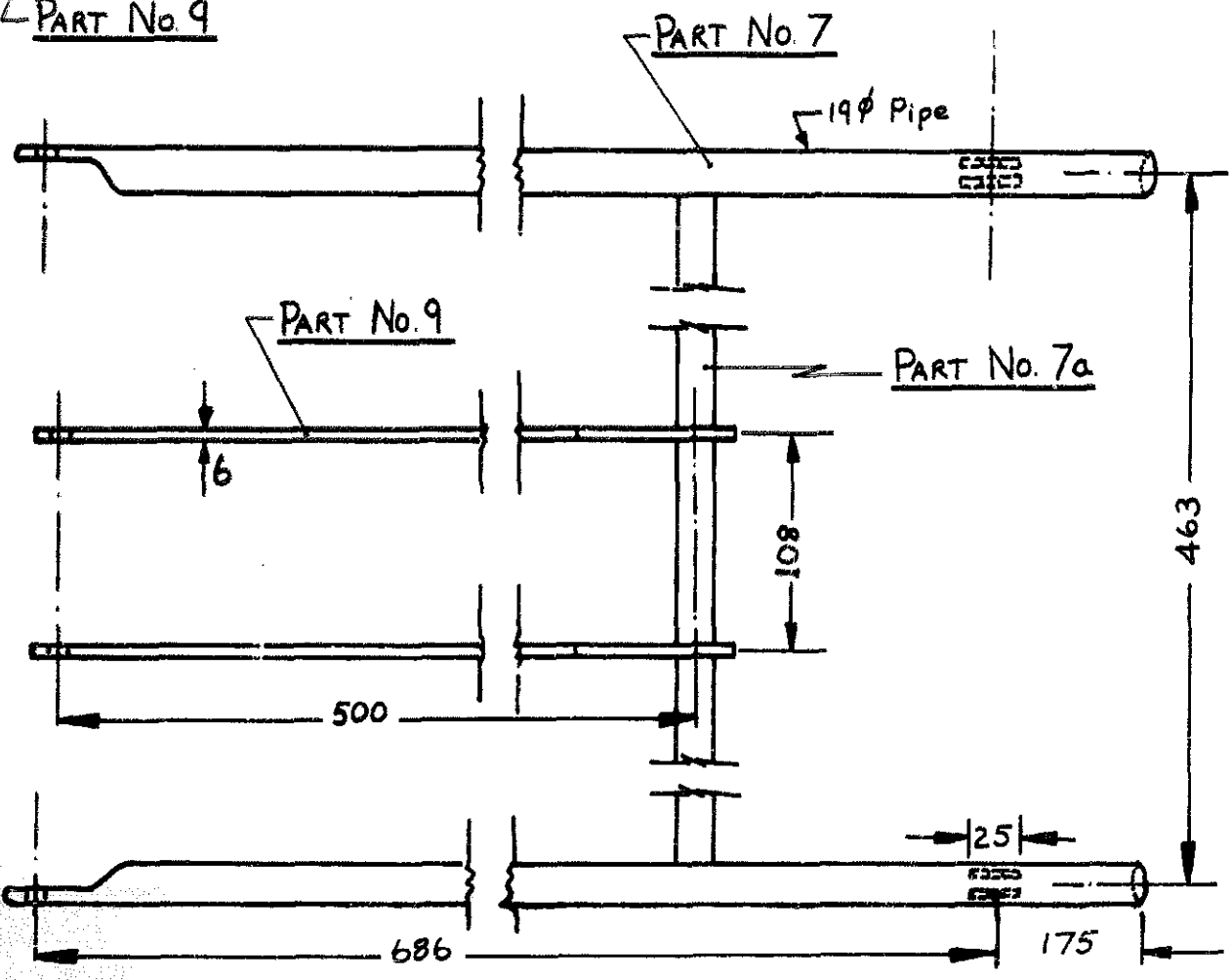
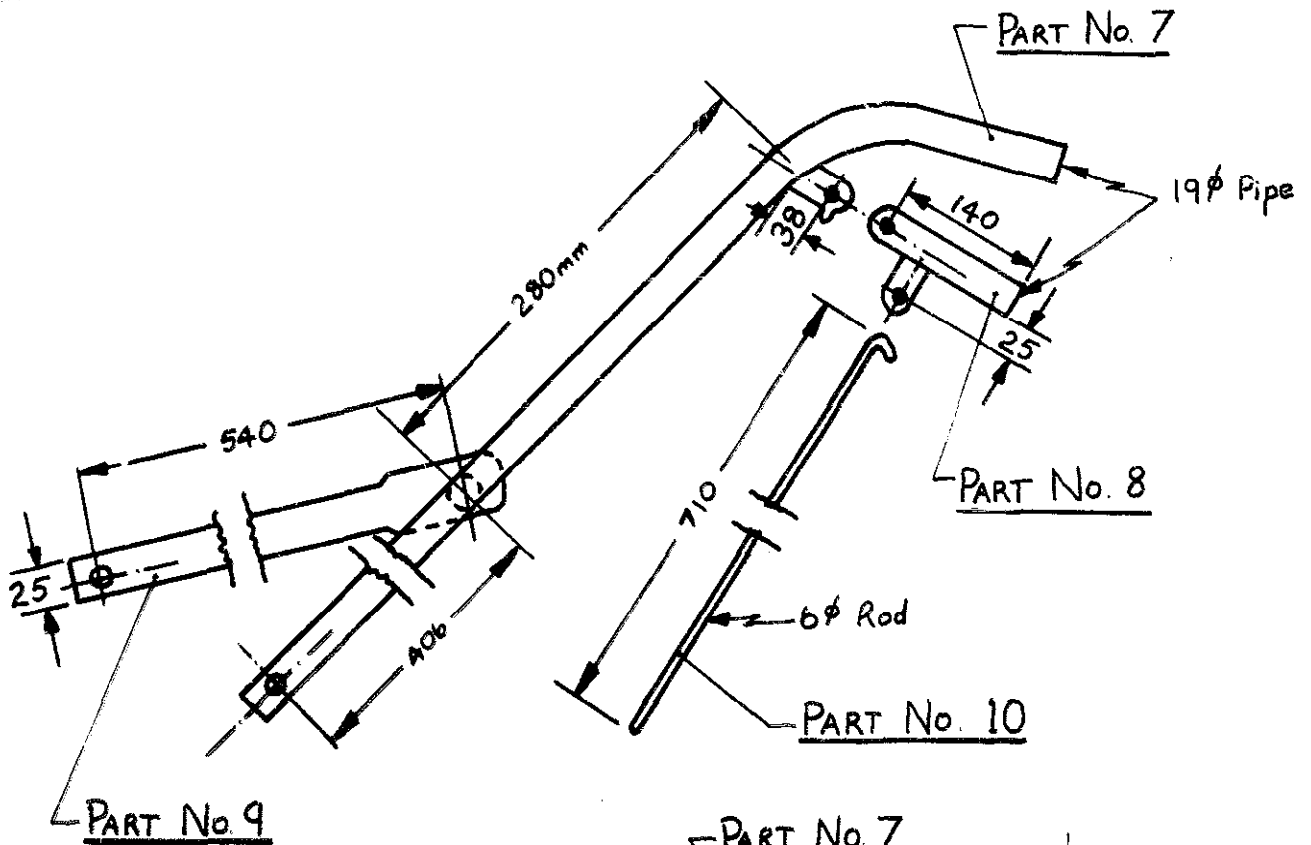
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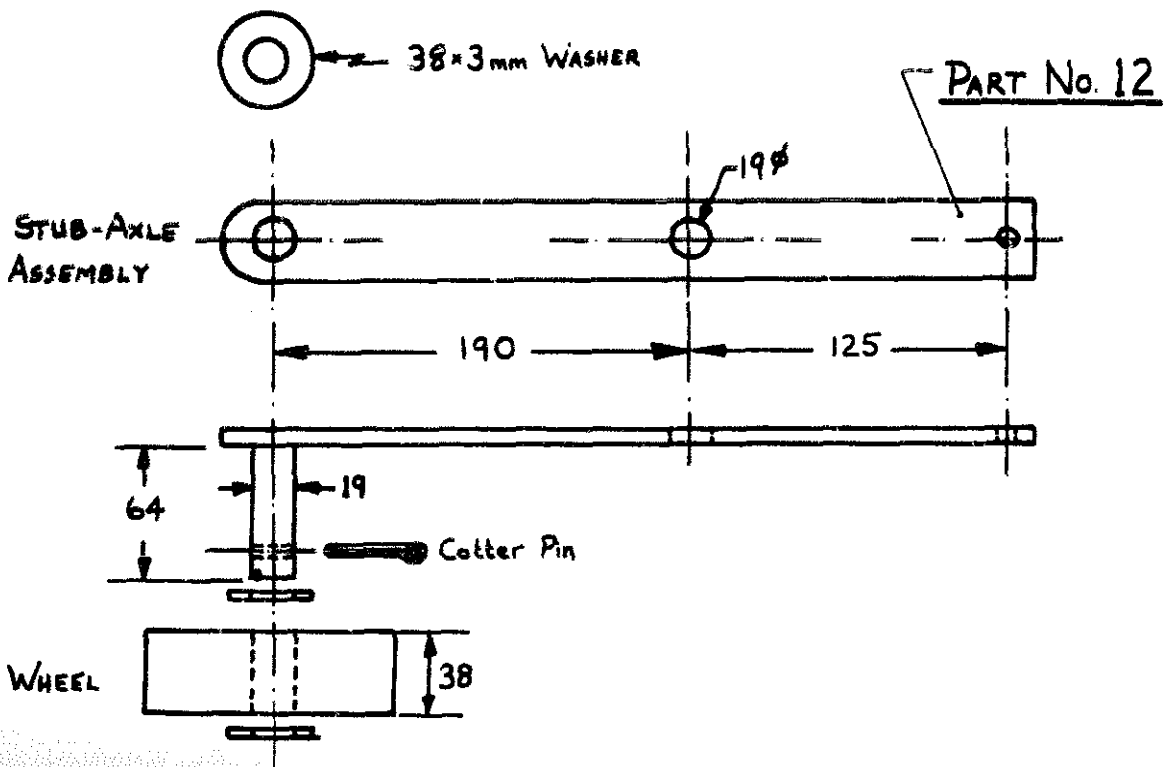
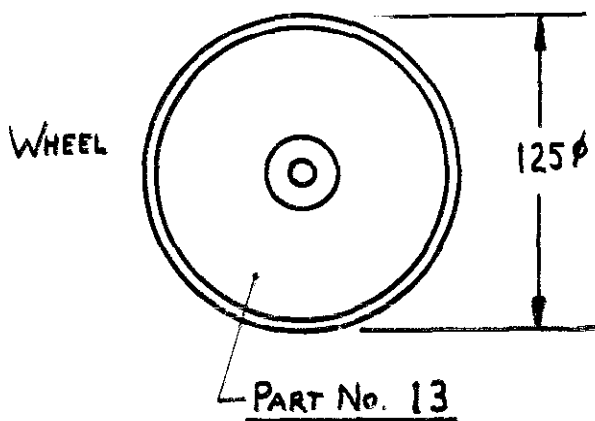
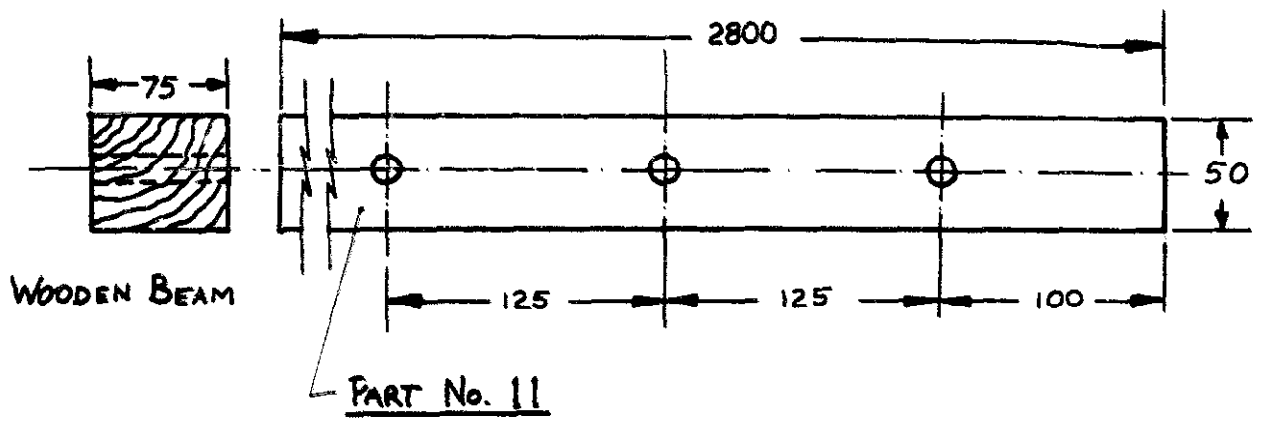




PART No. 6







37

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Foot Powered Thresher

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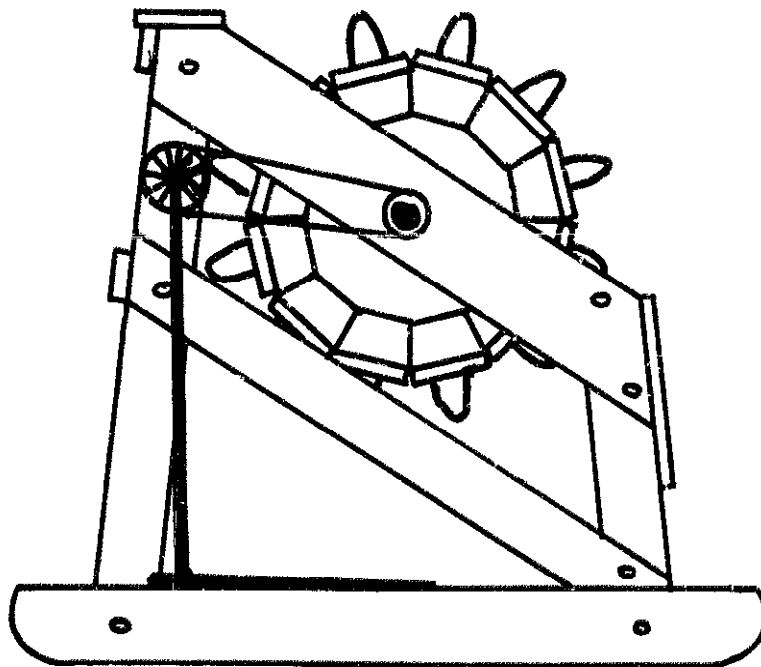
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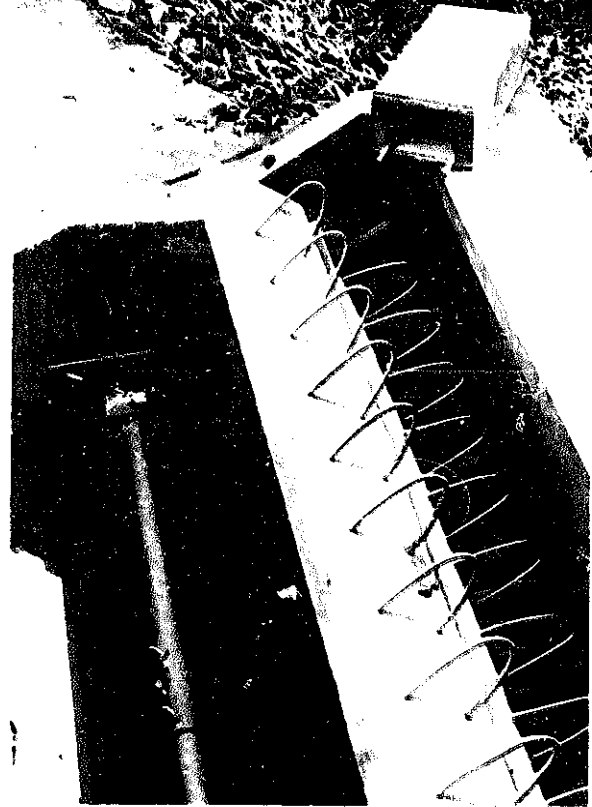
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FOOT POWERED THRESHER

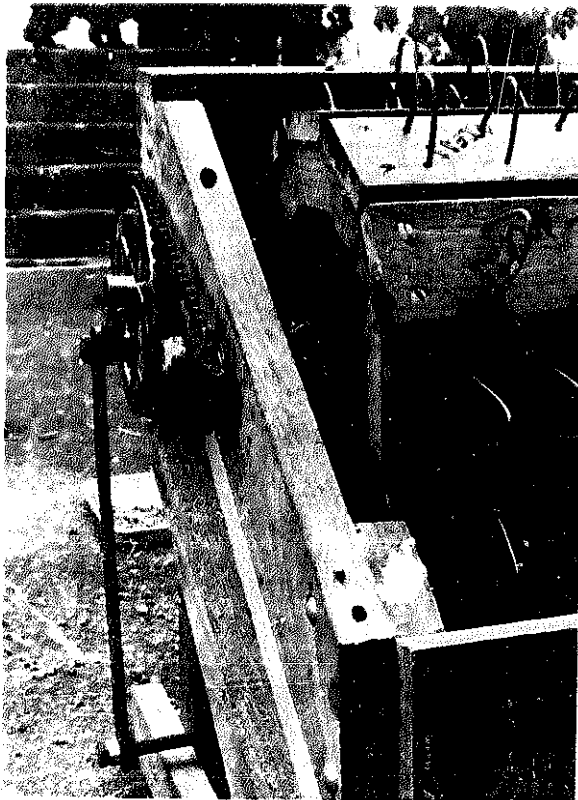




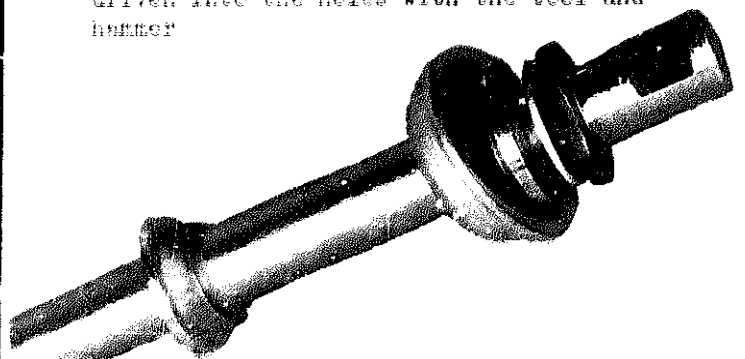
1. Using the threshing



2. Two of the boards have been removed from the drum to show the construction details of the inside. Note the plates to hold the drum firmly to the shaft. The shaft is in two pieces, with a connector for ease of assembly. Inside the threshing at upper right can be seen the adjustable plate for the large sprocket shaft assembly. On top of the threshing is shown the tool for inserting wire hoops into the drum. Undersize holes are drilled, and pre-formed loops are driven into the holes with the tool and hammer

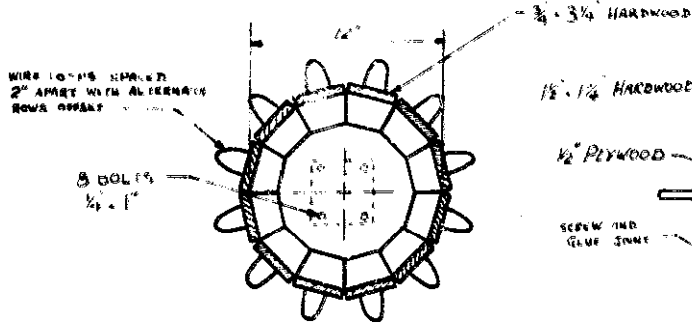


3. Wire loops 2" apart, with alternate rows offset, strike the grain from the stalk. Note the holes in the frame for the steel rod hoops, which hold a cloth cover. A simple chain guard should be added for safety.

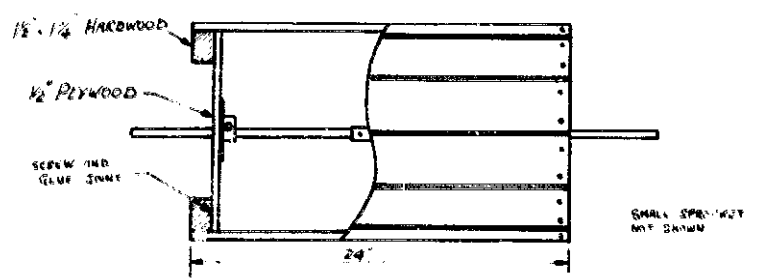


4. This is the type of bicycle pedal shaft assembly used (minus the ball bearings), showing at one end the bearing cup, adjustable cone, washer and lock-nut. The shaft for the large sprocket is used intact. The one for the drum is cut in half and extended with ordinary mild steel round bar.

END VIEW OF DRUM



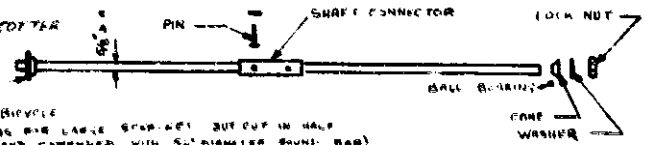
SIDE (CUT AWAY) OF DRUM



1/8" PLATE TO
CONNECT DRUM
TO SHAFT

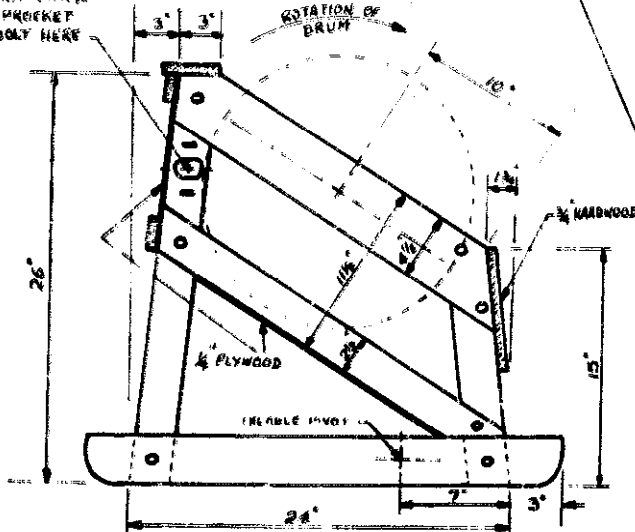


BICYCLE PEDAL ARM COUPLER

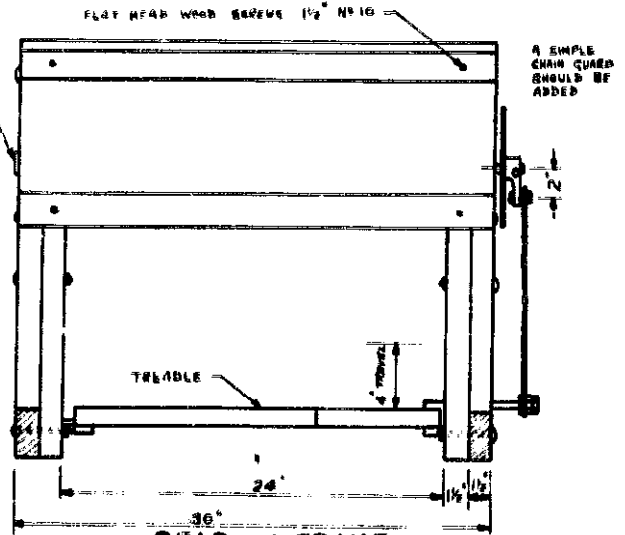


BEARINGS FROM BICYCLE
100LB. SHAFT (AS FOR LARGE SPROCKET BUT CUT IN HALF
AND FINISHED WITH 5/8" DIAMETER ROUND BAR)

FLYING SHAFT BEZEL
AND LARGE
SPROCKET
BOLT HERE



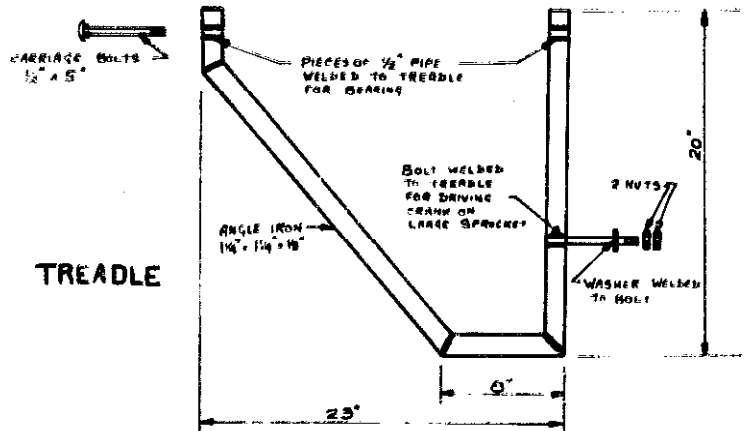
SIDE OF FRAME



REAR OF FRAME

ALL FRAME BOLTS 5/16" x 3"

A CLOTH COVER SUPPORTED BY TWO
HOOPS OF 3/8" DIA STEEL BAR WILL
HELP TO GUIDE THE GRAIN TO THE
GROUND IN WINDY CONDITIONS



TREADLE

STEEL PLATE $\frac{1}{8} \times 2 \times 4$
 (BOTH SIDES OF FRAME FOR
 ADJUSTING CHAIN TENSION)

STEERING CUP
 BALL
 CONE (ADJUSTABLE)
 WASHER

SHAFT

LOCK NUT

THRASHER FRAME

ADJUSTING BOLTS
 $\frac{1}{4} \times 3\frac{1}{2}$ "

LARGE SPROCKET

TAPERED
 COTTER

SPACER

BOLT
 $\frac{1}{2} \times 1$ "

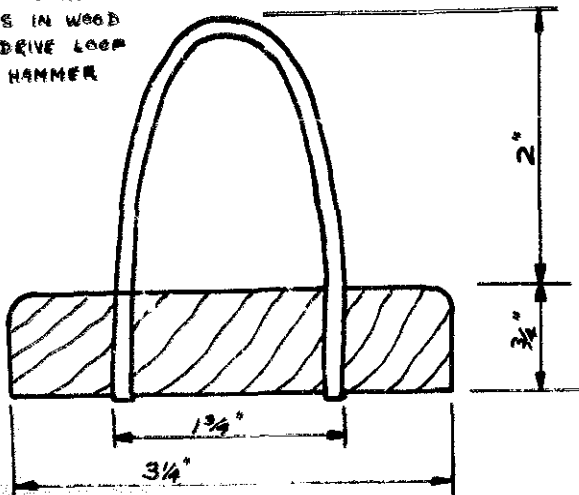
LOCK NUT

NUT WELDED
 TO PEDAL
 ARM

CONNECTING
 ROD
 $\frac{1}{8} \times 1$ "

SECTION OF BICYCLE PEDAL SHAFT ASSEMBLY FOR LARGE SPROCKET

DRILL UNDERSIZE
 HOLES IN WOOD
 AND DRIVE LOOP
 WITH HAMMER



WIRE LOOP

FOOT POWERED THRESHER

Source

Melanesian Council of Churches. P.O.Box 80, Lae, Papua New Guinea.

I.T.D.'s. has not yet had an opportunity to build or test this thresher and the information given below was supplied by B.David Williams Jr., Agricultural Secretary of the Melanesian Council of Churches.

Description.

Threshers of this type have been used in large numbers in Asia, but have generally been factory-built and have used spur gear drives and expensive bearings. This Melanesian Council of Churches design substitutes bicycle chain and sprockets for the gears and employs bearings taken from bicycle pedal shafts. To make the thresher, some electric welding and use of a drill press are required, but all other operations can be done with simple hand tools.

The thresher is suitable for rice and also sorghum, oats and other small grains. When the treadle is operated the drum rotates at 250 to 300 revolutions per minute. The wire loops on the drum are the "teeth" which strike the grain off the stalks. This machine does not separate the chaff from the grain and therefore winnowing is still necessary.

The threshing is done by holding a bundle of unthreshed grain firmly in the hands, beating and twisting the bundle lightly against the drum, which revolves away from the worker, and throwing the bundle of threshed straw aside. The good grains fall down upon a canvas or plastic sheet, which is placed under the thresher.

The work of cleaning the grain will be greatly facilitated by putting the threshed material into a box with $\frac{3}{4}$ inch wire mesh screen on top. This will remove many of the broken stems and longer trash.

To maximize the output of this machine, the work should be systematically organized. The following recommendations for organizing field procedures when using treadle operated threshers come from the International Rice Research Institute in the Philippines and are based on observations of experienced workers in Taiwan.*

1. The straw is cut with a scythe in one hand and gathered in the other. Each single handful of straw is laid aside on the stubble parallel to the previous ones and left to dry one to two days.
2. The sled-mounted pedal thresher with a box and screen is brought into the field by 3 to 5 persons who work as a team.
3. Each person has a cord about 50cm long attached to one wrist and free at the other end. He slips his hand under 4 to 8 handfuls of the dry straw and binds the large bundle by wrapping the free end of the cord around the bundle. This technique permits one hand to hold the straw firmly.

4. The crew members rotate in a circle. While one or two are threshing, the others are returning, gathering, and bringing new bundles. Each person threshes the bundle that he gathers by pedaling with a rhythmic body action while holding and twisting the bundle. The inertia of the cylinder keeps the thresher going as the labourers take turns threshing, gathering, and bringing in new bundles.
5. After threshing the straw is discarded in a small pile. The sled-mounted thresher is moved in 5 to 10 metre stages so that the haul distance is always short and straw piles are small.
6. The threshed grain accumulates in the box along with some flag leaves and chaff. The leaves are removed and the grain and chaff are sacked for drying and cleaning.

Taiwan reports indicate that experienced workers can thresh approximately 1,000 kg. of paddy per day with a treadle operated thresher if the material is dry. CECOCO (a dealer in small agricultural equipment in Japan) reports 115 kg. of paddy per hour as the capacity of a similar machine. The amount of work done will vary greatly according to conditions. Johnson, Casem, and Manalo report ** that five women in the Philippines with one thresher were able to thresh about 500 kg. of grain in 8 to 10 hours, working with wet materials from a stack in a muddy field. Under the latter conditions threshing by hand would be nearly impossible.

Engine Driven Thresher.

Those who want a simple engine-driven thresher can build a similar machine, but with a wider drum, for example, 36 inches; with a stronger shaft, say 3/4 inch; and with a large pulley on one side. A three to five horsepower engine will be sufficient, and in this case approximately 400 revolutions per minute would be best.

References.

- * Johnson, Casem, and Manalo, "Labor and Procedure for The Pedal Thresher", International Rice Research Institute Technical Paper No.2 September 1966.

** op. cit.

CONVERSION TABLE

8th fractions and inches to millimetres (mm)

Inches	0 in	1 in	2 in	3 in
Fractions	mm	25.400	50.800	76.200
1/8 in	3.175	28.575	53.975	79.375
1/4 in	6.350	31.750	57.150	82.550
3/8 in	9.525	34.925	60.325	85.725
1/2 in	12.700	38.100	63.500	88.900
5/8 in	15.875	41.275	66.675	92.075
3/4 in	19.050	44.450	69.850	95.250
7/8 in	22.225	47.625	73.025	98.425

4. The crew members rotate in a circle. While one or two are threshing, the others are returning, gathering, and bringing new bundles. Each person threshes the bundle that he gathers by pedaling with a rhythmic body action while holding and twisting the bundle. The inertia of the cylinder keeps the thresher going as the labourers take turns threshing, gathering, and bringing in new bundles.
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1/4 in.	6-350	31-750	57-150	82-550
3/8 in.	9-525	34-925	60-325	85-725
1/2 in.	12-700	38-100	63-500	88-900
5/8 in.	15-875	41-275	66-675	92-075
3/4 in.	19-050	44-450	69-850	95-250
7/8 in.	22-225	47-625	73-025	98-425

38

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The Rasulia Bladed Roller Thresher
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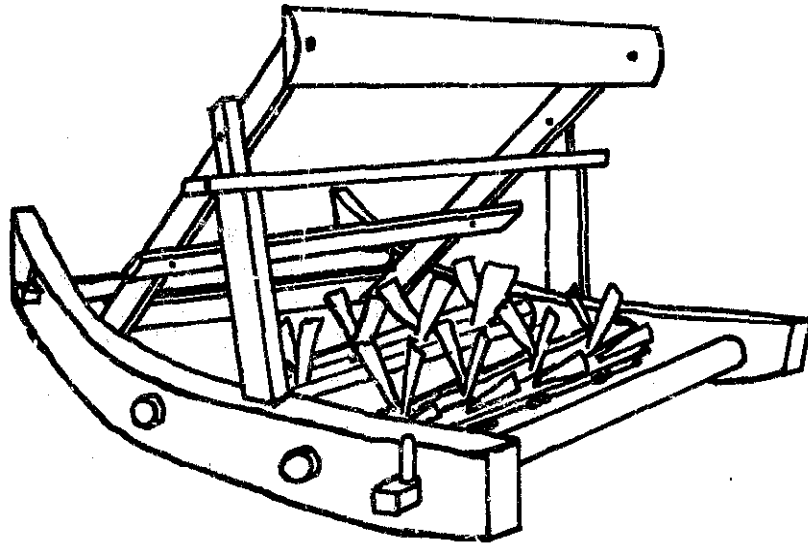
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THE "RASULIA" BLADED ROLLER THRESHER



RASULIA ANIMAL DRAWN ROLLER THRESHER

Source

This implement was seen in use in Iran by Ed Abbot, who subsequently built examples at the Friends' Rural Development Centre, Rasulia, Hoshangabad, M.P. India.

I.T.D.G. has not yet had an opportunity to build or test the Rasulia thresher and this leaflet is based on information supplied by Ed Abbot.

Description

The thresher is apparently suitable for all types of corn and similar crops, and could be made and used anywhere where bullocks are available and suitable local craftsmen and materials can be found. It has proved to be 60% more efficient than the traditional Indian method of using bullocks to trample the harvested crops.

Construction.

The basic structure is a frame which holds two octagonal rollers on which are fixed the threshing blades. Above this frame a seat is provided together with a foot rest. The side frames are made by selecting a suitably sized bent log and cutting it in half lengthways. This produces two parallel five feet by eight inches. Braces are made from a suitable material; they are squared off at the ends and firmly fixed to the frame.

The rollers are first carefully planed square and cut to length. Bearings are formed at each end, three inches long with a three inch diameter. Next, two lines are scribed the length of each face of the roller at a distance of $7/8$ " from the centre-line. The corners now marked are cut away, producing the required octagonal cross-section. The markings for blade-spike holes must now be made as follows. Centre-lines should be scribed on each face if this has not already been done. The first hole should be marked on any centre line two inches from the end excluding the bearing. Holes are now marked spirally at one inch intervals, till the final hole is reached two inches from the far end.

The holes are now drilled out to $1/2$ inch diameter and the roller is ready for the fixing of the blades.

Blades are made from flat strips of iron or steel $1/2$ " x 2" such as are used for rims for bullock-cart wheels.

Blades are driven into the holes at the correct angle as described below, the projecting inch or so of the spike being bent over to retain the blade. This job is made much easier if a punch is made to the shape of the blade-spike and inserted red hot into the drilled hole at the correct angle, thus also serving to locate the blade as now described.

The angles at which blades are placed are crucial to efficient performance. The first blade should be placed parallel to the length of the roller, but the next blade (on the next face) is placed at 45° to the length of the roller, and the next is at right angles. The next is placed at 45° but tilted the 'other way', and so on until all blades are in place.

The rest of the structure is more or less straight forward and could be modified within practical limits to suit requirements.

Draught ropes are attached to the outer ends of the forward brace and thence to the yoke of a pair of bullocks, the operator directing them from a moderately comfortable sitting position.

N.B. The measurements in this design have been given in inches. A simple conversion table is shown below:

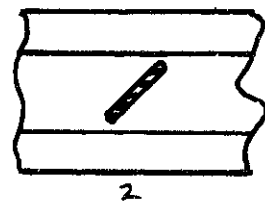
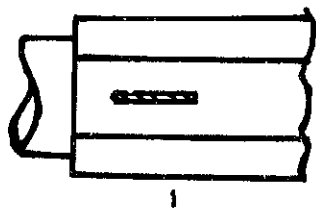
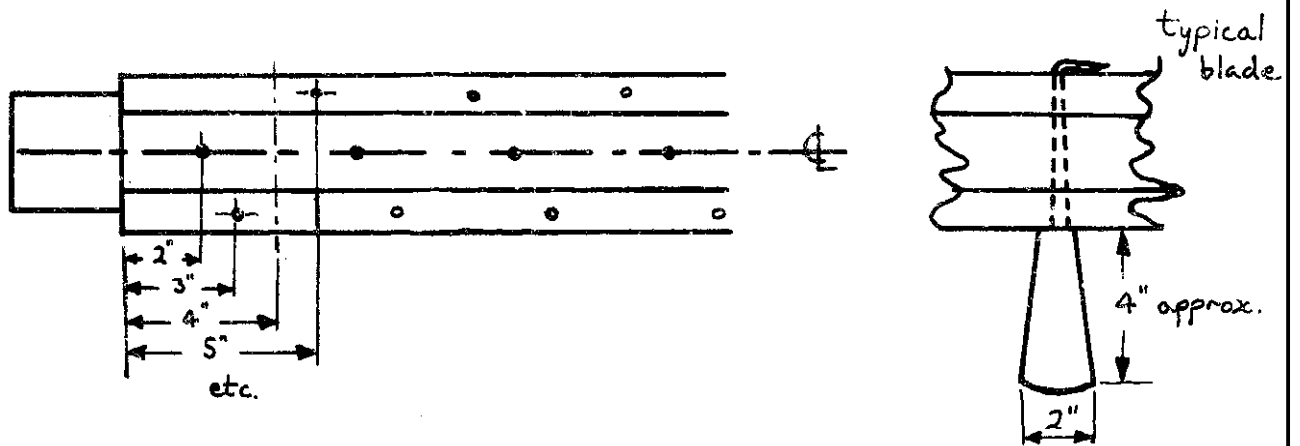
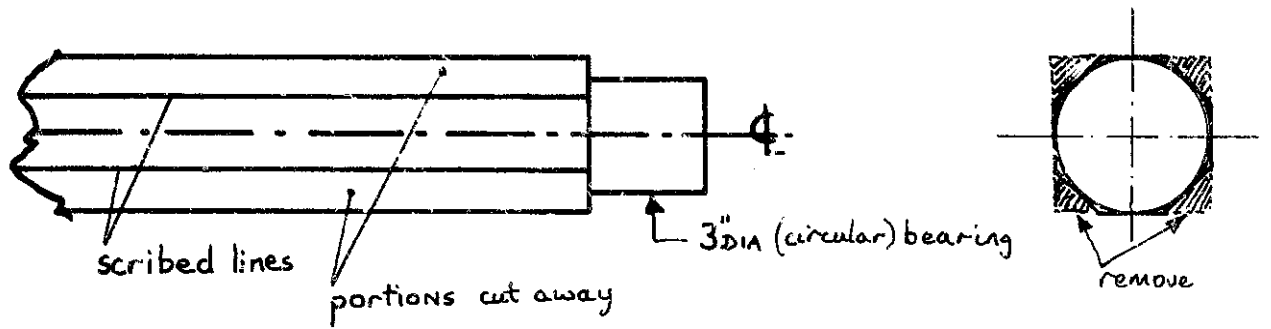
CONVERSION TABLE

8th fractions and inches to millimetres (mm)

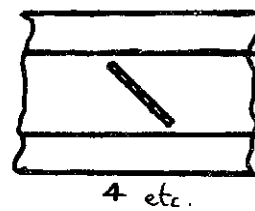
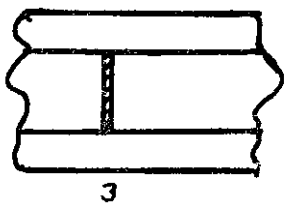
Inches	0 in	1 in	2 in	3 in.
Fractions	mm	25·400	50·800	76·200
1/8 in.	3·175	28·575	53·975	79·375
1/4 in.	6·350	31·750	57·150	82·550
3/8 in.	9·525	34·925	60·325	85·725
1/2 in.	12·700	38·100	63·500	88·900
5/8 in.	15·875	41·275	66·675	92·075
3/4 in.	19·050	44·450	69·850	95·250
7/8 in.	22·225	47·625	73·025	98·425

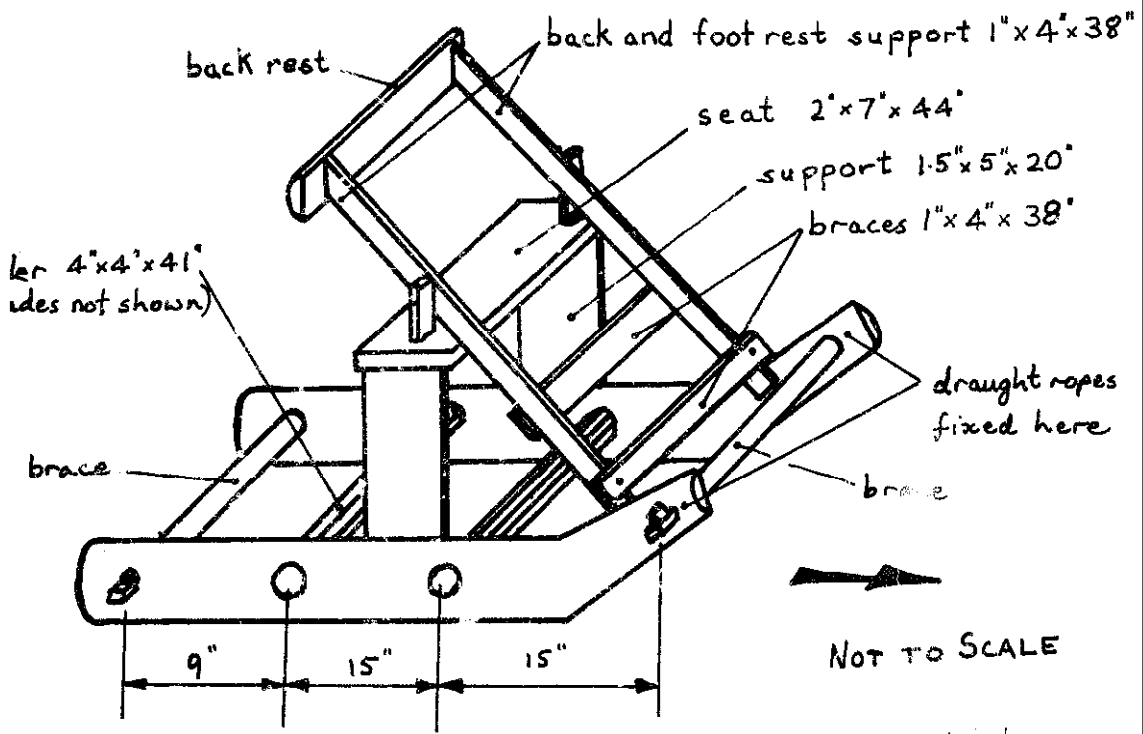
Inches	4 in	5 in	6 in	7 in.
Fractions	mm	101·600	127·000	152·400
1/8 in.	104·775	130·175	155·575	180·975
1/4 in.	107·950	133·350	158·750	184·150
3/8 in.	111·125	136·525	161·925	187·325
1/2 in.	114·300	139·700	165·100	190·500
5/8 in.	117·475	142·875	168·275	193·675
3/4 in.	120·650	146·050	171·450	196·850
7/8 in.	123·825	149·225	174·625	200·025

Inches	8 in	9 in	10 in	11 in
Fractions	mm	203·200	228·600	254·000
1/8 in.	206·375	231·775	257·175	282·575
1/4 in.	209·550	234·950	260·350	285·750
3/8 in.	212·725	238·125	263·525	288·925
1/2 in.	215·900	241·300	266·700	292·100
5/8 in.	219·075	244·475	269·875	295·275
3/4 in.	222·250	247·650	273·050	298·450
7/8 in.	225·425	250·825	276·225	301·625



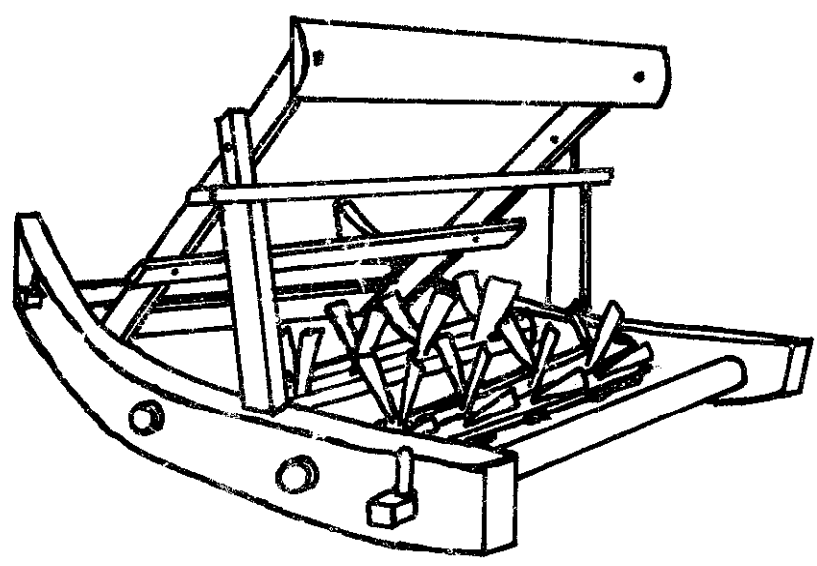
ANGLE SEQUENCE OF BLADES ON ROLLER





ler 4"x4"x41"
ides not shown)

picture
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40

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A project of Volunteers in Asia

Oil Soaked Wood Bearings: How to Make Them and
How They Perform

ITDG Agricultural Equipment and Tools No. 40

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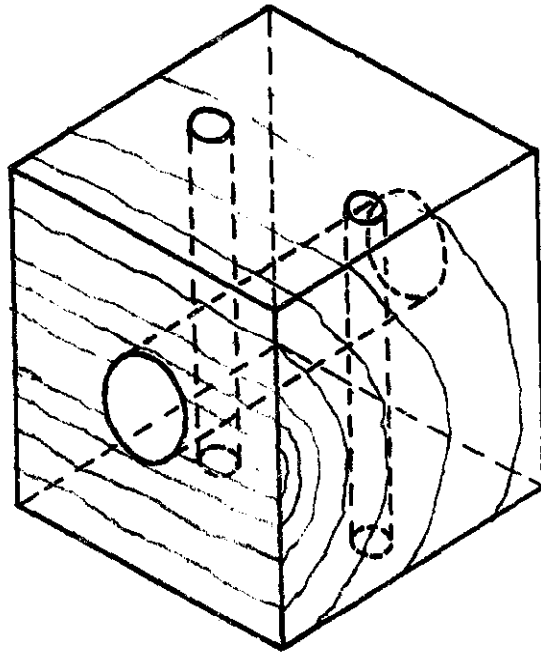
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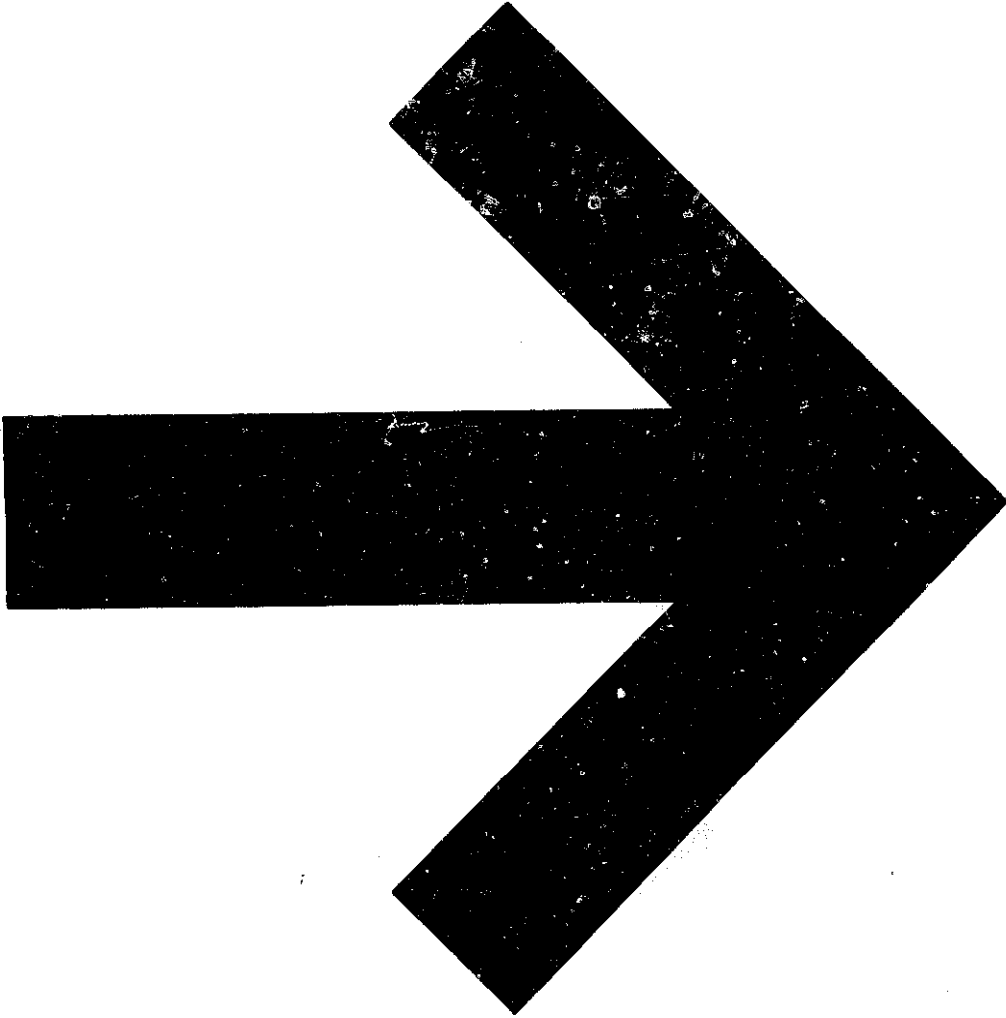
OIL SOAKED WOOD BEARINGS

How To Make Them And
How They Perform

No. 40



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Compiled by J. Collett from designs by H.S. Pearson

1. INTRODUCTION

The purpose of this leaflet is to provide some background information for both constructors and designers who wish to use wood bearings.

The type of wood to use, its treatment, lubrication, and expected performance will be discussed.

2. SOME ADVANTAGES OF OIL-SOAKED WOOD BEARINGS

Made from locally available materials.

Made by local craftsmen with woodworking skills.

Easily assembled.

Do not require lubrication or maintenance.

Operate under dirty conditions.

Easily inspected for wear.

Quickly repaired or replaced.

Can provide a temporary means of repairing a more sophisticated production bearing.

Require low tolerance on both the shafts and the housings.

3. CHOICE OF WOOD

The composition of wood is very complex, but in simple terms it consists of fibrous material bound together with a glue-like substance, water, resins, and oils.

3.1 Initial Selection

D.A. Atkinson (1972) stated that one of the essential characteristics to look for in the choice of wood is hardness.

- The harder the bearing surface, the less the deformation and the smaller the coefficient of friction
- The harder the bearing surface, the lower the rate of wear.
- The harder the bearing surface the less likely it is to breakdown prematurely, singe, and ultimately burn.
- The harder the bearing surface the greater its strength.

It is also worth noting that generally, the harder the wood, the greater its weight and the more difficult it is to work.

The oiliness of the wood is a particularly important consideration when the bearings are unlikely (or not intended) to receive lubrication during their service. Practical indicators that assist the identification of timbers which may have good self-lubricating properties are:

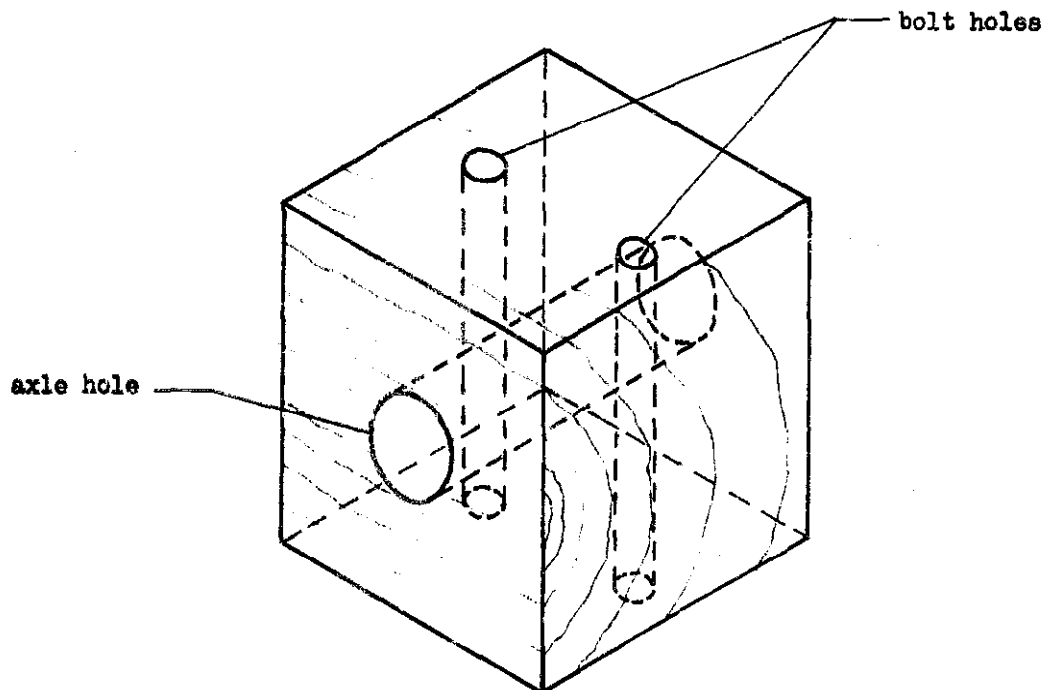
- a) they are easily polished
- b) they do not react with acids
- c) they are difficult to impregnate with preservatives
- d) glue does not easily stick to them

3.2 Other Considerations

High moisture content causes a reduction in hardness and results in greater wear. For most applications low moisture content is preferred and excess moisture must be removed to prevent subsequent shrinkage especially if the bearing is to be used as a bush.

The hardest wood is to be found in the main trunk just below the first branch.

Grain direction should be considered, and if possible advantage taken of the close grain to provide hardness at the wearing surface.



One-piece block bearing (full size)

Fig. 1.

The piece of timber selected for the bearing should be free from cracks. Some suitable timbers are listed in Table 1.

"Greasy " woods	Lignum vitae	(Gusiacum officinale)
	Tallowood	(Eucaliptus microcorys)
	Teak	(Tectona grandis)
	Blackbutt	(Eucaliptus pilularis)
Other woods	Poon	(Calophyllum tomentosum)
	Hornbeam	(Carpinus betulus)
	Degame	(Calycophyllum carididissimum)
	Boxwood	(Phyllostylon brasiliense)
	Pear	(Pyrus communis)
	Oak	(Quercus robur)
	Camphorwood	(Dryobalanops aromatica)

Table 1.

If the timber is not of the self-lubricating variety (or of doubtful self-lubricating characteristics) it can be soaked in oil to minimize the need for subsequent lubrication. It is important to have dry wood to assist maximum absorption of oil.

4. CONSTRUCTION

The following notes relate to experience gained in the "field" manufacture and testing of three types of wood bearing. All were of the oil-soaked variety.

4.1 Types of Bearing

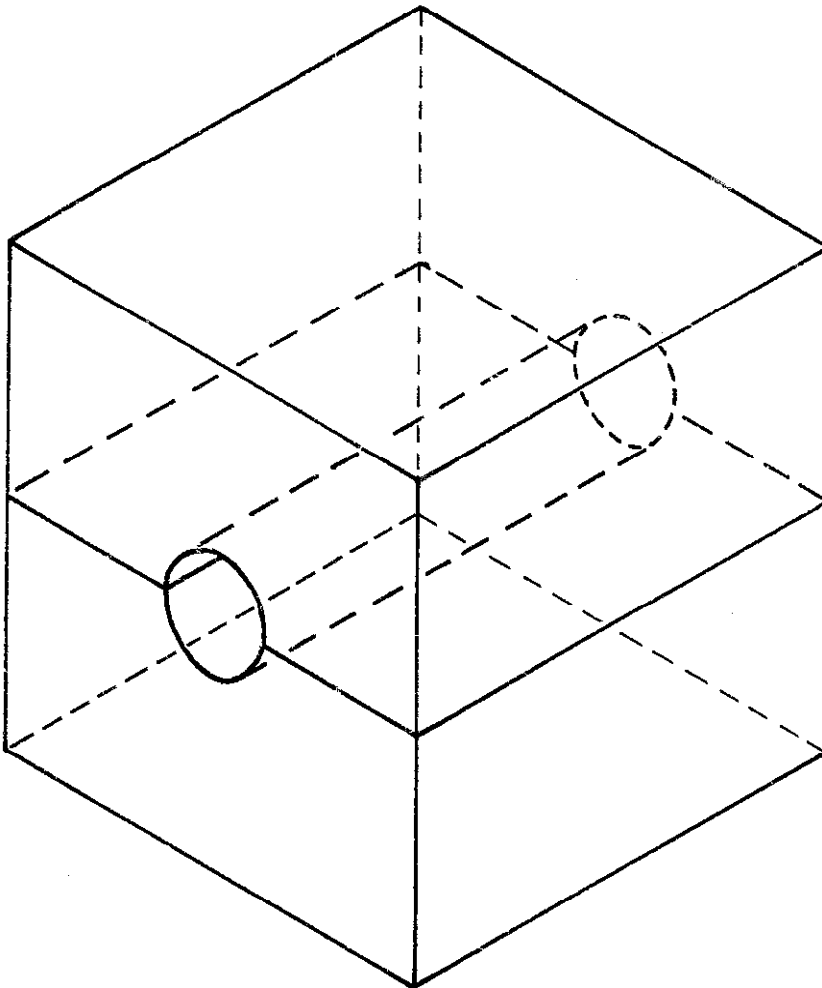
- Bush bearing
- Split-block bearing
- One-piece block bearing

4.2 General Remarks

H.S.Pearson (1975) has suggested that as a general rule-of-thumb guide to the size of timber needed for the bearing, the axial length of the bearing should be at least twice the shaft diameter. For example, for a 25mm diameter axle, the bearing should be at least 50mm long.

In the case of the block bearings, the thickness of bearing material

at any point should not be less than the shaft diameter.



Split-block bearing (half size).

Fig. 2

The drilling of radial holes for lubrication purposes is only recommended by Pearson for the bush type of bearing. He found that if lubrication holes were drilled in block bearings not only were the bearings weakened but also the holes acted as dirt traps.

The bearing should be located whenever possible in a position where falling dirt will not directly enter the bearing. For example, if the axle is carried in bearings mounted under the floor of a cart instead of a fixed axle with bearings at the hub of the wheel, then dirt falling from the rim of the wheel will not fall directly onto the bearings.

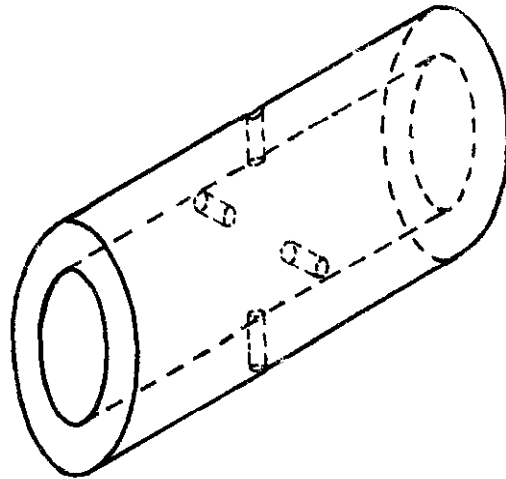
If the bearing is expected to take side-thrust, large flat washers must be used, the one next to the end of the bearing being free to rotate on the shaft.

The bearing surface of the shaft should be perfectly round and smooth and polished in appearance.

4.3 How to Make the Bearings

Available timber often has rather doubtful self-lubricating properties and high moisture content. In this instance, a simple procedure for making an oil-soaked bush bearing has been devised by the Industrial Development Center, Zaria in Nigeria. Excess water is removed and subsequent shrinkage prevented. (Shambaugh, Pearson and Jibril, 1969).

- a) Reduce the timber to a square cross section and bore a hole through the centre the same diameter as the journal on which the bearing will be working.
- b) Place the blocks into a metal container of commercial groundnut oil and keep them submerged by placing a brick on top. Raise the temperature of the oil until the water in the wood is turned into steam - this will give the oil the appearance of boiling vigorously. Maintain the temperature until only single streams of small pin-size bubbles are rising to the surface of the oil. This may take anything from 30 minutes to 2 hours depending on the moisture content of the wood.
- c) Remove the heat source and leave the blocks in the oil to cool overnight if possible. During this stage the wood will absorb oil. BE VERY CAREFUL IF YOU NEED TO HANDLE THE CONTAINER WHILST IT IS FULL OF HOT OIL. If the temperature of the oil is allowed to get too high after the bubbles have ceased to appear, the wood will change to charcoal and the bearings will be ruined.
- d) Rebore the centre hole to compensate for any shrinkage that may have taken place.
- e) Place on a mandrel and turn the outside diameter to the required measurement that will give the bush a press fit into the hub.
- f) Bore four equally spaced holes through the wall of the bush at its mid-point and fill with lubricant - in general terms, the harder the lubricant the better, so animal fat, soap or tallow are preferable although grease is an excellent alternative.

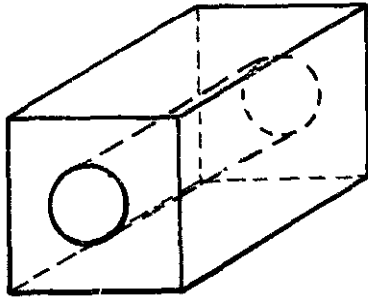


Bush bearing showing the four lubrication holes (full size).

Fig. 3

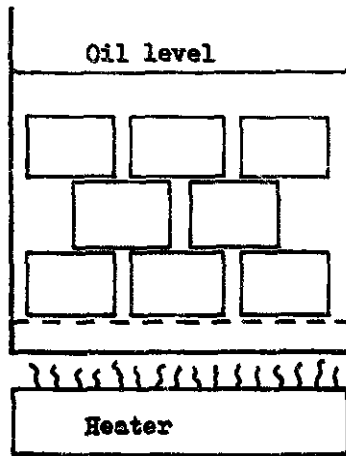
g) Finally press the bush into the hub.

The forty bush bearings made and tested at Zaria were $2\frac{1}{2}$ " long by 1.550" outside diameter with a 0.855" bore. They were pressed into $1\frac{1}{2}$ " seamless black iron Class C pipe, and turned on a $\frac{1}{2}$ " pipe journal. The wood used was mahogany (being the most readily available) and rig tests with a loading of 100 lbs and a speed of 100 - 200 rev/min indicated sufficient lubrication. These test conditions were chosen to simulate the working forces on a 7" gauge wheel of an ox-drawn plough. Tests performed on bush bearings without the four radial lubrication holes again indicated sufficient lubrication.



INITIAL PREPARATION.

Saw timber into shape of an oblong block somewhat larger than the O.D. of the finished bearing to allow for shrinkage and bore being off centre. Bore hole through centre of block the size of the journal.

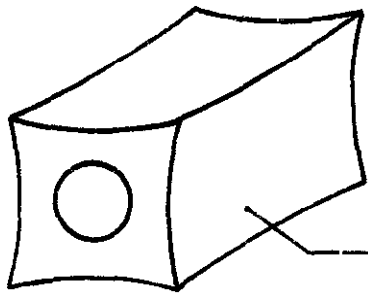


DEHYDRATION

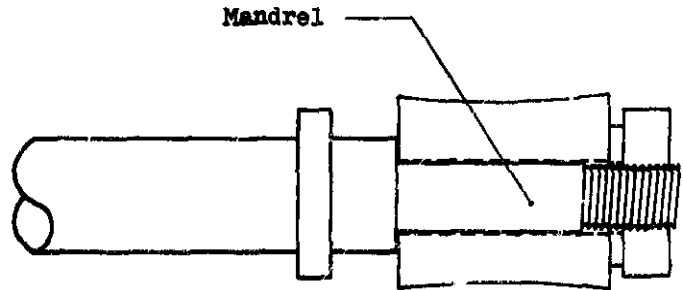
Soon after submerging the bearing blocks in hot ground-nut oil, many surface bubbles 1" in diameter, made from a multitude of smaller bubbles, will appear on the surface.

As the moisture content of blocks is reduced, the surface bubbles will become smaller in size.

When the surface bubbles are formed from single streams of pin-size bubbles, the dehydration process has gone far enough. Stop heating, and let blocks cool in the oil overnight.

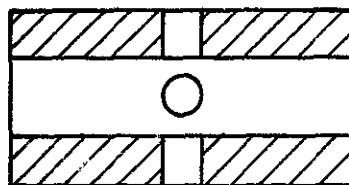
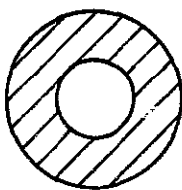


Shrunken block



FINISHING

Re-drill centre hole and place shrunken oil-soaked bearing block on mandrel and turn to the desired size.



Cross section of the finished oil-soaked wood bearing showing grease reservoir holes.

On heavy equipment such as ox-carts or where it is not possible to push the axle through a bush bearing, the split-block bearing provides a more practical solution.

It is simple to fit and replace, and if wear takes place the two halves can be changed around. After further wear, the life of the bearing can be extended by removing a small amount of material from the matching faces.

A simple procedure was devised by the GRZ/ITDG Project at the Magoye Regional Research Station in Zambia for the production of such a bearing, again using an oil soaking technique. The timber in this case was teak, and used engine-oil provided a satisfactory alternative to groundnut oil. (Coombs & Pearson, 1974)

- a) Reduce the timber to a square cross-section and cut lengthwise into two halves.
- b) The two halves of the bearing must be clamped firmly together for the drilling operation. It is most important that the hole for the axle is bored exactly square through the blocks. For the best results an electric powered pillar-drill should be used although a hand powered pillar-drill would be quite satisfactory. If neither of these is available, a jig would have to be made to keep the drill bit in line.

After drilling, the two halves should be tied together to keep them in pairs.

- c) For soaking in oil an old 20 litre (5 gal.) drum is needed. Fill it three-quarters full with used engine-oil and bring to the boil over an open fire. GREAT CARE is needed when handling the drum of hot oil. Lift the drum off the fire and carefully place the pairs of bearings into the hot oil. Put a brick on top of the last pair to stop them floating, and leave the drum and contents to cool slowly overnight.

The split-block bearings measured 150mm x 150mm x 75mm with a 38mm diameter bore. They were field tested for reliability by installing them on ox-carts fitted with iron or pneumatic wheels and carrying loads of up to 2 tons.

A radial clearance on one of these assemblies of about 1mm was found to be essential. If carefully run in at low speeds (ox work),

the clearance is increased to 1.5-2.0mm and the bearing surface attained a highly polished glass-like appearance. Having reached this condition it was found capable of withstanding journeys of a few kilometers at higher speeds (Landrover towing).

A soft pine-wood oil-soaked bearing was tested as an alternative to the hardwood bearing, and this also gave satisfactory performance but might have a shorter life.

For lower load, lower speed applications such as the seed-drive mechanism on a small planter, a smaller one-piece oil-soaked block bearing was used measuring 50mm x 50mm x 50mm with a 16m diameter bore, and this gave satisfactory results, although tests were not extensive.

The possibility of boring the axle hole by hot irons was not investigated but there should be no serious objections to this alternative.

5. PERFORMANCE

The following general points can be concluded:-

- a) The running-in period is of critical importance. It is characterised by a high initial rate of wear whilst smoothing and polishing of the bearing surface takes place, after which wear becomes approximately proportional to time.
- b) The greater the speed of rotation, the greater the wear, especially during the running-in period.
- c) The greater the axle loading, the greater the rate of wear.

More specifically, wear is approximately proportional to load, BUT increases rapidly for small increments in speed.

Very high loading and low speeds should be avoided since this results in a jerking movement of the journal in the bearing and subsequent shaking and vibration will result in wear of other parts.

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A project of Volunteers in Asia

Harrows: High-Clearance Peg Tooth, Triangular
Spike Tooth, Flexible Peg Tooth and Japanese
Harrow

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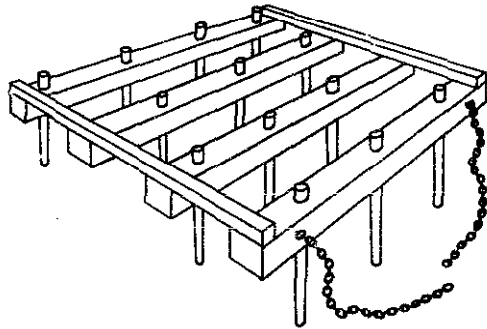
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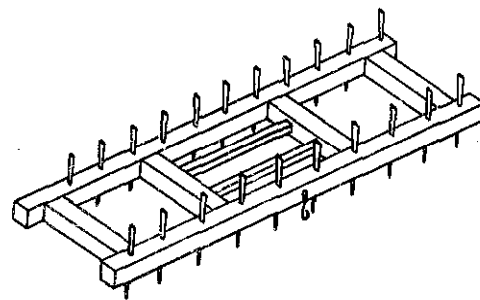
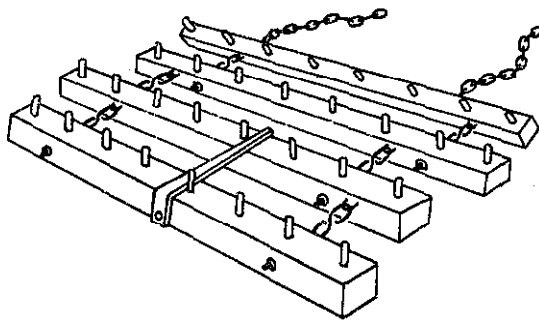
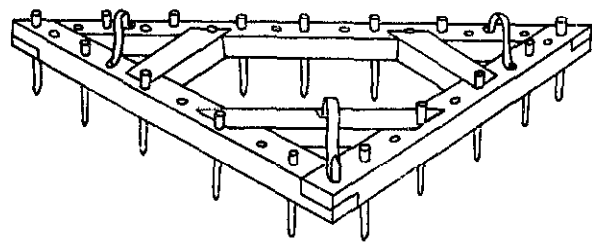
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No. 41

HARROWS



Triangular Spike-Tooth
High Clearance Peg Tooth
Flexible Peg Tooth
Japanese Harrow



HIGH-CLEARANCE PEG-TOOTH HARROW

DEVELOPED BY: Ministry of Agriculture, Tanzania.

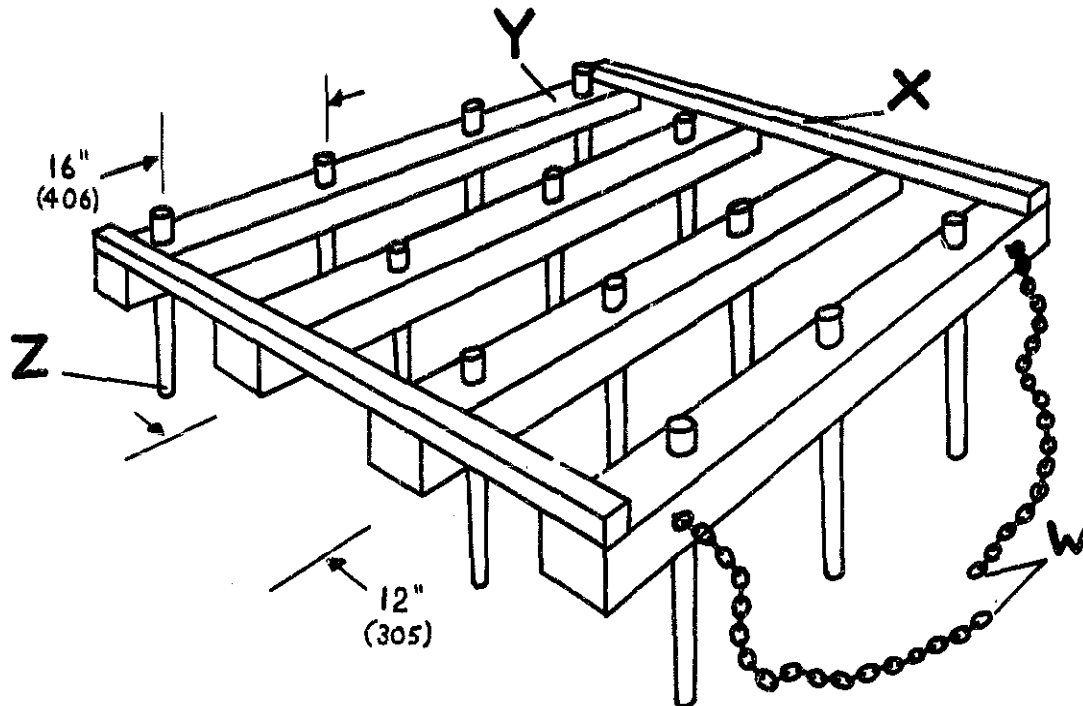
DESCRIPTION: This harrow is constructed entirely of timber. Its high ground clearance and wide tooth spacing make it suitable for working in minimal tillage systems where it is advantageous to leave a trash cover on the soil surface.

It can be used following sweep tillage operations to break down soil clods before crop planting, and also for covering of seed after broadcast seeding.

Note: Figures in brackets are in millimetres.

KEY:

<u>ITEM</u>	<u>NAME</u>	<u>QUANTITY</u>	<u>ITEM DESCRIPTION</u>
W	DRAUGHT CHAIN	2	Mild steel chain.
X	FRAME SIDE	2	Of 2" x 2" x 40" (51 x 51 x 1016) hard wood.
Y	CROSS BEAM	4	Of 4" x 4" x 60" (102 x 102 x 1524) hard wood.
Z	PEG	13	Of 1" (25) diameter hard wood, 16" (406) long with 10" (254) protruding below frame beams, peg teeth staggered in each row to give 4" (102) overall tooth spacing.



FLEXIBLE PEG-TOOTH HARROW

DEVELOPED BY: Locally-built design from Iran (extract from Central Treaty Organisation economic publication No. 47).

DESCRIPTION: A low-cost peg-tooth harrow designed for animal or tractor power.

The flexible linkage between the bars helps to make the harrow self-cleaning, and the linkage arrangement is designed to keep the teeth upright while in use. The bars are offset to give an average tooth spacing of 2" (51).

Note: Figures in brackets are in millimetres.

KEY:

<u>ITEM</u>	<u>NAME</u>	<u>QUANTITY</u>	<u>ITEM DESCRIPTION</u>
A	DRAUGHT CHAINS	2	Mild steel chain
B	LINKAGE ASSEMBLY	6	$\frac{1}{2}$ " (19) diameter mild steel eye-bolts and 'S' hook links.
C	AR	4	Each of 4" x 4" x 64" (102 x 102 x 1626) hard wood.
D	TOOTH	32	Each 10" (254) in length, of $\frac{1}{4}$ " (19) diameter hard wood or $\frac{1}{4}$ " (19) square section steel bar.

"JAPANESE" HARROW

DEVELOPED BY: Locally-built design from Japan.

DESCRIPTION: A simple rigid two-row harrow with its flat-steel teeth driven through the wooden frame. The teeth are spaced 6" (152) apart in each row.

This implement has a cutting action, the narrow edge of the teeth being parallel to the line of draught.

Note: Figures in brackets are in millimetres.

KEY:

<u>ITEM</u>	<u>NAME</u>	<u>QUANTITY</u>	<u>ITEM DESCRIPTION</u>
X	FRAME CROSS MEMBER	4	Each of 2" x 2" x 18" (51 x 51 x 457) hard wood.
Y	TOOTH	As required	Each of 1" x $\frac{1}{4}$ " (25 x 6.3) mild steel, 9" (229) long and tapered towards working end.
Z	MAIN FRAME MEMBER	2	Each of 2" x 2 $\frac{1}{2}$ " (51 x 63) hard wood, 66" (1676) long.

TRIANGULAR SPIKE-TOOTH HARROW

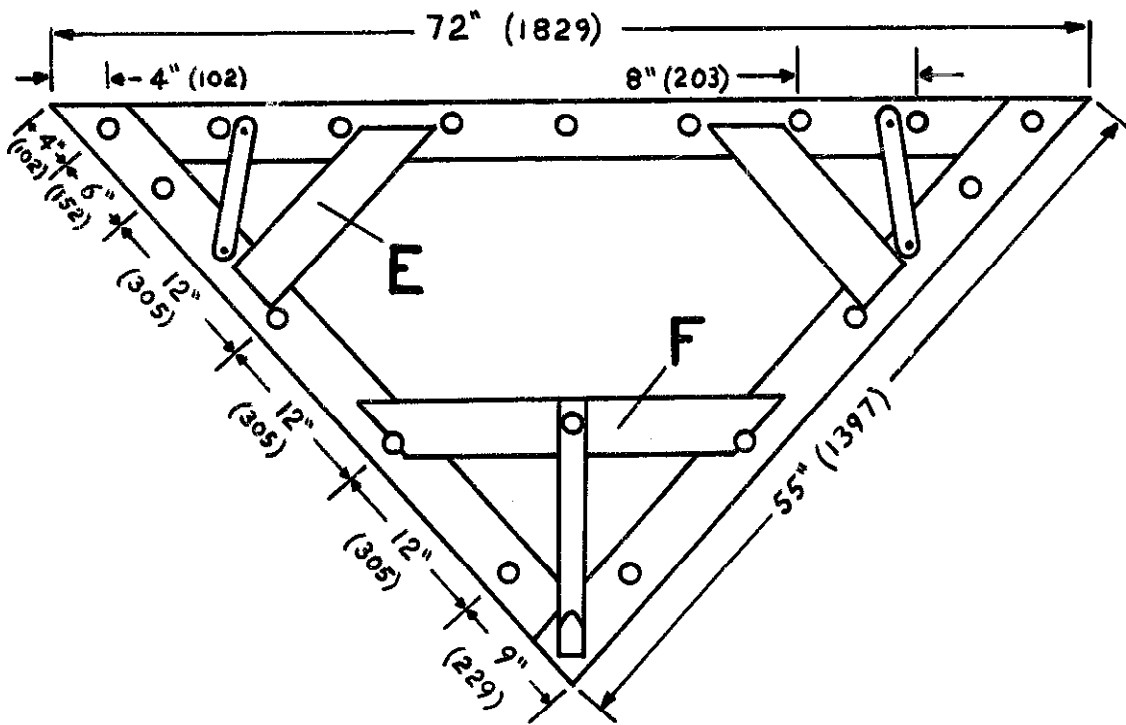
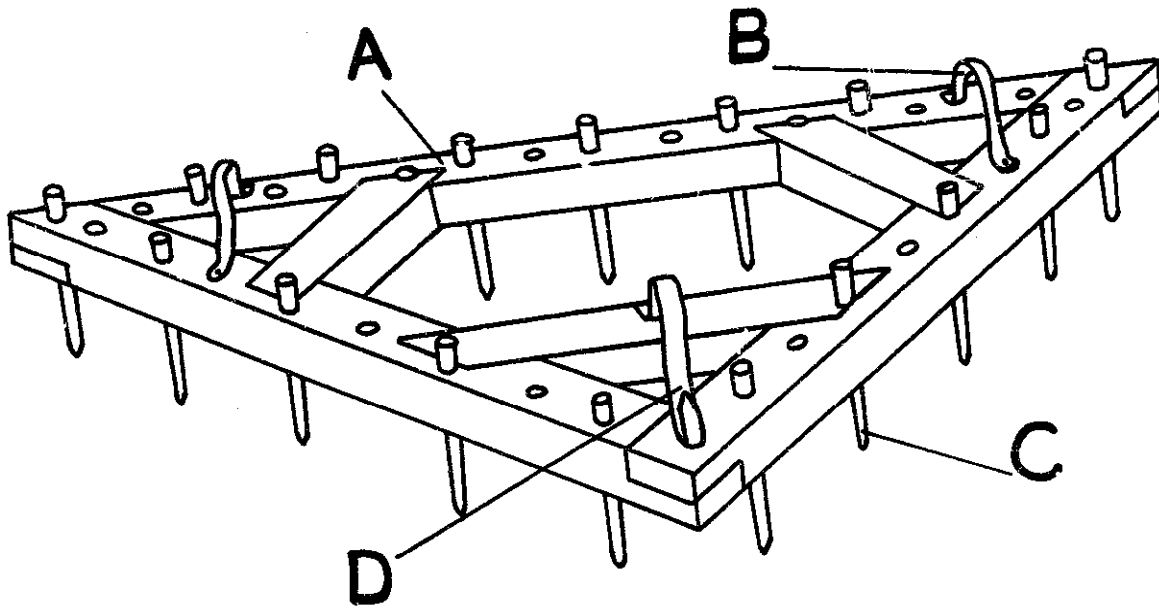
DEVELOPED BY: Originally designed in India.

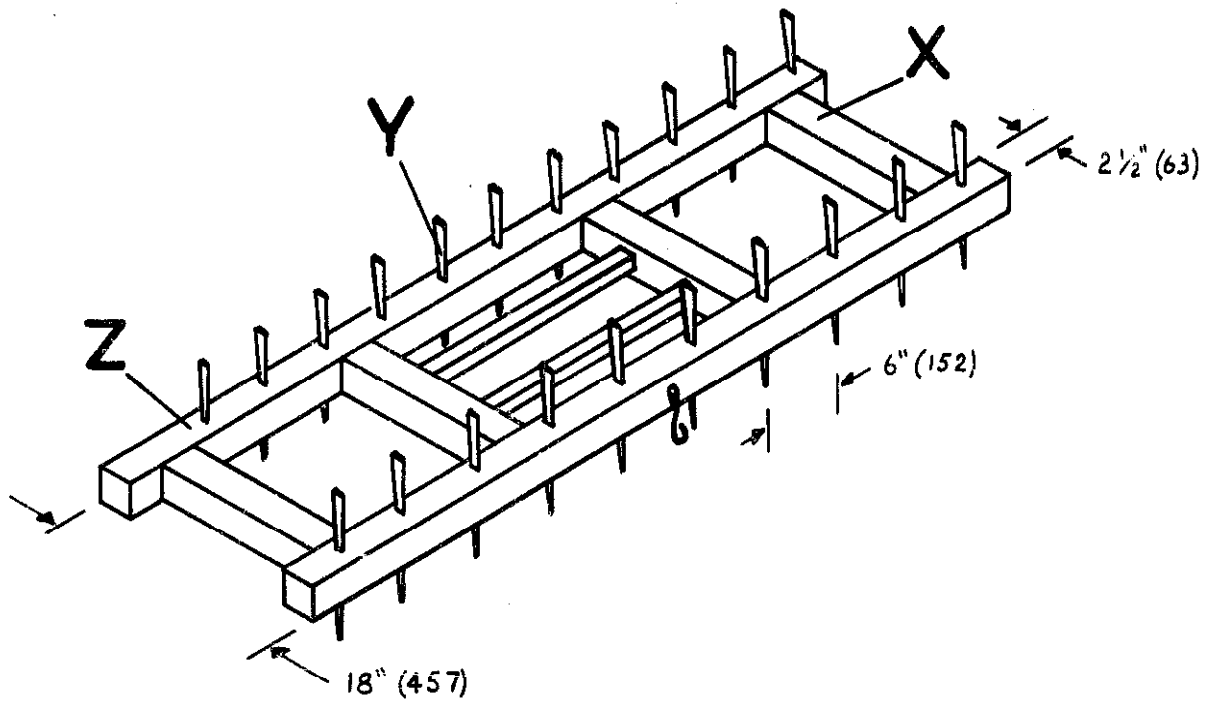
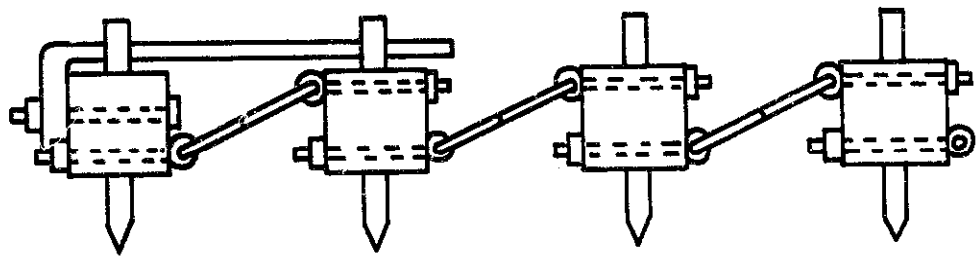
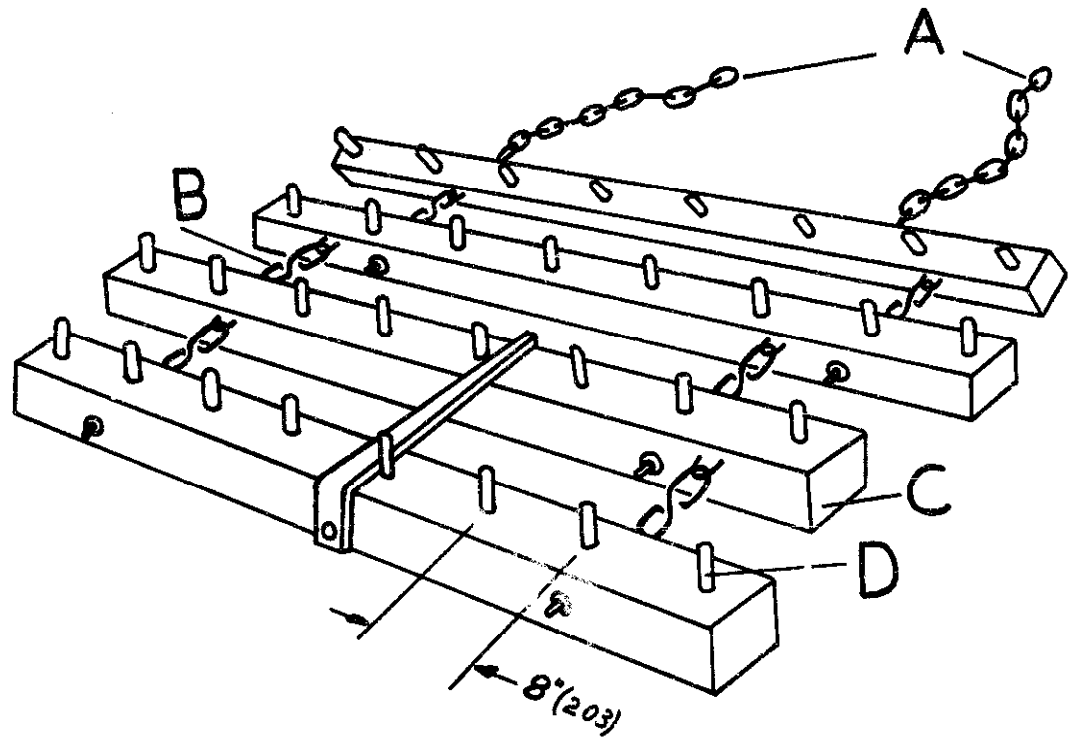
DESCRIPTION: The teeth of this harrow can be made of hard wood or mild steel. In the drawing overall tooth spacing is shown as 4". Tooth spacing can be varied to suit the soil conditions by removing teeth to give wider spacing or by drilling holes and inserting additional teeth to give closer spacing. The harrow can be used for preparing a seedbed, after ploughing, and for covering the seed after broadcasting. While in work the harrow should be horizontal and this is achieved by adjusting the length of the pulling rope or chain. The harrow can be loaded with logs or stones to give greater penetration when necessary. For transport to and from the field the harrow is turned on its back and runs on the skids.

Note: Figures in brackets are in millimetres.

KEY:

<u>ITEM</u>	<u>NAME</u>	<u>QUANTITY</u>	<u>ITEM DESCRIPTION</u>
A	MAIN FRAME	1	Made of one piece 3" x 4" x 72" (76 x 102 x 1829) and two pieces 3" x 4" x 55" (76 x 102 x 1397) hard wood.
B	SKID	2	Each of $\frac{1}{2}$ " x $1\frac{1}{2}$ " x 23" (12.5 x 38 x 584) mild steel.
C	TOOTH	(As required)	Each of $\frac{3}{4}$ " x $\frac{3}{4}$ " x 12" (19 x 19 x 305) mild steel or $\frac{3}{4}$ " (19) diameter x 12" (305) hard wood.
D	TOWING HOOK/ SKID	1	$\frac{1}{2}$ " x $1\frac{1}{2}$ " x 29" (12.5 x 38 x 737) mild steel.
E	REAR STRUT	2	Each of 3" x 4" x $17\frac{1}{2}$ " (76 x 102 x 444) wood.
F	FRONT STRUT	1	3" x 4" x $23\frac{1}{2}$ " (76 x 102 x 597) wood.





42

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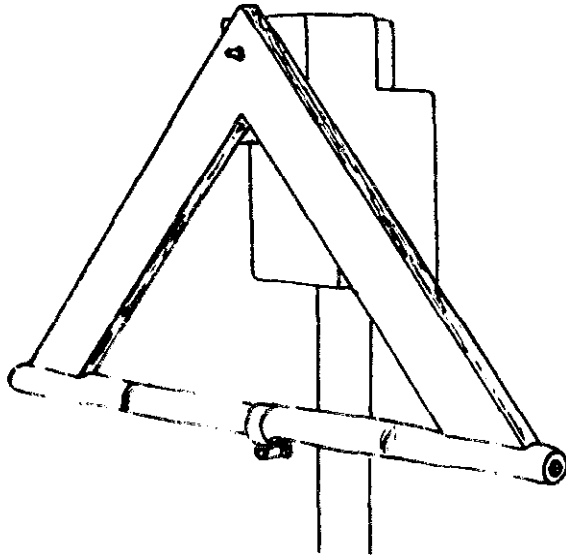
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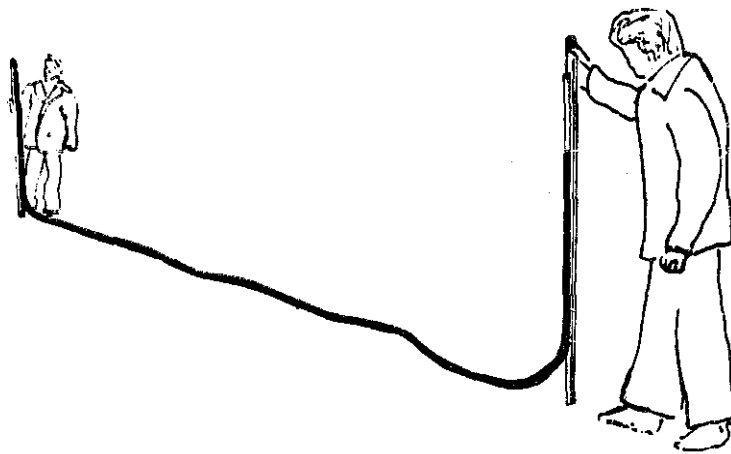
AGRICULTURAL EQUIPMENT AND TOOLS FOR FARMERS DESIGNED FOR LOCAL CONSTRUCTION

No. 42

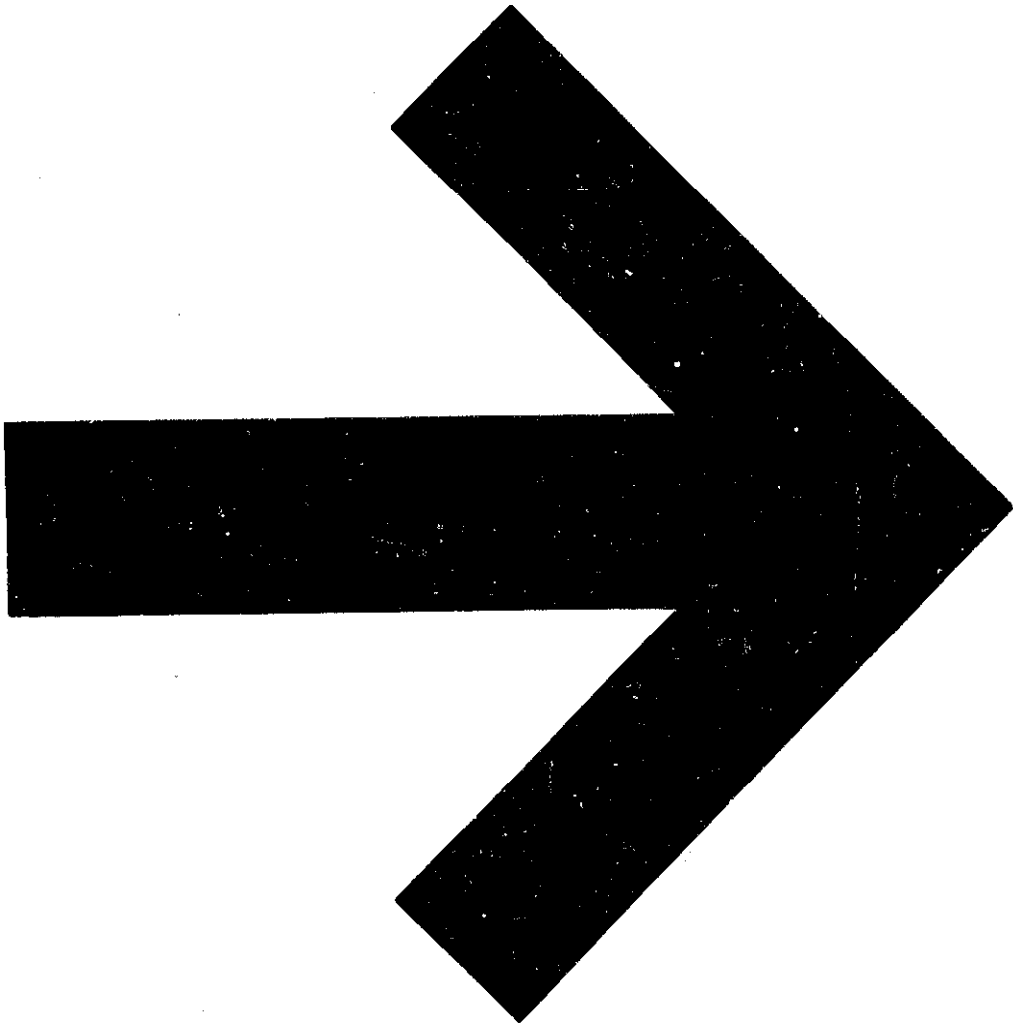


EIGHT SIMPLE SURVEYING LEVELS

CONSTRUCTED AND COMPARED BY
JOHN COLLETT
AND
JOHN BOYD



**Intermediate
Technology** Publications Ltd
9 King Street, London WC2E 8HN, England
Telephone 01-836 6379



EIGHT SIMPLE SURVEYING LEVELS

Constructed and Compared by

John Collett

and

John Boyd

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SIMPLE SURVEYING LEVELS

Introduction

The surveying instrument most used on farms in developing countries is the level. It can be used to make a map before starting earthmoving work, it can be used to mark out on the ground either level contours, or else lines with a small, uniform slope for drainage, irrigation, soil conservation, roadmaking or building work.

Modern surveying instruments are very accurate, but expensive and easily damaged and need skilled workers to operate, adjust and repair them. The levelling work on small farms often does not require extreme accuracy because lines are being marked out on ordinarily rough field surfaces. There is, therefore, a case for examining alternatives to the modern surveyor's level which would be cheaper, simpler to operate and still reasonably accurate. This is what has been attempted here.

The Levelling Devices

The simple levelling devices tested can be divided into two groups:

1. *Levels with which the operator sights along a horizontal line to take readings on a graduated staff held by a second man some distance away.*

This is the same method used with a modern surveyor's level.

2. *Levels which do not require sighting onto a distant staff.*

The accuracy of these devices is not affected by the operator's eyesight or by the lighting conditions.

These simple levels did not have telescopes fitted with cross hairs, which are the costly parts of modern levels. Various types of simple sights were fitted and a clear target attached to the staff, but it was still not possible to read the staff consistently to within less than ± 5 mm at a distance of 10m. The accuracy of any level which requires sighting onto a distant staff is affected by the operator's eyesight and the degree of daylight.

A modern surveyor's level is usually mounted on a tripod, which is itself rather expensive to buy, difficult to make and awkward to carry. For simplicity, the devices tested were supported on a simple pole, although a tripod would be necessary on very hard ground. The pole was 1.5m long and 28mm diameter. One end was sharpened to a point and fitted with a protective metal sheath. The mounting block was made from a 140mm x 90mm x 70mm piece of softwood and was drilled with a 30mm diameter hole to a depth of 80mm using a brace and bit. The top of the pole was smoothed with glass paper until the block rotated freely. A 6mm diameter hole was drilled to take a carriage bolt for securing the instruments to the block.

SQUARE AND PLUMB

Construction

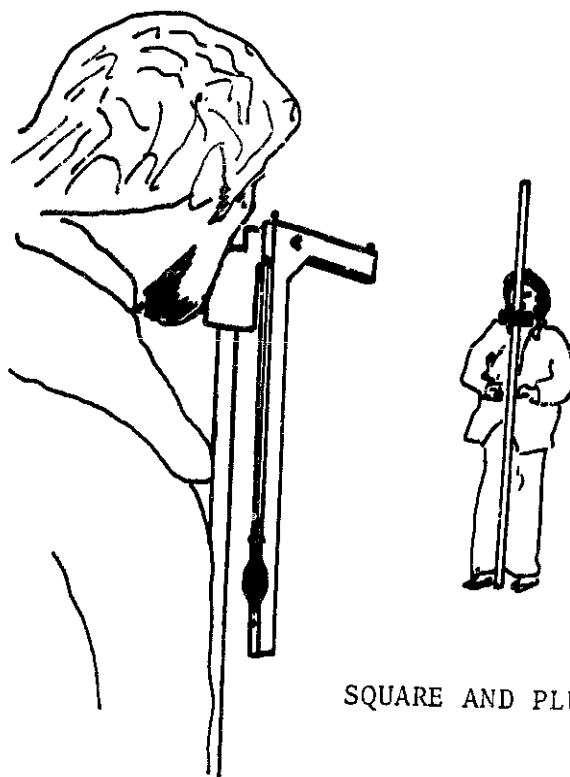
A right-angle square with arms 450mm long was cut from a sheet of 12mm thick plywood. A pair of sights was screwed into the top of the horizontal arm and a hook and marker fixed to the vertical arm for use with a plumb. The sights were adjusted so that when the plumb registered with the marker, the top edge was exactly horizontal. A 6mm diameter hole was drilled through the horizontal arm for the securing bolt.

Use

The instrument was attached to the mounting block by a carriage bolt and wing nut. It was aimed at the staff and then levelled by adjusting its angle until the plumb was exactly over the marker. The wing nut was then tightened. It was difficult to read the staff through the sights, although a moveable target on the staff made sighting easier.

Results

No testing was possible because the plumb bob was blown about by the wind.

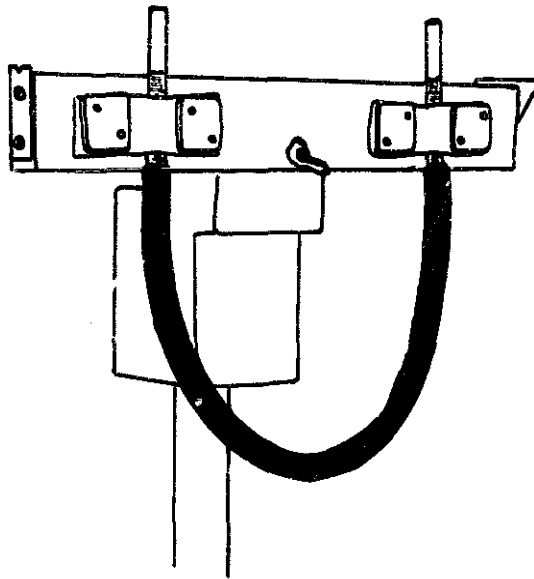


SQUARE AND PLUMB

WATER MANOMETER

Construction

A 300mm length of planed 40mm x 20mm soft wood was fitted with two rubber straps made from motor tyre inner tube and secured with nails and thin hardboard pads. Each end was fitted with a sight cut from scrap sheet metal. A 6mm diameter hole for the mounting bolt was carefully drilled through the wood at the mid-point. A 100mm length of glass tube (7mm internal diameter) was inserted behind each strap and the lower ends joined with a 400mm length of rubber tubing. Water was poured into the U-tube arrangement until the level in each glass tube was about 30mm from the top. The ends were fitted with stoppers to prevent loss of water whilst transporting the instrument.

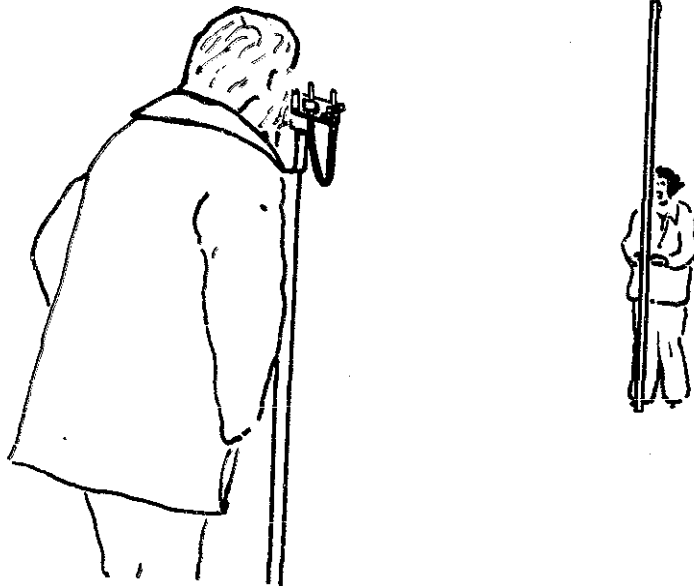


WATER MANOMETER

Uses

The mounting pole was pressed firmly in the ground as nearly vertically as possible. The mounting block was placed on top of the pole and the instrument secured by a carriage bolt and wing nut. The device was aimed at the staff at the first station, about 10 metres away. It was then levelled by removing the two stoppers and adjusting the angle until the two menisci were exactly level with the top edge of the wood. (Sometimes it was necessary to slide the glass tubes up or down in their rubber strap holders to achieve this condition.) Sighting from about 300mm behind the rear sight, it was possible to line up the horizontal front sight and read the staff. A moveable horizontal target on the staff made sighting easier.

TAKING A READING



Results

The staff could be read at a distance of 8-10 metres, but this range depends on the operator's eyesight. A 50 metre line was laid out 'on the contour' and checked with a modern optical surveying level. The worst error was 42mm in height over a horizontal distance of 8 metres.

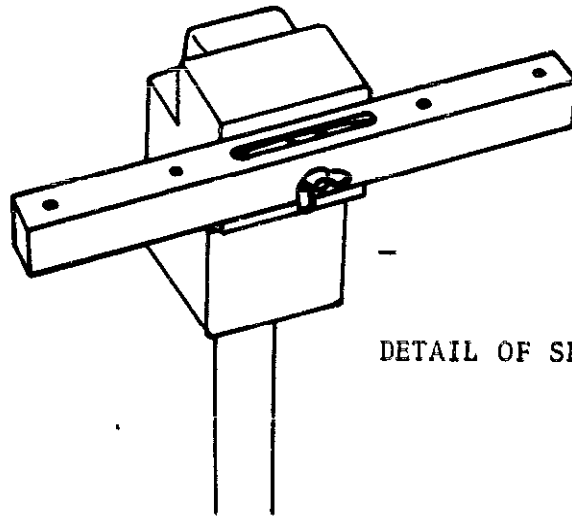
Evaluation

Various types of water manometer have been described in surveying literature. Devices that require sighting along or through two menisci without the aid of a straight edge are difficult to use and liable to large errors. The inclusion of a sighting edge makes this a more practicable instrument. With care it would be used for setting level lines or graded lines of slopes not less than 1 in 200. The device must be kept upright when moving position to avoid loss of water, or alternatively the tubes can be stoppered.

SPIRIT LEVEL

Construction

A cheap wooden-cased spirit level 250mm long formed the basis of this instrument. A 6mm diameter hole for the securing bolt was drilled through the case, care being taken to avoid the glass tube.



DETAIL OF SPIRIT LEVEL

Use

The pole and mounting block were again used for support. The instrument was aimed at the staff and then levelled by adjusting its angle until the bubble was exactly between the centre marks. No sights were fitted to this device and sighting was achieved by looking along the top edge of the level. As before, a moveable horizontal target on the staff made sighting easier. Wind caused some movement of the apparatus, making exact setting of the bubble difficult. Wind effects could be eliminated if the level were mounted on a tripod.

Results

The ability to read the staff was dependent on the operator's eyesight and limited the range to 8-10 metres. A 100m line was laid out 'on the contour' and the worst error was measured as 30mm over a distance of 9 metres.

Evaluation

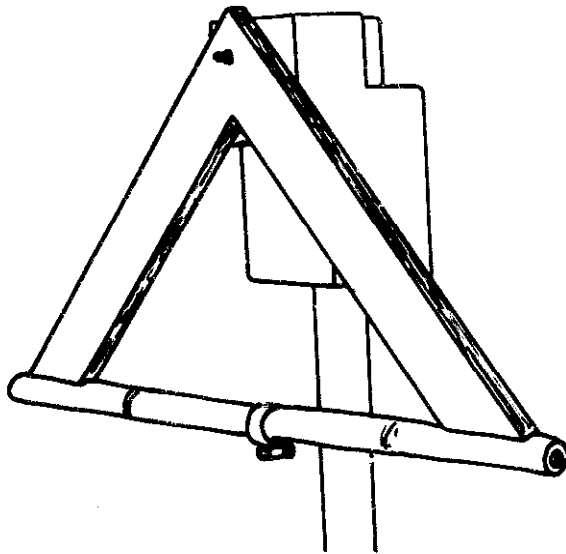
If a spirit level is available it is a simple matter to convert it into a sighting level. With care it could be used for setting level lines or graded lines of slopes not less than 1 in 300.



ROAD TRACER

Construction

This device consisted of a triangular wooden frame, free to swing on its supporting bolt. The base of the triangle served as a sighting tube and was made from a 450mm length of bamboo cane. The nodes were drilled out from each end. One end was fitted with cross wires (thin wire glued into slots) whilst the other end was covered with tape pierced with a viewing hole. A hose clip was used as the balance weight and this was placed over the bamboo tube before the latter was glued to the suspending A-frame. An 8mm diameter hole was drilled near the top of the A-frame so that the instrument could swing freely on the carriage bolt.



DETAIL OF THE ROAD
TRACER SHOWING THE
HOSE CLIP ON THE
BAMBOO POLE

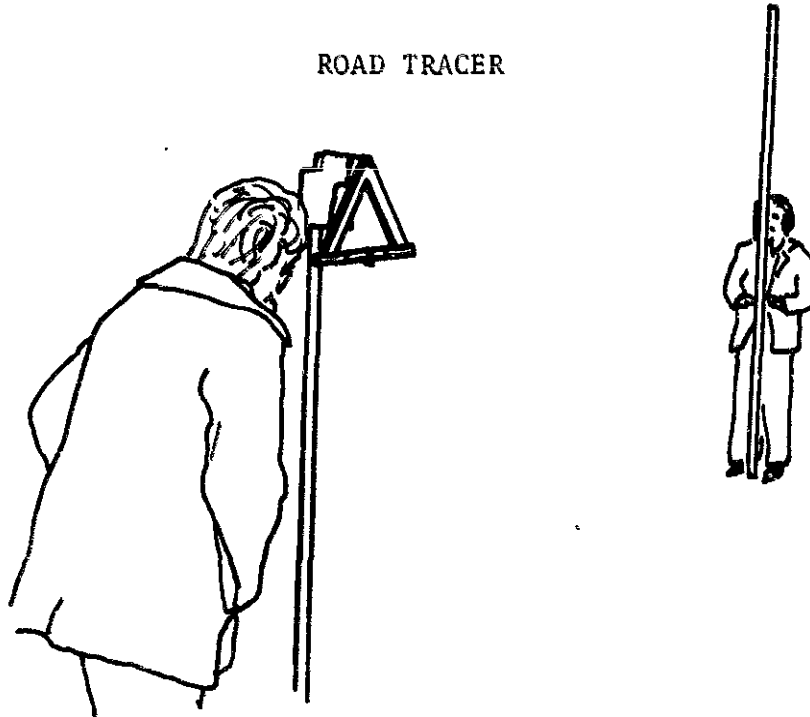
Setting the Instrument

The road tracer and the staff were placed side by side on a flat surface and the moveable target on the staff was adjusted to be exactly level with the cross wires. The staff was then moved to a point about 20m away from the road tracer, chosen so that the target appeared to be at the same level when viewed through the sighting tube. The positions of the staff and the instrument were then reversed to check if there was any difference in the reading. Adjustment for the error was made by moving the balance weight so that half of the difference in readings was removed. The weight was secured and the procedure repeated to check the setting.

Use

To set out a level contour line, after checking the setting of the instrument, the staff was placed next to the road tracer and the target adjusted to coincide with the cross wires. The staff was then moved to a point about 10 metres away and moved up or down the slope until the target again coincided with the cross wires when viewed through the tube. The road tracer was then swung slightly and allowed to come to rest again so that the reading could be checked. If the reading was confirmed, the position was marked with an arrow and the staff moved on. The device was adversely affected by any wind and it was essential to use a target on the staff.

ROAD TRACER



Results

The range was limited to a maximum of about 20 metres by the operator's eyesight. A line was laid out on the contour and checked with a modern instrument. The worst height error was 59mm over a distance of 10 metres.

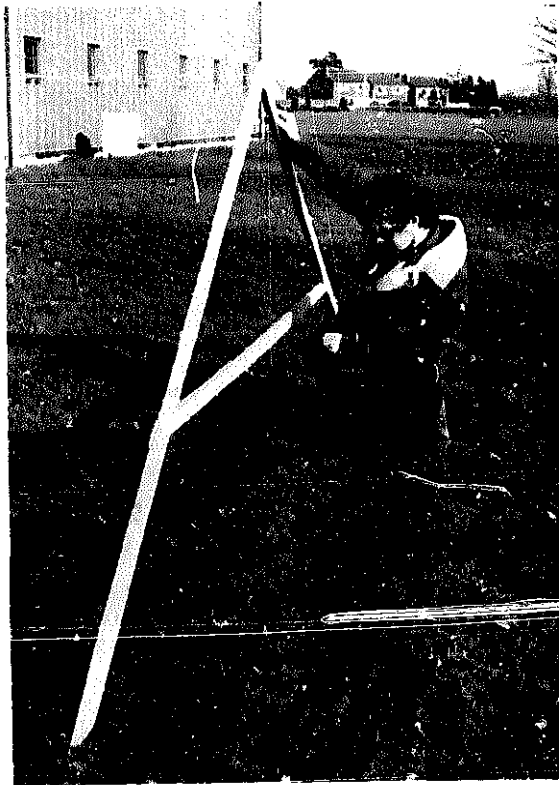
Evaluation

Care and patience are needed with this device to allow it to come to rest. Heavier construction, e.g. of steel, would make it less susceptible to movement by the wind. The need to 'set' the instrument and check both the setting and results is a disadvantage. Its use is restricted to level lines and graded lines of slopes not less than 1 in 200.

A-FRAME AND PLUMB

Construction

Two 2.5m lengths of 60mm x 20mm soft wood were laid together at one end and spread apart by 4m at the other. The joint was glued and screwed. Another piece of 60mm x 20mm wood was glued and screwed to the side pieces so that it formed the horizontal of the A-frame. The 'feet' of the frame were cut level after marking with a long straight piece of wood. A hook was screwed into the frame near the apex for attachment of the plumb.



Setting the Instrument

Two bricks were placed 4 metres apart and the A-frame was placed upon them. When the plumb came to rest, the position of the string was marked on the horizontal bar. The frame was then placed the other way round on the same bricks and the procedure repeated. A permanent mark was then made halfway between these two marks to show when the feet of the frame were exactly level.

Use and Results

To set out a level contour, one leg of the frame was placed at the starting point and the other was positioned so that the plumb registered with the permanent mark. This position was marked with an arrow. The frame was then moved up to this arrow and the procedure repeated. Care was taken to get the plumb as close as possible to the marker. Although the plumb was affected by the wind it was possible to damp the movement by allowing the cord to rub against the frame. A line was laid on the contour and the worst height error was 13mm in 4 metres.

Evaluation

Progress with this instrument can be quite fast even though each 'step' is limited by the physical span of the frame. The taller the frame, the more sensitive the instrument becomes to differences in level. The device described here could be used for setting level lines or graded lines of slopes not less than 1 in 500.

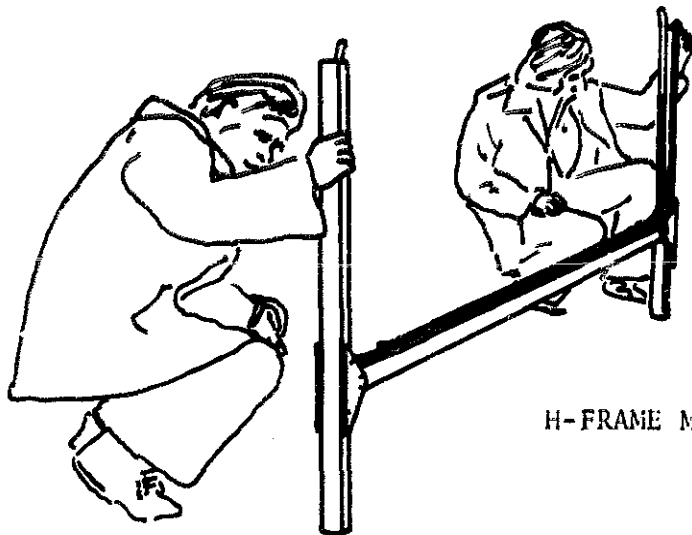
H-FRAME MANOMETER

Construction

The frame of this device was made from two 1m high uprights (50mm x 50mm softwood) and a 2.5m horizontal joined to form an H shape. A 1m length of clear plastic tube (12mm internal diameter) was secured to each end of a 2m length of metal conduit using hose clips. The conduit was attached to the horizontal of the frame with nails, and the plastic tube fastened to the uprights with soft wire. Water was poured in until the level was about halfway up each tube. The tube ends were stoppered to prevent loss of water during transport.

Setting the Instrument

Two bricks were placed 2.5 metres apart and the feet of the frame placed upon them. The stoppers were removed and a mark was made on each wooden upright, level with the bottom of the meniscus. The frame was placed on the bricks the other way round, the procedure repeated and two more marks made. A permanent mark was then made midway between the marks on each upright. Finally the stoppers were replaced for transport.



H-FRAME MANOMETER

Use and Results

A level line was laid out by placing the foot of one of the uprights at the starting point, removing the stoppers and moving the leading foot until the bottom of the meniscus was level with the permanent mark. With two operators, the following man could observe his reading to provide a check, (it should also be opposite the mark). The position of the leading foot was marked with an arrow, the stoppers replaced, and the frame moved forward to repeat the procedure. In this way a line was set on the contour and the worst height error was measured as 8mm over a distance of 2.5 metres.

Evaluation

Care was needed to avoid spilling water whenever the instrument was moved. Although each 'step' was limited to 2.5 metres, (the span of the frame) progress with the device was comparable with the previous levels. It could be used for setting level lines or graded lines of slopes not less than 1 in 300. A refinement could be made by attaching a scale to the uprights for measuring height differences.

FLEXIBLE TUBE WATER LEVEL

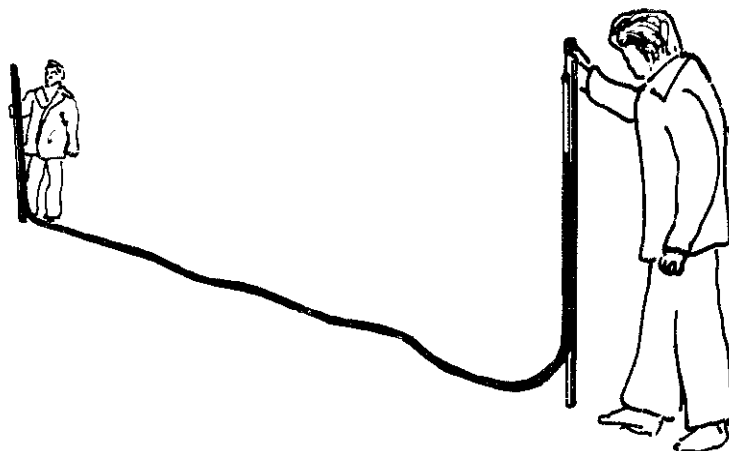
Construction

Two 1.6m wooden staves (40mm x 20mm) had battens (2m x 10mm) nailed to one side of the broad face. A 1.5m tape was carefully glued to each batten with the zero level with the end of the batten. The two ends of a 13m length of clear non-reinforced PVC tube (16mm internal diameter) were attached to the staves by drilling four 1.5mm holes at 400mm centres and using soft wire to secure the pipe firmly against the edge of the batten. The tube was then slowly filled with water, care being taken to expel all air bubbles, until the level was about 1m high in each of the stand pipes when they were held together. The ends of the tube were fitted with rubber stoppers to prevent loss of water during transport.

Use

To set a level line, the two stand pipes were brought together at the starting point, the stoppers removed and the readings taken level with the bottom of each meniscus. (The readings should be the same and may be marked with a pencil.) The ends of the tube were then stoppered and the lead man took his standpipe and stretched out the tube in the direction of the line. The stoppers were carefully removed and the lead man moved his standpipe up or down the slope until he obtained the original reading. (At this point, the following man could look at his reading which should also be the same - this provided a simple checking procedure.) An arrow was placed by the lead man, stoppers were replaced and both men moved forward to repeat the operation.

FLEXIBLE TUBE WATER
LEVEL





Results

If care was taken, the accuracy of reading the meniscus was $\pm 0.5\text{mm}$, (the smallest graduation of the tape being 1.0mm). It did not take long for the levels in the stand pipes to settle, and progress was quite fast. When moving the instrument the procedure to avoid spilling should be observed. A line was laid on the contour and the worst height error was 10mm over a 10 metre distance.

Evaluation

The accuracy of this device was far superior to the other instruments, and it was one of the fastest to use. However, its construction relies upon the availability of clear plastic pipe. This is only strictly necessary for the standpipe portions as the joining length could be any type of hose. The instrument does not rely on good eyesight for sighting purposes. A possible disadvantage is its bulkiness although the instrument described here was easily carried by one man. With care it could be used for setting level lines or graded slopes not less than 1 in 1000.

LINE LEVEL

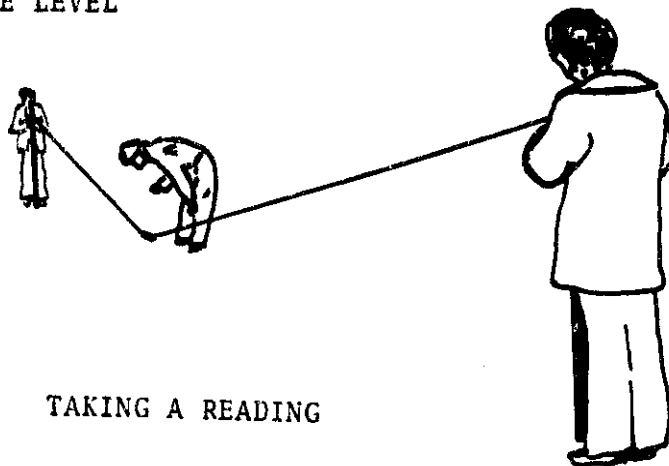
Construction

A cheap wooden-cased spirit level 250mm long formed the basis of this instrument. A small screw-eye was screwed into each end face (on the centre-line and close to the top face) and a 10m length of cord tied to each eye. Two staves were made by glueing 1.5m tape measures onto straight battens.

Use

Three people were needed to operate this device - one with a staff at each end of the cord, and the third at the centre watching the spirit level. The leading staff man either moved his position up or down the slope, (for laying out contours) or moved the string up or down the staff when measuring height differences. The centre man gave the instructions by observing the spirit level. Even though the device swayed around in the wind it was still easy to see the bubble, which came to rest after a few seconds.

LINE LEVEL



TAKING A READING

Results

The range of the device depends on the length of the line, in this case 20 metres. 5 arrows were set on the contour in 5 minutes and the worst height error was 55mm in 20m.

Evaluation

Of the instruments tested the line level gave the fastest rate of progress. Accuracy might be improved by suspending the level from the line in a different manner to ensure that it always hangs correctly. It was the most compact of the eight devices (the level and cord could be carried in a pocket) and with care could be used for setting level lines or graded lines of slopes not less than 1 in 300.

SUMMARY

Eight simple surveying levels were constructed and compared. Those which involved sighting onto a distant staff were the least satisfactory. Of the remaining four levels, the flexible tube water level was the most accurate, but the most expensive. The wooden A-frame and plumb line and the rigid H-frame manometer were simple to use but cumbersome to transport. The line level (small spirit level and cord) was cheap, fairly accurate, quick to use and easy to carry, but needed three operators.

All the levels were made using simple hand tools. The materials used included wood, screws, nails, string, scrap sheet metal, glass, rubber tube, plastic tube, soft wire and a length of metal conduit.

CONCLUSIONS

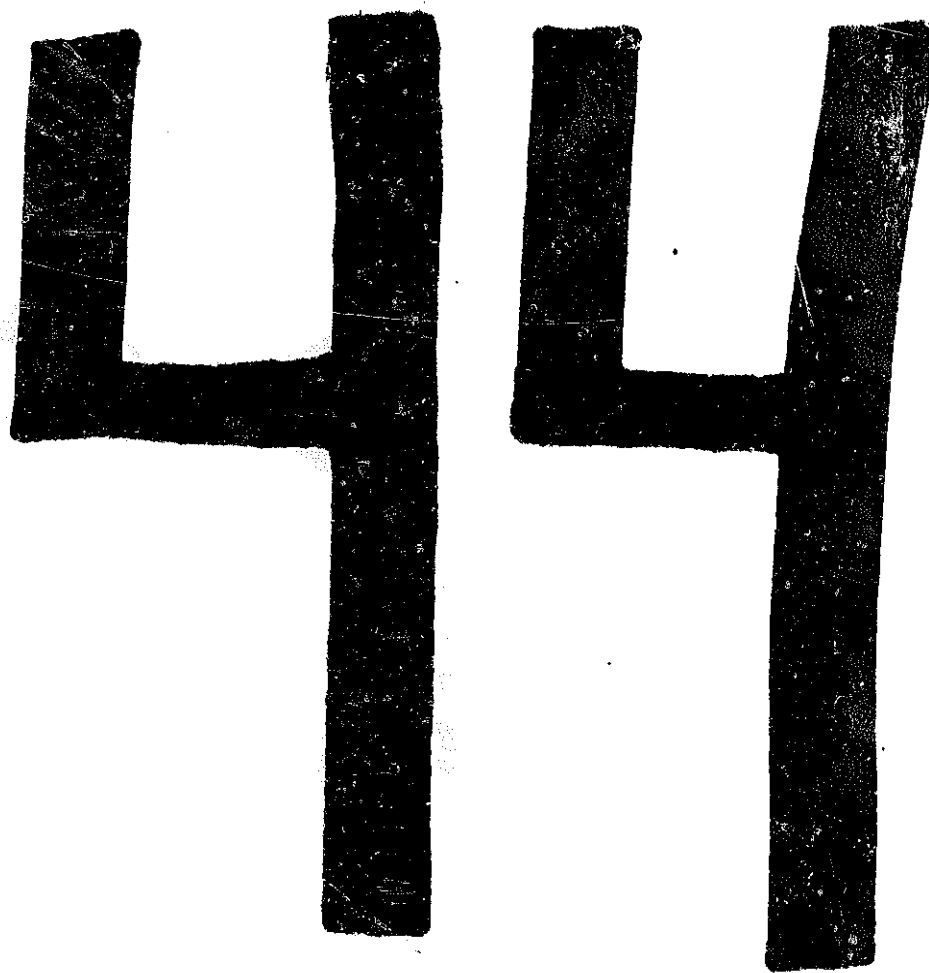
All the devices were cheap and simple to construct. They did not require delicate handling or skilled operators. They were all accurate enough to be useful in irrigation, drainage, soil conservation, roadmaking and building at the farm level.

The four levelling devices which involved sighting onto a distant staff (water manometer, spirit level, square and plumb and road tracer) were more difficult to use, particularly in less than perfect lighting, and their accuracy depended largely on the operator's eyesight. In each case a robust tripod would have been some improvement over the mounting pole used, but would have made transport more difficult. The remaining devices which did not require sighting onto a staff seemed more suitable for unskilled operators.

The A-frame and plumb and the H-frame manometer were simple to make and use, but were cumbersome to transport and could only be used over fixed intervals equal to the lengths of the frames.

The flexible tube manometer was the most accurate of the devices. Measuring or marking out gradients of up to 1 in 1000 was possible with this instrument. It was one of the fastest to use but was the most expensive to construct. Being flexible, it could be used for levelling two points not in sight of each other - a common problem in building construction.

The line level was cheap to make, very easy to transport and a very quick means of laying out contours, but required three operators.



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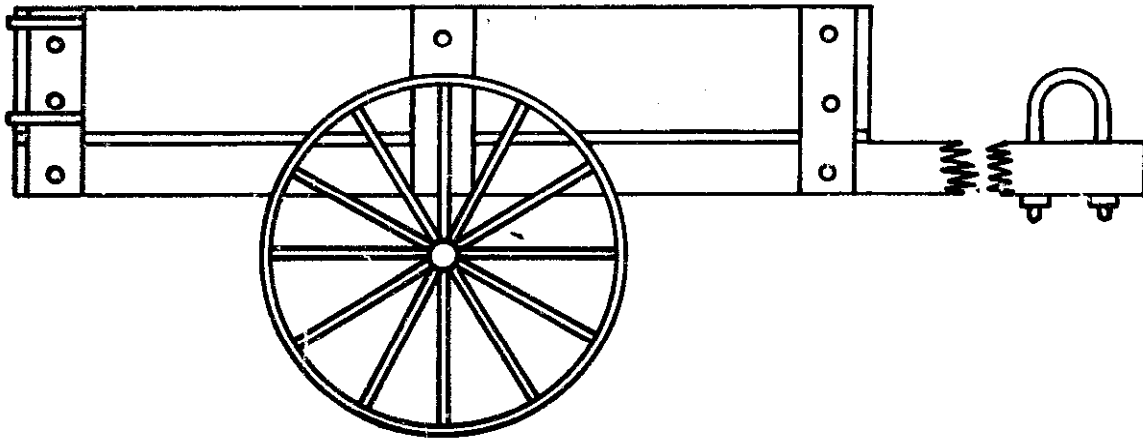
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No. 44A



THE "WANANCHI" OX-CART

"WANANCHI" OX-CART

DEVELOPED BY: Originally designed by Rev. V. Swenson of Singida Mission and later developed further at T.A.M.T.U., Tanzania.

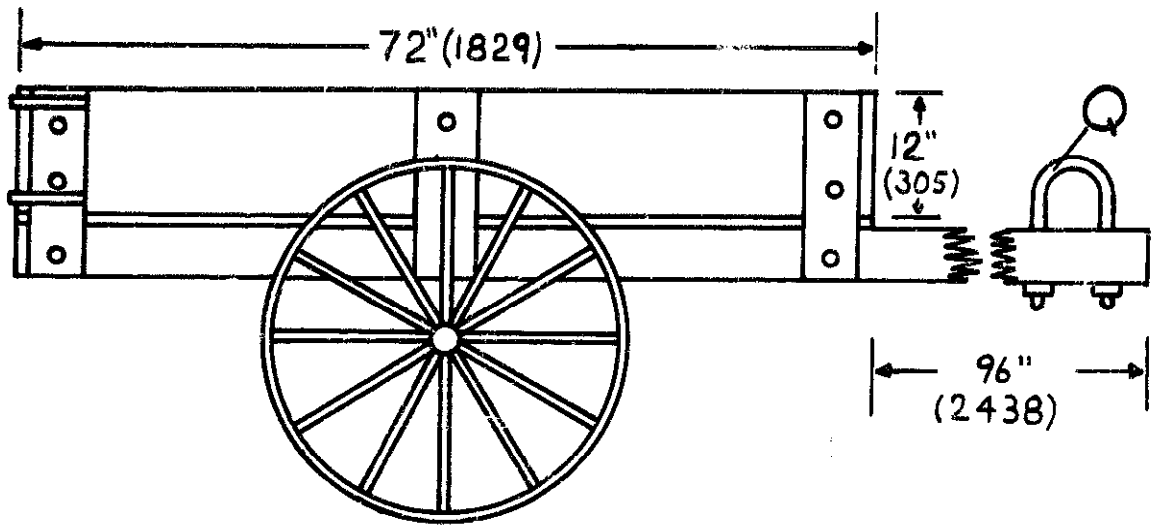
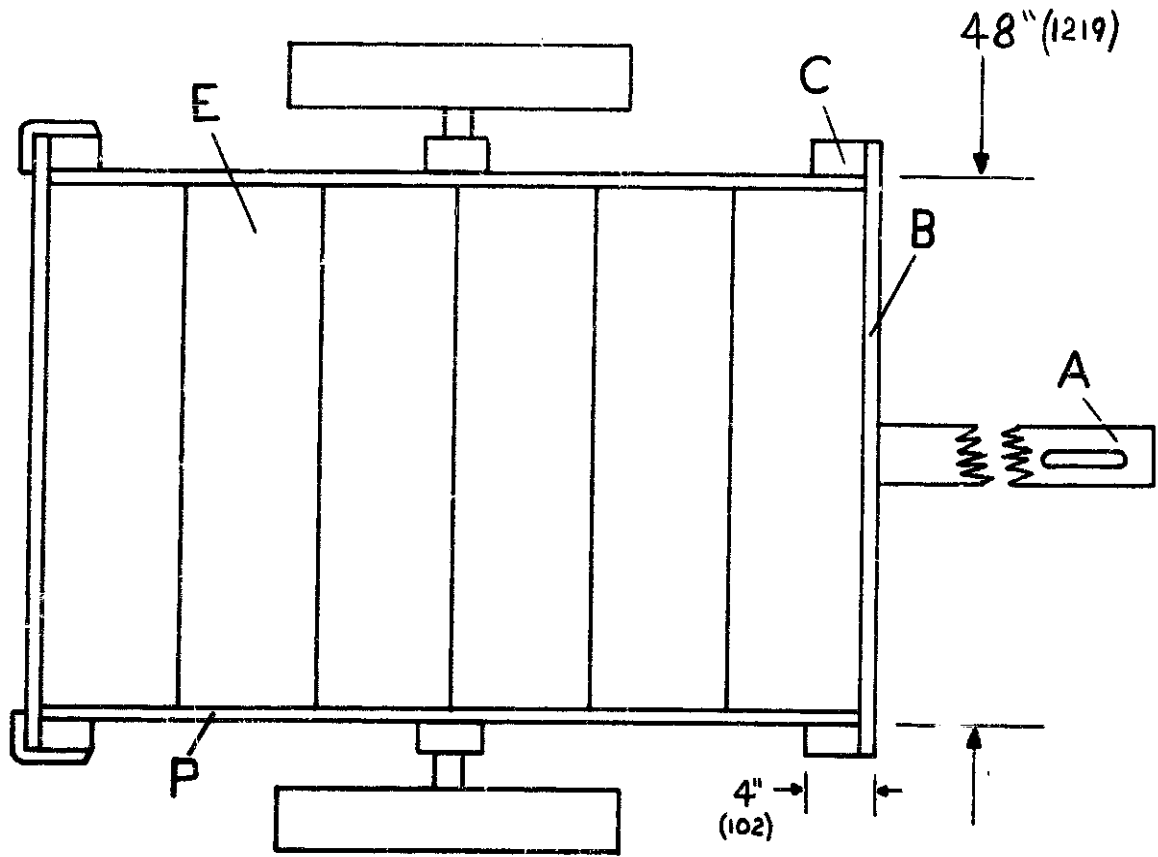
DESCRIPTION: Built to carry a load of 1400 lbs. (636 kg), pulled by two oxen. An important design feature of this cart is the wood-block axle bearings, each made of two pieces of wood, oil-impregnated by soaking in hot oil, the axle bearing hole of $1\frac{1}{2}$ " (38) diameter being drilled centrally through the blocks. This bearing design facilitates ease of maintenance and renewal of the bearings by carpenters in rural areas.

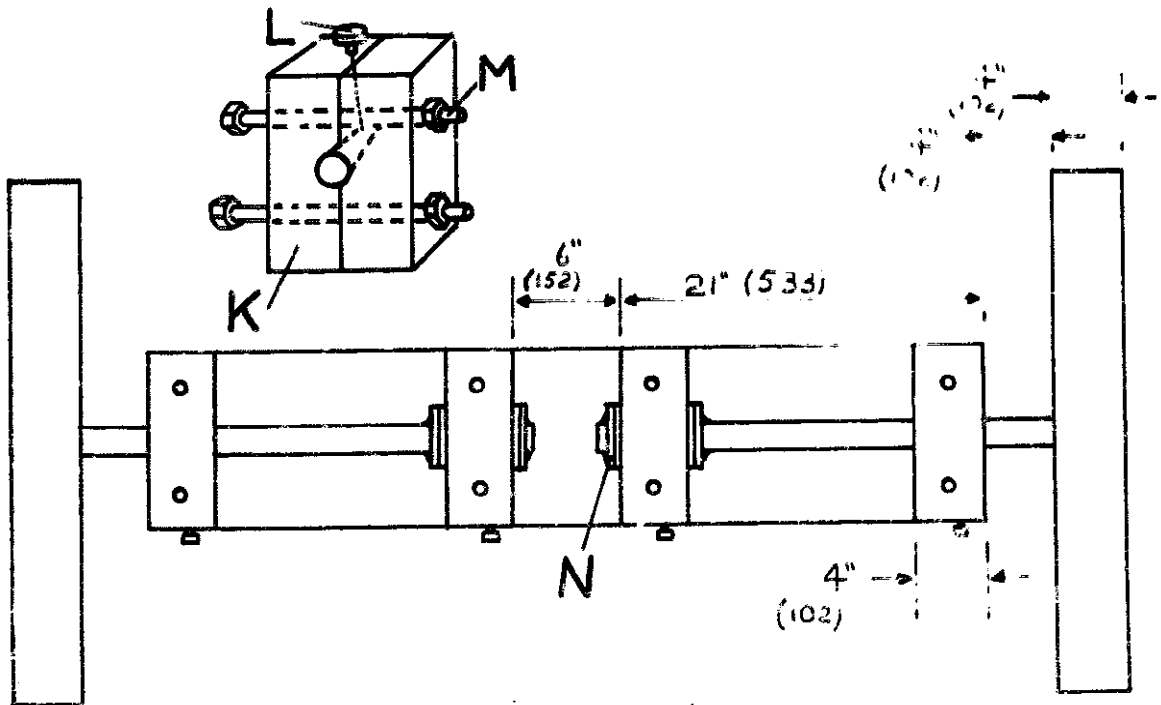
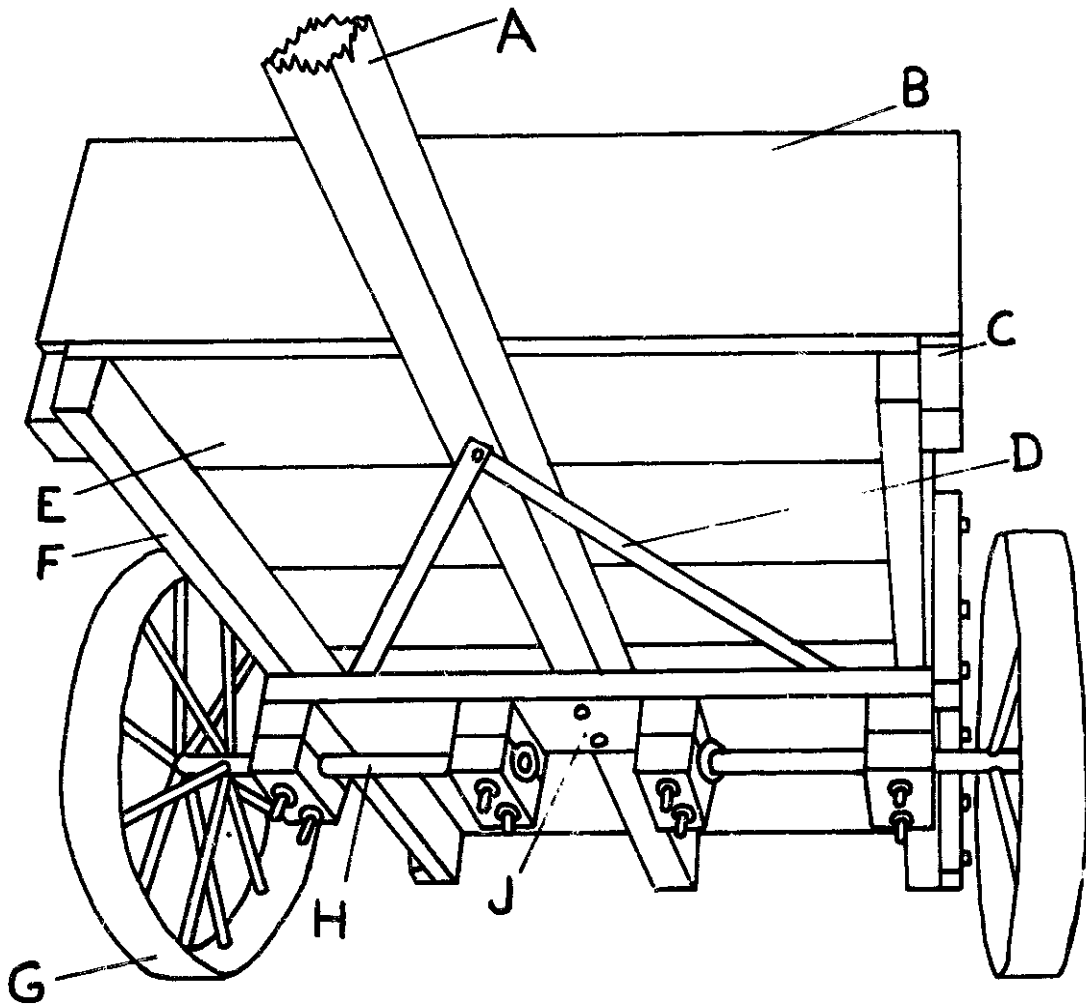
Each of the wheel assemblies is an integral unit, the wheel spokes welded to the axle shaft.

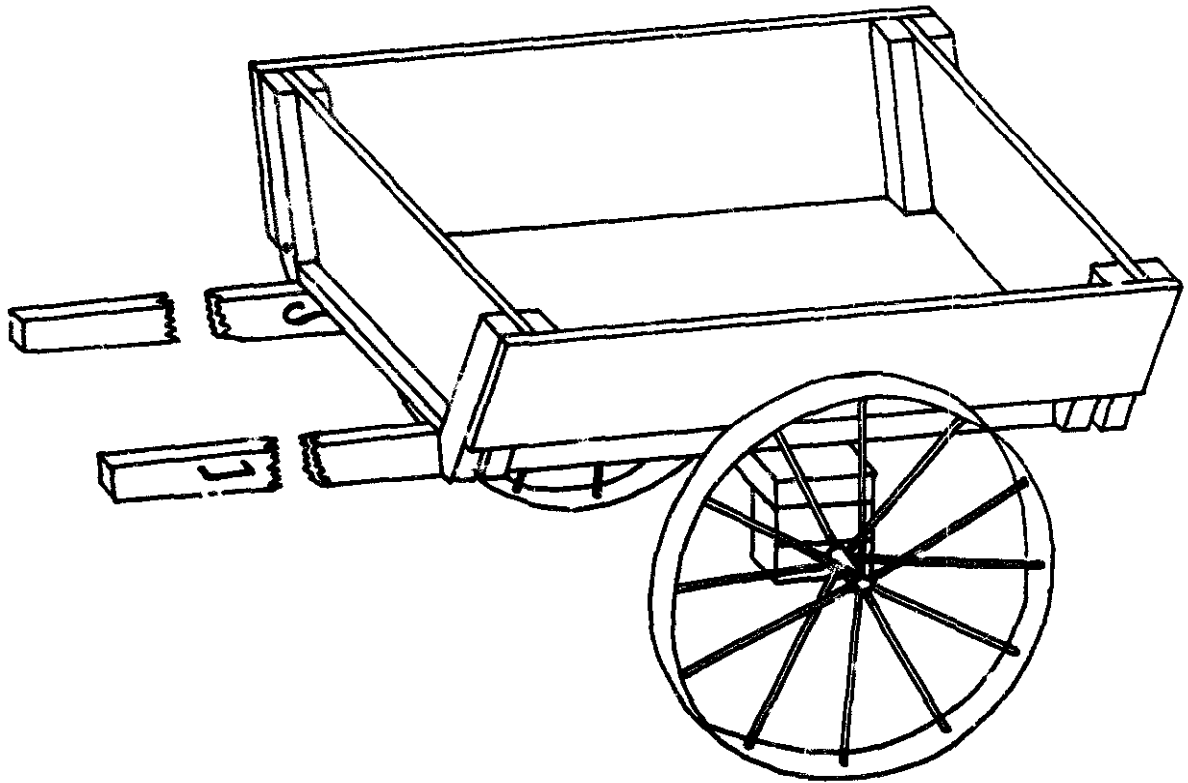
Note: Figures in brackets are in millimetres.

KEY:

<u>ITEM</u>	<u>NAME</u>	<u>QUANTITY</u>	<u>ITEM DESCRIPTION</u>
A	SHAFT	1	Of 4" x 4" x 168" (102 x 102 x 4267) soft wood, or a termite-resistant bush pole can be used instead.
B	FRONT/BACK BOARD	2	Of 1" x 12" x 52" (25 x 305 x 1321) soft wood.
C	SIDE SUPPORT	6	Of 2" x 4" x 17" (51 x 102 x 432) hard wood.
D	SHAFT BRACE	2	$\frac{1}{4}$ " x $1\frac{1}{2}$ " x 36" (6.3 x 38 x 914) mild steel.
E	FLOOR BOARD	6	Of 1" x 12" x 48" (25 x 305 x 1219) soft wood.
F	CHASSIS MEMBER	2	Of 2" x 4" x 72" (51 x 102 x 1829) hard wood.
G	WHEEL ASSEMBLY	2	Wheel rims of 4" x $\frac{1}{8}$ " (102 x 9.5) mild steel, 30" (762) diameter, with $\frac{1}{2}$ " (19) diameter spokes of mild steel bar, 12 spokes per wheel.
H	AXLE	2	Each of 30" (762) x $1\frac{1}{2}$ " (38) diameter mild steel bar.
J	AXLE BEARING PLATE CHASSIS CROSS MEMBER	1	Of 2" x 10" x 48" (51 x 254 x 1219) hard wood.
K	WOOD-BLOCK BEARING	4	Each bearing consists of two pieces of hard wood 3 " x 4" x 10" (76 x 102 x 254).
L	GREASE CUP	4	Of screw-type design.
M	BEARING BOLTS	8	10" (254) long x $\frac{1}{2}$ " (12.5) diameter mild steel.
N	FLAT WASHER	8	Of $1\frac{1}{2}$ " (38) inner diameter, in pairs each side of inner bearings to locate axles. Inner washers free to rotate and outer washers welded to axle.
P	SIDE BOARD	2	Of 1" x 12" x 70" (25 x 305 x 1778) soft wood.
Q	YOKE HITCH	1	'U' bolt of $\frac{1}{2}$ " (12.5) diameter mild steel.







CART FOR ONE DRAUGHT ANIMAL

CART FOR ONE DRAUGHT ANIMAL

DEVELOPED BY: J. Wirth, Engineer at the Tanzania Agricultural Machinery Testing Unit, Tanzania.

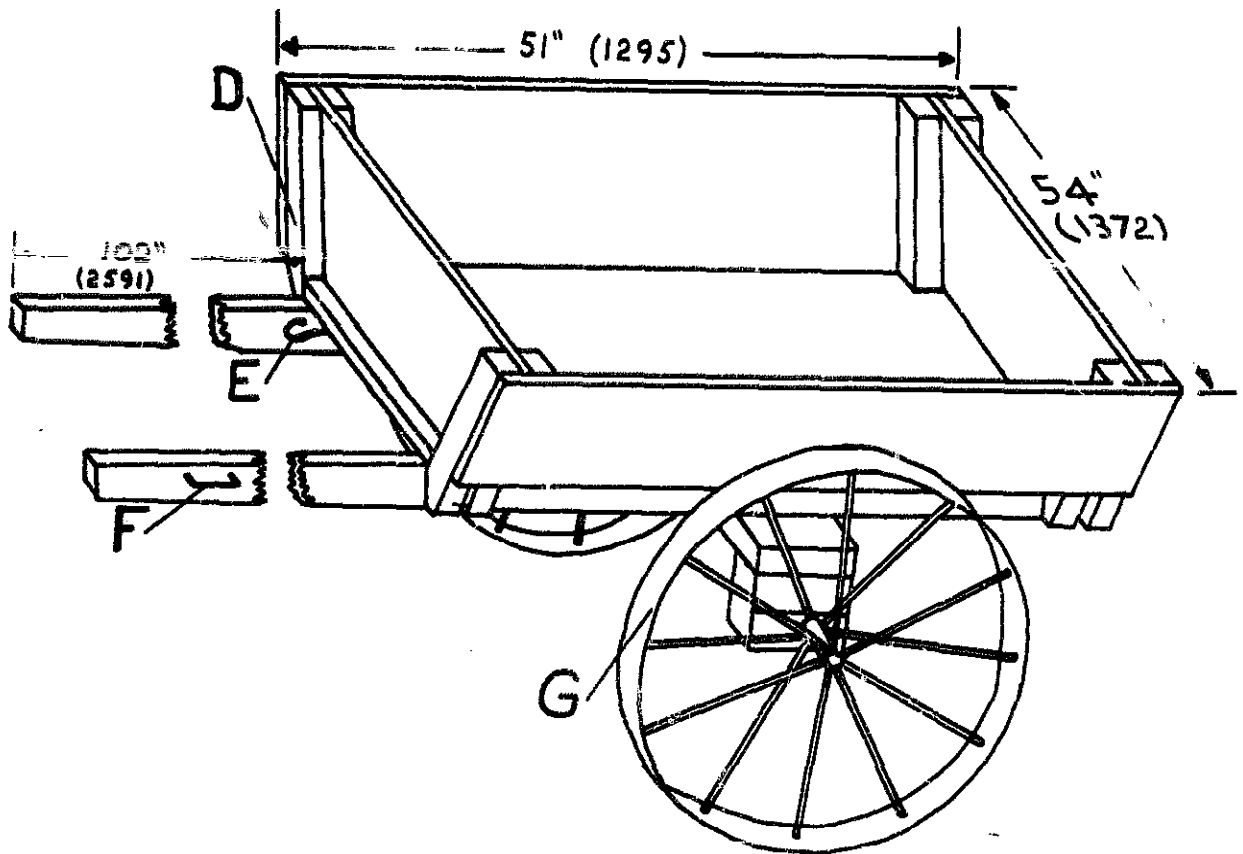
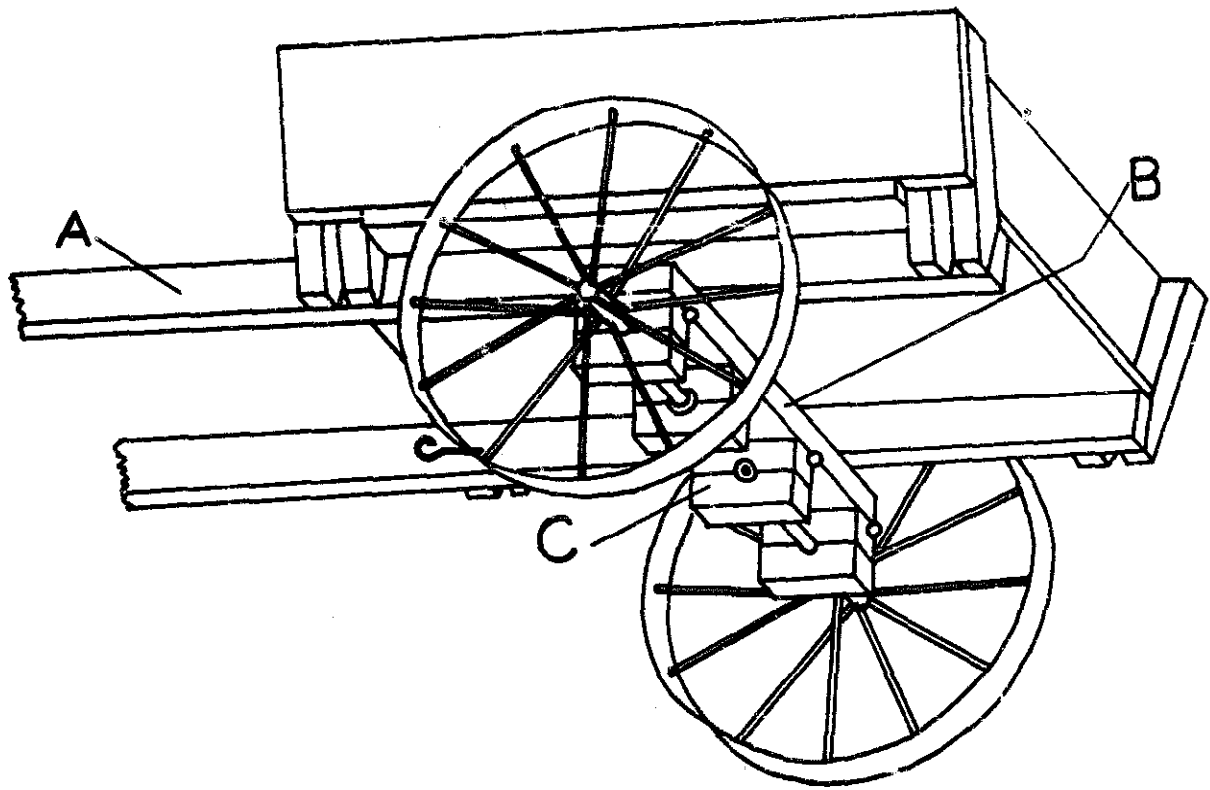
DESCRIPTION: Designed to carry a load of 700 lbs (318 kg), pulled by a single ox or donkey. The wood-block axle bearings fitted underneath the cart body are oil-impregnated by soaking in hot oil before drilling and assembly.

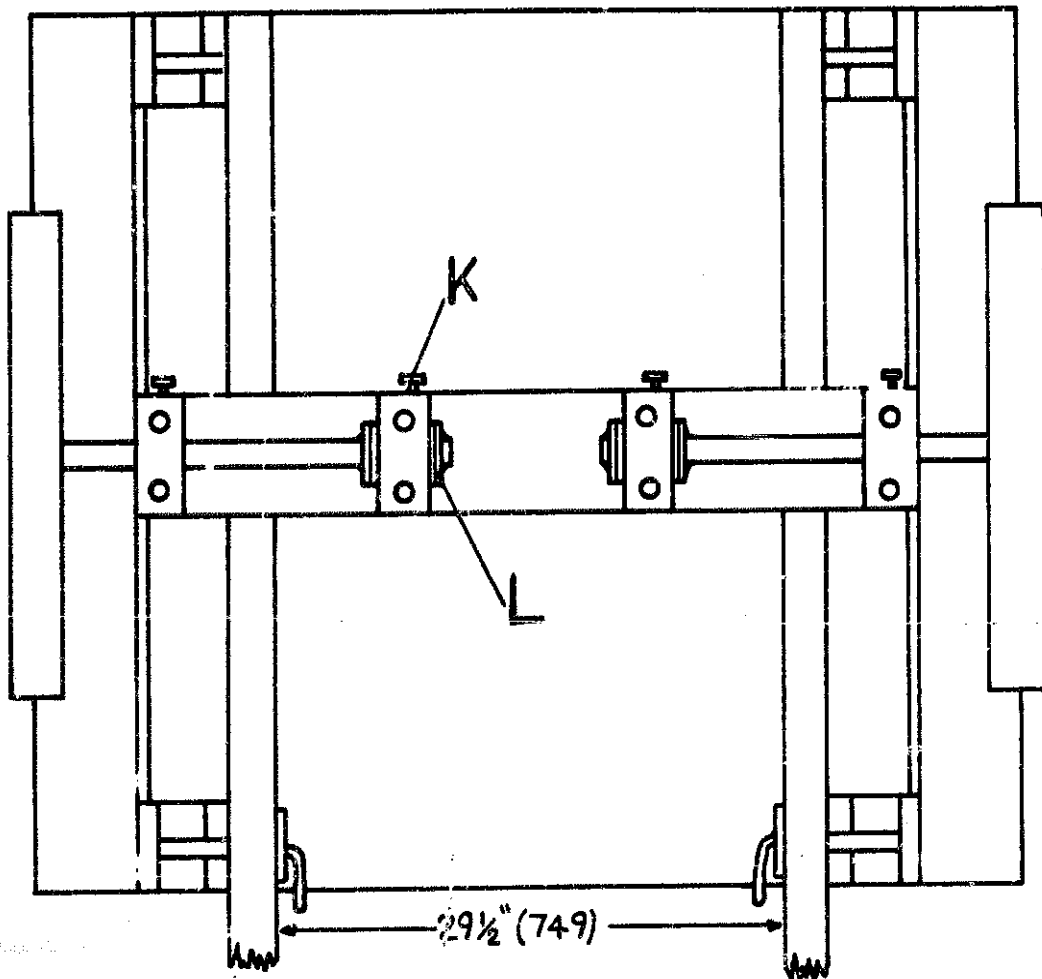
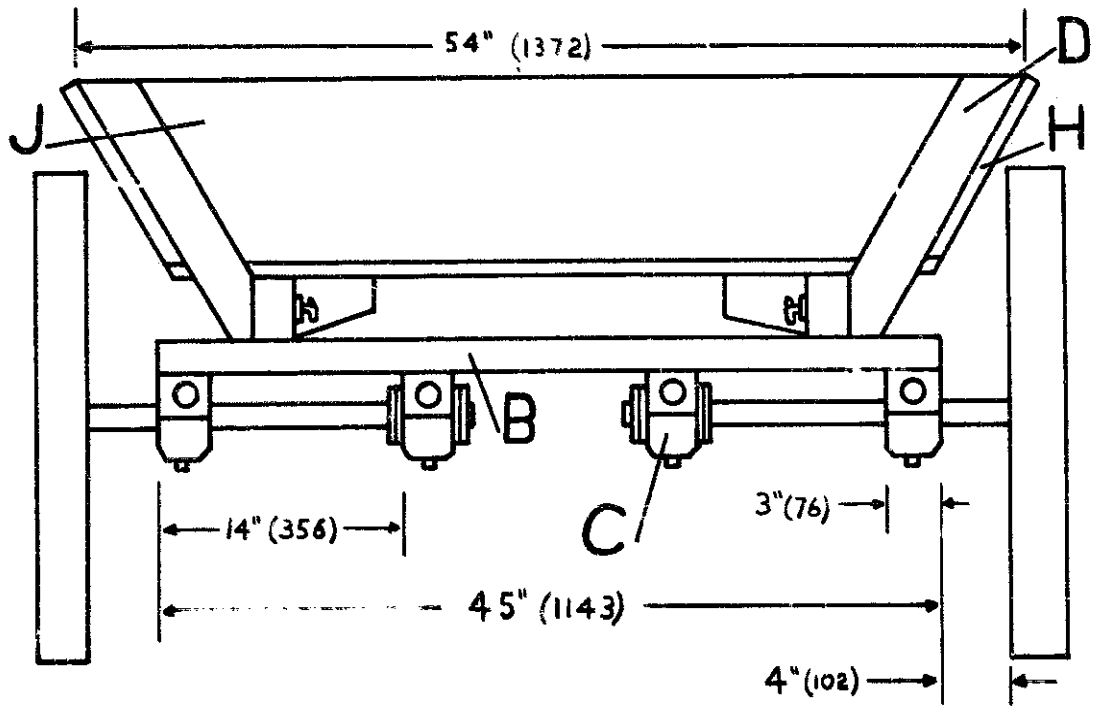
Both the front and back boards of the cart body are removable. The cart shafts can be made of tubular metal pipe instead of timber if extra strength is found necessary.

Note: Figures in brackets are in millimetres.

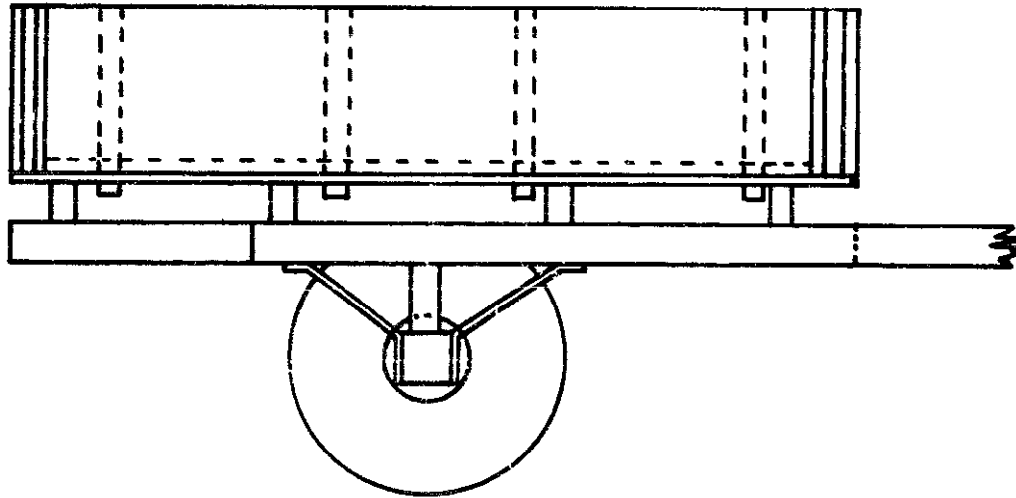
KEY:

<u>ITEM</u>	<u>NAME</u>	<u>QUANTITY</u>	<u>ITEM DESCRIPTION</u>
A	SHAFT/CHASSIS MEMBER	2	Of 2½" x 3½" x 153" (64 x 89 x 3886) wood. Shaft length can be varied to suit animal size.
B	AXLE BEARING PLATE/CHASSIS	1	Of 7" x 2" x 45" (178 x 51 x 1143) hard wood.
C	WOOD-BLOCK BEARING	4	Each bearing consists of two pieces of hard wood 2½" x 3" x 7" (64 x 76 x 178) with a 1½" (32) diameter hole drilled centrally for the axle.
D	CORNER SUPPORT	8	Of 2" x 3" x 18" (51 x 76 x 457) hard wood.
E	DRAUGHT HOOK	2	Made from ½" (12.5) diameter mild steel bar.
F	HARNESS EYE	2	Made of 5/8" (9.5) diameter mild steel bar, bolt-heads countersunk on inside of shafts.
G	WHEEL AND AXLE ASSEMBLY	2	All parts of mild steel: wheel rims of 3" x 3/8" (76 x 9.5) 28" (711) in diameter; spokes of 1/2" (12.5) diameter bar, 12 spokes per wheel. Axle of 1½" (32) diameter, 25" (635) long.
H	SIDE BOARD	2	Of 1" x 12" x 51" (25 x 305 x 1295) soft wood.
J	FRONT/BACK BOARD	2	Of 1" x 10½" x 54" (25 x 267 x 1372) soft wood.
K	GREASE CUP	4	Of screw-type design.
L	FLAT WASHER	8	Of 1½" (32) inner diameter, in pairs each side of inner bearings to locate axles, inner washers free to rotate and outer washers welded to axle.





No. 44C



OX-CART USING OLD CAR WHEELS

OX-CART USING OLD CAR WHEELS

DEVELOPED BY: Rev. L.H. Robertson, Mlanje, Malawi.

DESCRIPTION: This cart makes use of the front wheels from an old car or lorry, the wheel mountings being cut off and welded on to a box-section axle fabricated from angle iron. A car rear axle complete with differential can be used, but this adds unnecessary bulk and weight to the cart.

The cart chassis and body are constructed of wood, all parts being bolted together. The body side and end boards are made of planks $\frac{1}{2}$ " (19) in thickness, and are detachable.

Note: Figures in brackets are in millimetres.

KEY:

<u>ITEM</u>	<u>NAME</u>	<u>QUANTITY</u>	<u>ITEM DESCRIPTION</u>
A	SLOT	4	Slots to provide for removal of end boards formed with 2" x 1" (51 x 25) wooden slats.
B	STAKE/RIB	14	2" x 1" (51 x 25) hard wood, of appropriate length to suit required height of cart sides.
C	FLOOR BOARD	5	Of $\frac{1}{2}$ " x 12" x 84" (19 x 305 x 2134) soft wood.
D	BRACE	4	Of 2" x $\frac{1}{2}$ " x 16" (51 x 12.5 x 406) mild steel.
E	SHAFT	1	Of 4" x 4" (102 x 102) sawn timber, or a termite-resistant bush pole can be used instead.
F.	CHASSIS MEMBER	2	Of 4" x 2" x 84" (102 x 51 x 2134) hard wood.
G.	CHASSIS BOLT	8	Of $\frac{3}{8}$ " (9.5) diameter mild steel, 8" (203) long.
H	CHASSIS CROSS MEMBER	4	Of 3" x 2" x 60" (76 x 51 x 1524) hard wood.
J	SHAFT BOLT	3	Of $\frac{1}{2}$ " (12.5) diameter mild steel, 8" (203) long.
K	CLAMP PLATE	4	Of 2" x 4" x $\frac{1}{2}$ " (51 x 102 x 12.5) mild steel.
L	RIB SUPPORT BOLT	8	Of $\frac{3}{8}$ " (9.5) diameter mild steel, 6" (152) long.
M	SLIDE RIB SUPPORT	2	Of 1 $\frac{1}{2}$ " x 1 $\frac{1}{2}$ " x 84" (38 x 38 x 2134) hard wood.
N	WHEEL	2	Front wheels from an old vehicle.
P	AXLE CLAMP BOLT	4	Of $\frac{1}{2}$ " (12.5) diameter mild steel, 12" (305) long.
Q	AXLE SUPPORT MEMBER	1	Of 8" x 2" x 54" (203 x 51 x 1372) hard wood.
R	AXLE	1	Two pieces of 2" x 2" (51 x 51) angle iron, 54" (1372) long, welded together to form box section angle.

