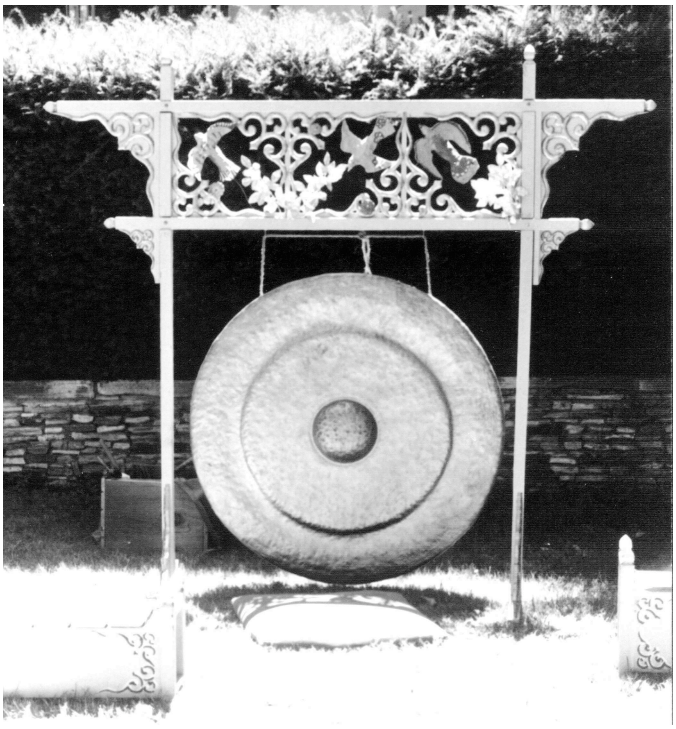
The Mills College Gamelan

Si Darius and Si Madeleine



instrument design and construction by
Lou Harrison, William Colvig, and Mills students
1981

text and drawings by Will Dithrich
1983

CONTENTS

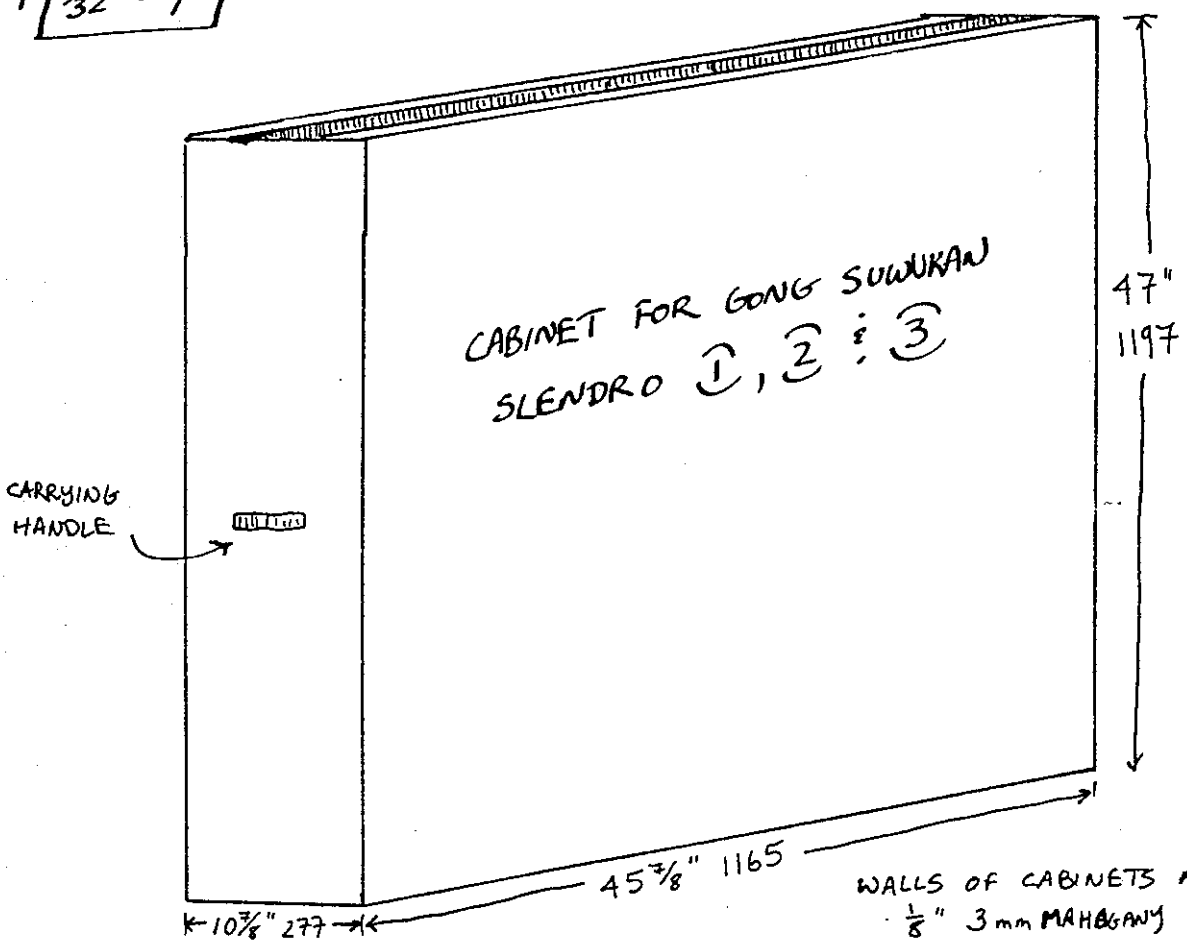
GONG SUWUKAN KEYS & RESONATORS

MEASURED FROM BASE of GONG SLAB FRAME. DOES NOT INCLUDE BASE THICKNESS

KEY	LENGTH	WIDTH	THICKNESS	RESONATOR DEPTH	RESONATOR DIAMETER
1 S	27 3/4" 704 mm	5" 127 mm	1/2" 6mm	46 7/8" 1190 mm	6 1/8" (155)
I S	19 3/4" 501 mm	12 13/16" 123 mm	1/2" 6mm	21 11/16" 550 mm	"
2 S	25 1/2" 648 mm	5 5/16" 135 mm	1/2" 6mm	40 7/8" 1040 mm	
2 S	19" 482 mm	3 7/8" 101 mm	1/2" 6mm	18 5/8" 473mm	
3 S	24 1/16" 611 mm	4 15/16 125 mm	1/2" 6mm	38 5/8" 980 mm	
3 S	16 7/8" 428mm	4 1/16" 103 mm	1/2" 6mm	16 1/8" 410mm	
5 S	34 1/8" 868 mm	7 3/4" 197 mm	5/16" 8 mm	CABINET RESONATOR : SEE 5 S	
5 S	22 5/8" 574mm	4 15/16" 125mm	1/2" 6mm	CABINET DIMENSIONS	
6 SP	30" 762mm	6" 152 mm	1/2" 6mm	CABINET RESONATOR : SEE 6 P,S	
6 SP	19 1/2" 496 mm	6" 152 mm	1/2" 6mm	CABINET DIMENSIONS	
7 P	28 1/16" 713mm	4 7/8" 123 mm	1/2" 6mm	47" 1197 mm	6 1/8" 155mm *
7 P	20" 509mm	3 7/8" 98mm	1/2" 6mm	23 3/4 603 mm	6 1/8" 155
5 P	30 7/8" 785mm	5 5/16" 151 mm	1/2" 6 mm	CABINET RESONATOR	"
5 P	21 3/8" 543mm	4 1/2" 115 mm	1/2" 6mm	(SEE PLANS)	"
3 P	23 15/16" 608mm	4" 101 mm	1/2" 6mm	36 5/8" 930mm	6 1/8" 155
3 P	16 7/8" 429mm	4 5/8" 117mm	1/2" 6mm	20" 507 mm	"
2 P	24 7/8" 632mm	4 3/4" 121mm	1/2" 6mm	40 3/8" 1027 mm	"
2 P	17 3/4" 450mm	4 7/16" 112mm	1/2" 6mm	16 1/2" 420 mm	"
1 P	25 1/4" 642mm	6" 153mm	1/2" 6mm	44" 1119 mm	"
1 P	18 1/4" 473mm	4 7/8" 125mm	1/2" 6mm	19" 484 mm	"

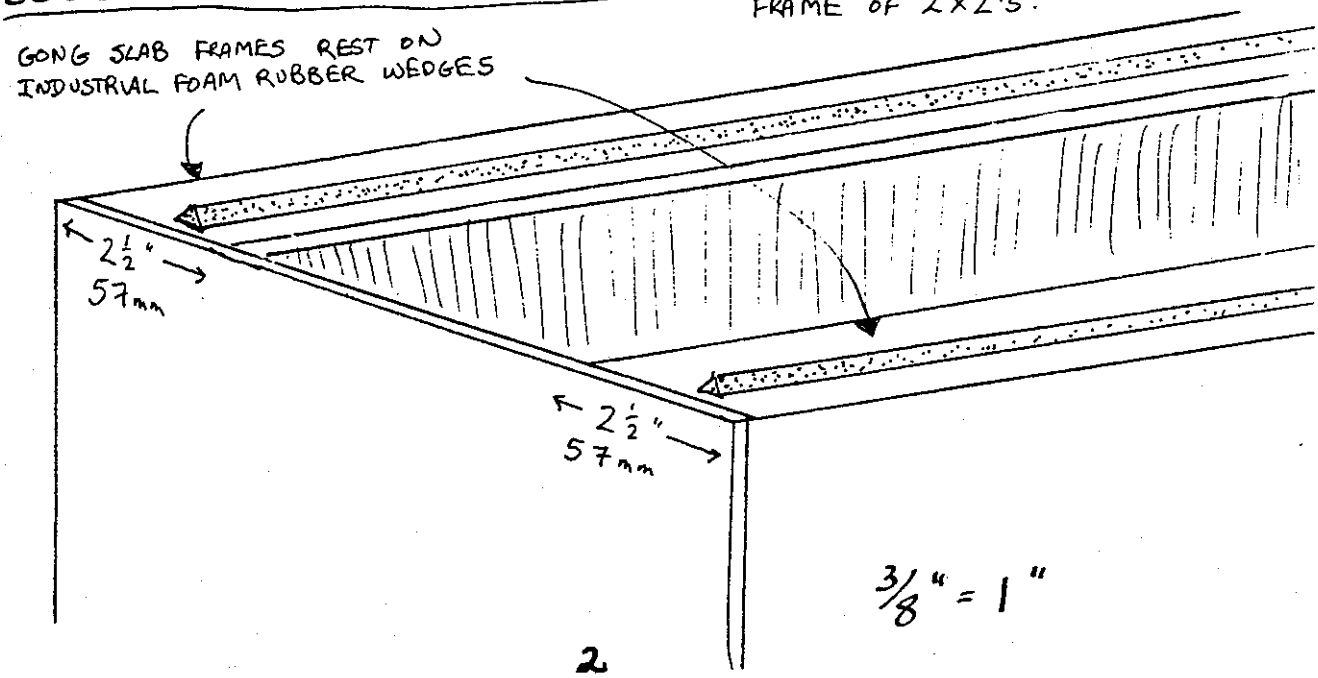
∪ INDICATES THE LOWER GONG SLAB, ∩ INDICATES THE HIGHER (THEY ARE AN OCTAVE APART)
TWO BEATERS ARE USED FOR GONG SUWUKAN, ONE OF THEM LARGER & HEAVIER THAN THE OTHER (FOR THE LOWER TONE). THIS LARGER BEATER HAS A 10 1/2" 267 mm HANDLE WHICH 1" 25 mm THICK AT THE BASE, TAPERING TO 5/8" 16 mm. THE BEATER HEAD IS 2 1/2" 64mm IN HEIGHT AND DIAMETER, AND FAIRLY HEAVY, BUILT UP WITH LAYERS OF FELT & RUBBER TUBING. 1/4" 6mm THICK PIANO HAMMER FELT IS WRAPPED AROUND, GLUED & SEWN TO THE BEATER HEAD, WHICH IS PULLED IN AT THE ENDS AND SEWN TO ROUND OFF THE EDGES.
THE LIGHTER BEATER HAS A 9" 229 mm HANDLE TOOLED OF 1/2" 13mm DOWEL. MANY LAYERS OF FELT ARE WRAPPED AROUND, AND GLUED AND SEWN TO SECURE THEM. THEN THE WHOLE HEAD IS COVERED WITH ONE PIECE OF FELT THAT IS TIED AT THE BOTTOM. THE HEAD IS 4" 102 mm LONG WITH A 3" 77 mm DIAMETER.
THE WEIGHT OF THE HEAD AND ITS RESILIENCE IS CONTROLLED BY WRAPPING LAYERS OF INNER TUBE RUBBER IN WITH THE FELT.
* PELOG 7, RESONATING BILLY CAN OPENING REDUCED TO 4" DIAMETER

1 [3/32" = 1"]



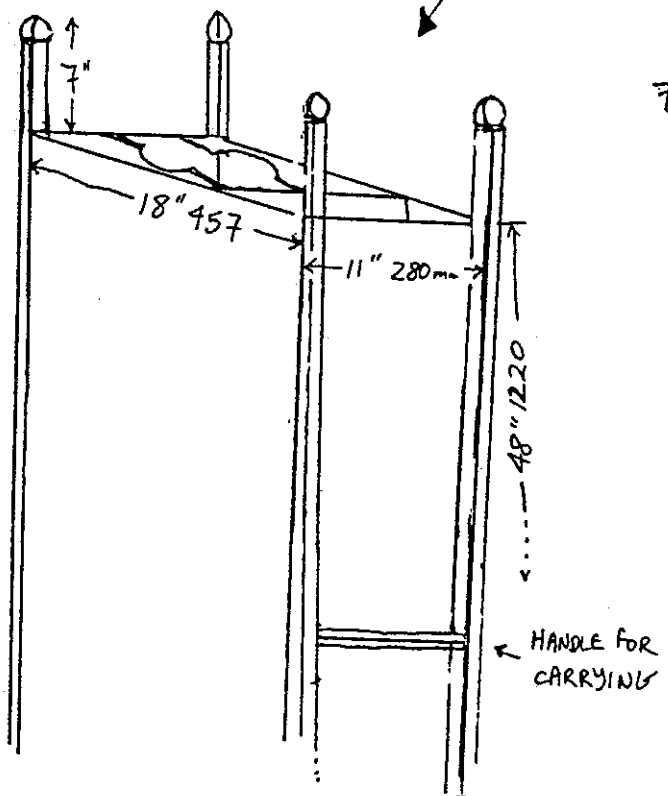
WALLS OF CABINETS ARE 1/8" 3mm MAHOGANY OR PLYWOOD. THE STRIPS ALONG THE TOP ARE 1X3's (LIT 3/4" 19mm X 2 1/2" 57mm). INSIDE IS A BASIC FRAME OF 2X2's.

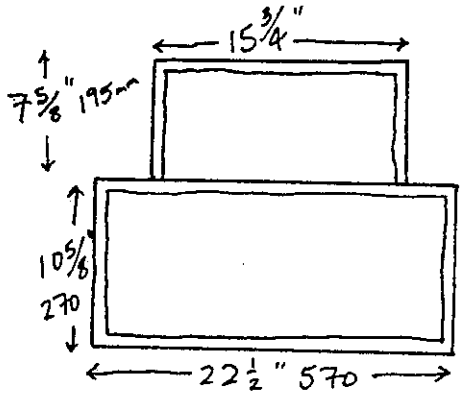
CLOSE UP OF TOP OF CABINET



3/8" = 1"

CABINET FOR SLENDRO 5





FRAME FOR SLENDRO 5 GONG SLABS

FRAMES MADE OF 1×2's
(3/4" 19mm × 1 1/2" 38 mm PINE STRIPS)

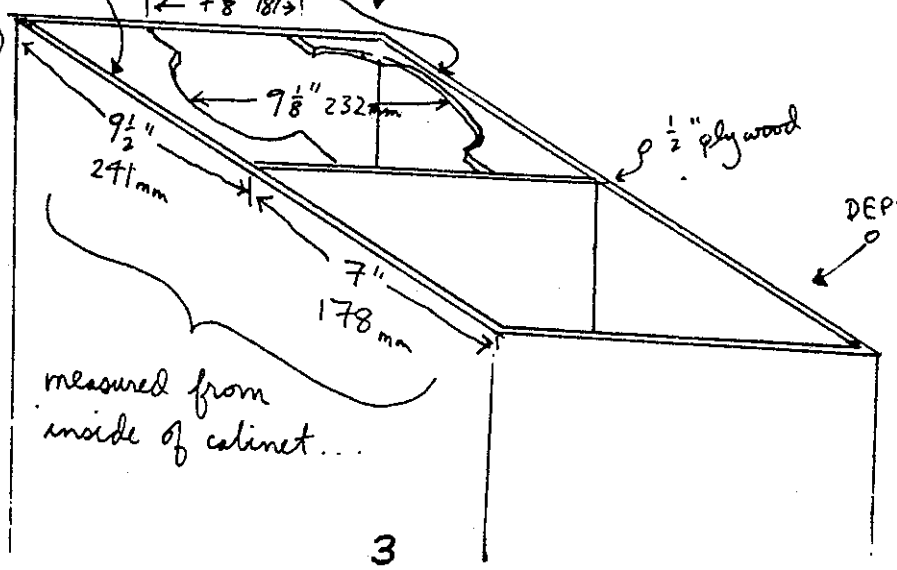
CLOSE UP OF SLENDRO 5 RESONATING CABINET

PLACE WEDGES OF INDUSTRIAL FOAM RUBBER ALONG THESE RIMS TO CUSHION THE GONG SLAB FRAMES

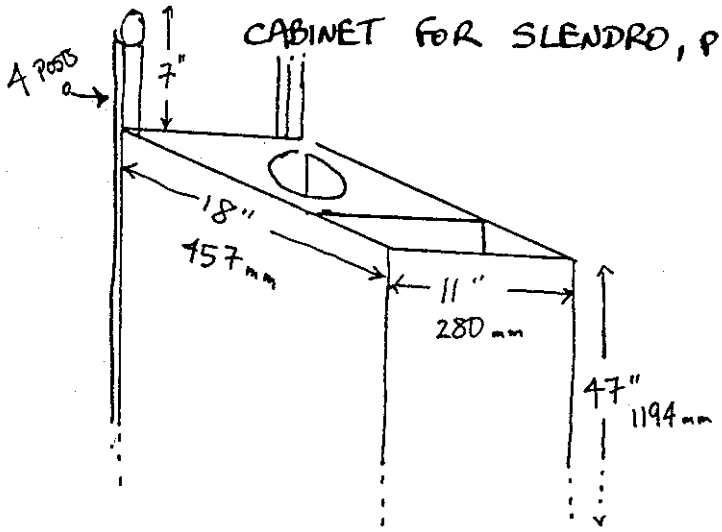
DEPTH 46 1/2" 1181 mm

CABINET MADE OF 1/2" PLY WOOD (13mm)

POSTS ARE MADE FROM PINE 2×2's (LIT. 1 5/8" 41 mm SQUARE).



CABINET FOR SLENDRO, PELOG (6)



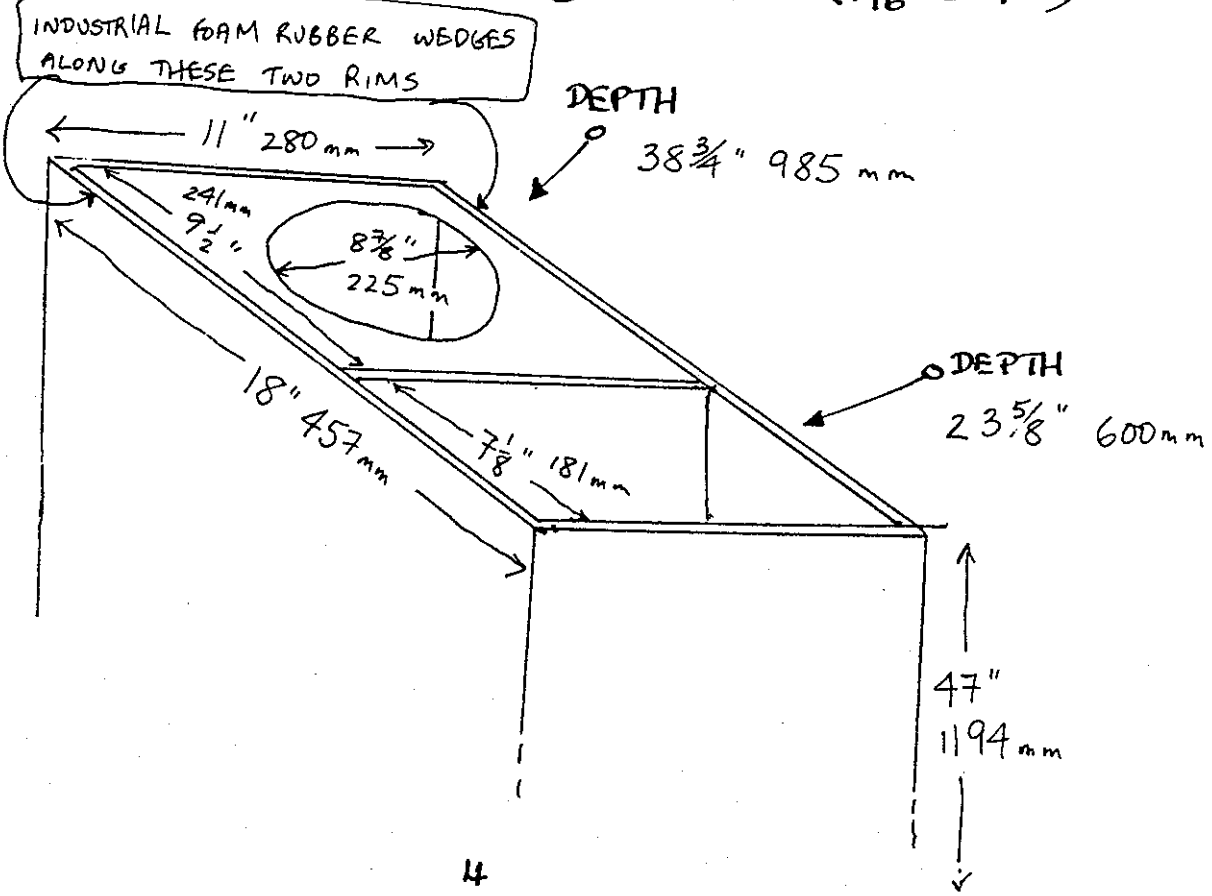
FRAME FOR GONG SLABS SAME AS SLENDRO (5).

$\frac{3}{32} = 1"$

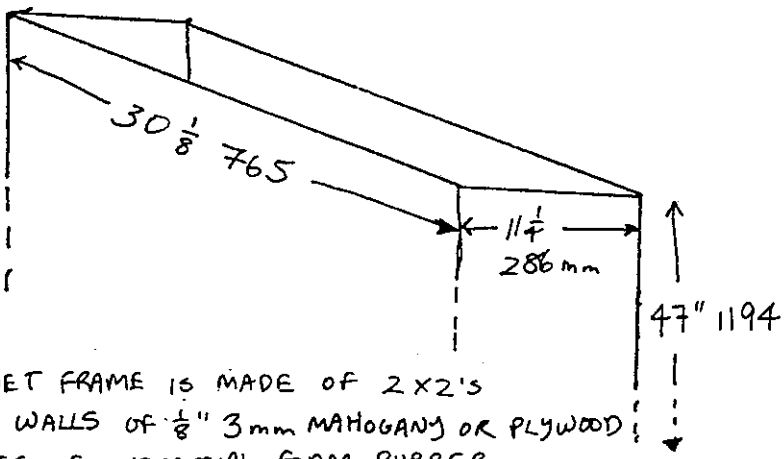
4 POSTS & CARRYING HANDLES LIKE SLENDRO (5)

CABINET MADE OF $\frac{1}{2}$" 13 mm PLYWOOD WITH 4 2×2 POSTS (LIKE SLENDRO (5))

CLOSE UP OF SLENDRO, PELOG (6) CABINET ($\frac{3}{16}" = 1"$)

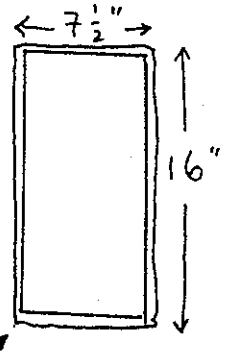


RESONATING CABINET FOR PELOG 7 & 3



3/32" = 1"

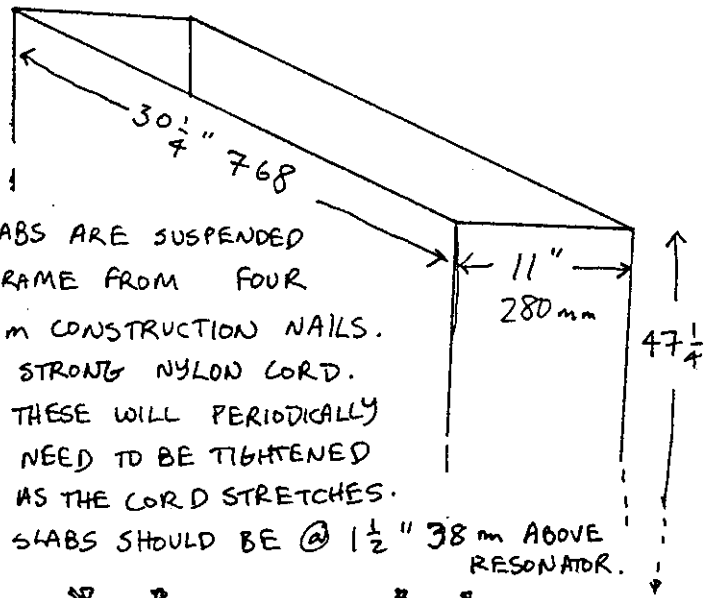
CABINET FRAME IS MADE OF 2X2'S WITH WALLS OF 1/8" 3mm MAHOGANY OR PLYWOOD. WEDGES OF INDUSTRIAL FOAM RUBBER SHOULD RUN LENGTHWISE ALONG THE TOPS OF THE TWO LONG SIDES TO CUSHION THE GONG SLAB FRAMES AND KEEP THEM FROM RATTLING.



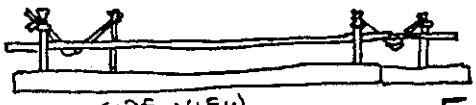
BASIC FRAME FOR GONG SLABS 1S, 3S, 3S, 1P, 2P, 3P & 7P 1P, 2P & 7P are 16 1/2" long.

FRAME IS MADE OF 1X2'S WITH A 1/2" 13mm PLYWOOD BASE ONTO WHICH RESONATOR CANS ARE ATTACHED.

RESONATING CABINET FOR PELOG 1 & 2



GONG SLABS ARE SUSPENDED ON THE FRAME FROM FOUR 4" 102 mm CONSTRUCTION NAILS. USE GOOD STRONG NYLON CORD. THESE WILL PERIODICALLY NEED TO BE TIGHTENED AS THE CORD STRETCHES. SLABS SHOULD BE @ 1 1/2" 38 mm ABOVE RESONATOR.



SIDE VIEW

PELOG KEMPUL

KEY	LENGTH	WIDTH *	RESONATING DEPTH	RESONATING HEIGHT **
2	18 5/16" 465 mm	3 3/4" 96 mm	15 5/8" 397 mm	5" 127 mm
1	18 3/4" 475 mm	3 3/4" 96 mm	18" 457 mm	4 1/2" 109 mm
7	19" 481 mm	4" 101 mm	20" 508 mm	4 1/8" 105 mm
6	18 5/16" 465 mm	4 1/16" 103 mm	20 5/8" 524 mm	4 1/8" 105 mm
5	19 1/4" 488 mm	4" 101 mm	23 3/4" 603 mm	4 3/4" 121 mm
4	19" 481 mm	4" 101 mm	27" 686 mm	4 3/8" 111 mm
3	20 1/2" 520 mm	4" 101 mm	33 1/4" 845 mm	4 3/8" 111 mm

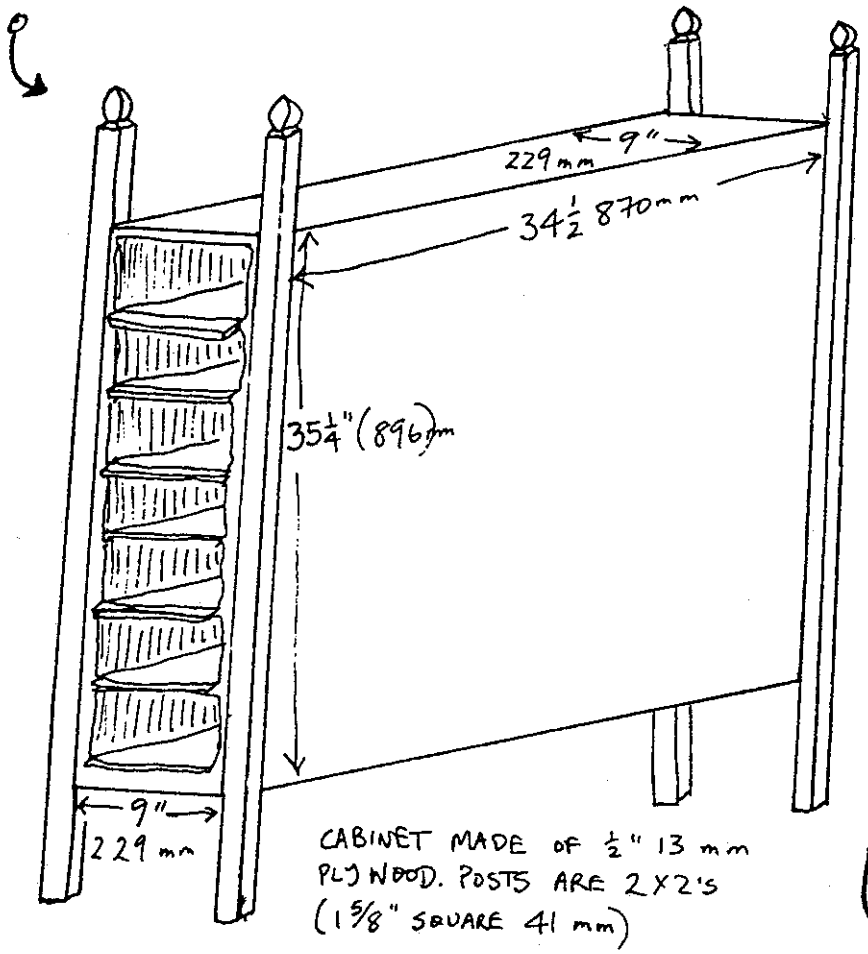
* ALL KEYS 1/2" (6mm) thick. ** ALL RESONATING CHAMBERS 8"/203 mm WIDE.

2 P HAS A 1 7/8" x 8" (48 mm x 203 m) PIECE OF 1/8" 3mm PLYWOOD BLOCKING THE HOLE.

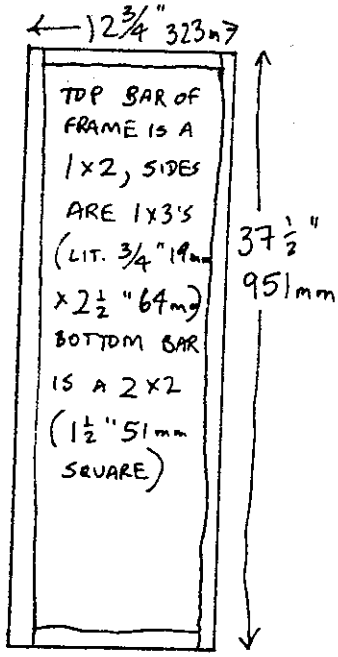
1 P HAS A 2 1/4" x 8" (57mm x 203) " " " " " " " " ".

ALL RESONATING CHAMBERS ARE SEPARATED BY 1/2" PLYWOOD. ALL THESE PIECES STICK OUT 1/2" EXCEPT THE TOP AND BOTTOM OF THE CABINET.

KEMPUL CABINET



CABINET MADE OF 1/2" 13 mm PLYWOOD. POSTS ARE 2X2's (1 5/8" SQUARE 41 mm)



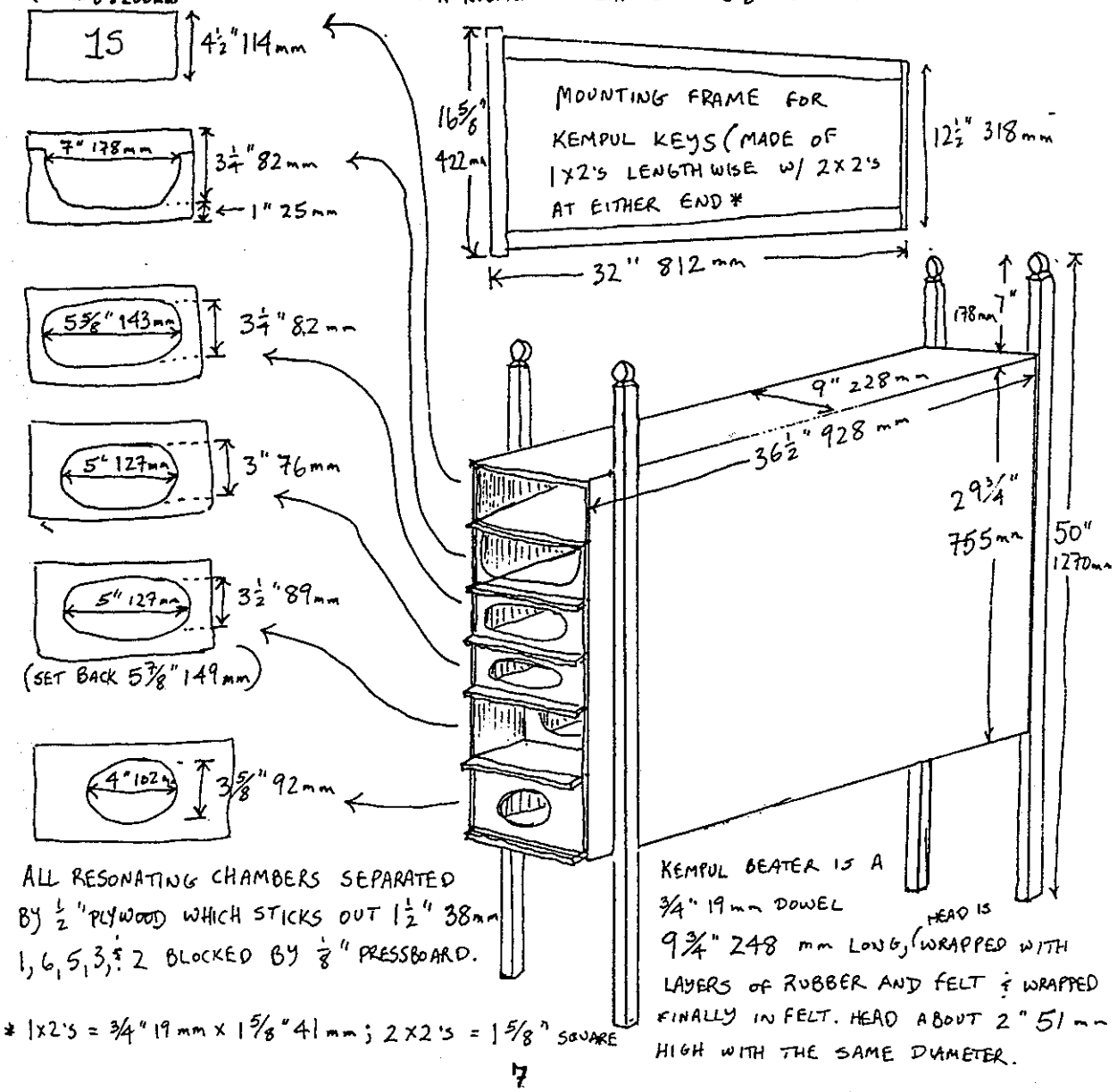
FRAME FOR KEYS

3/32" = 1"

SLENDRO KEMPUL

KEY	LENGTH	WIDTH	RESONATING DEPTH	RES. HEIGHT
2	18 5/8" 473 mm	3 3/4" 95 mm	18" 460 mm	4 1/2" 114 mm
1	18 3/8" 479 mm	4" 102 mm	20" 508 mm	4 3/8" 111 mm
6	20 1/2" 521 mm	"	23 1/4" 591 mm	4 1/2" 114 mm
5	20 3/4" 528 mm	"	27" 686 mm	4 3/8" 111 mm
3	23 7/8" 606 mm	"	32 1/2" 825 mm	"
2	24 13/16" 630 mm	"	36" 914 mm	"

All resonating chambers 8 1/8" wide (206 mm)



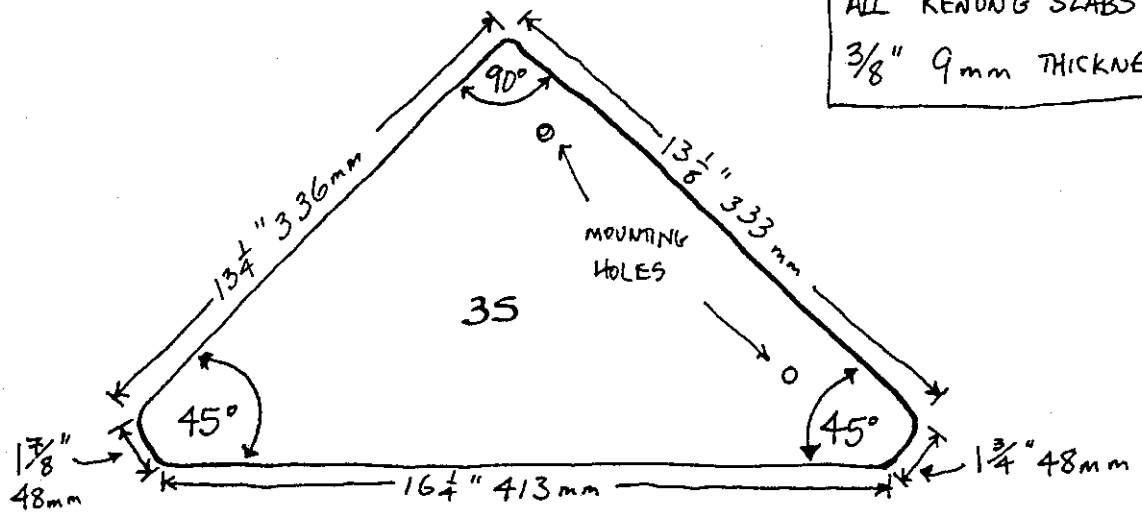
All resonating chambers separated by 1/2" plywood which sticks out 1 1/2" 38 mm 1, 6, 5, 3, & 2 blocked by 1/8" pressboard.

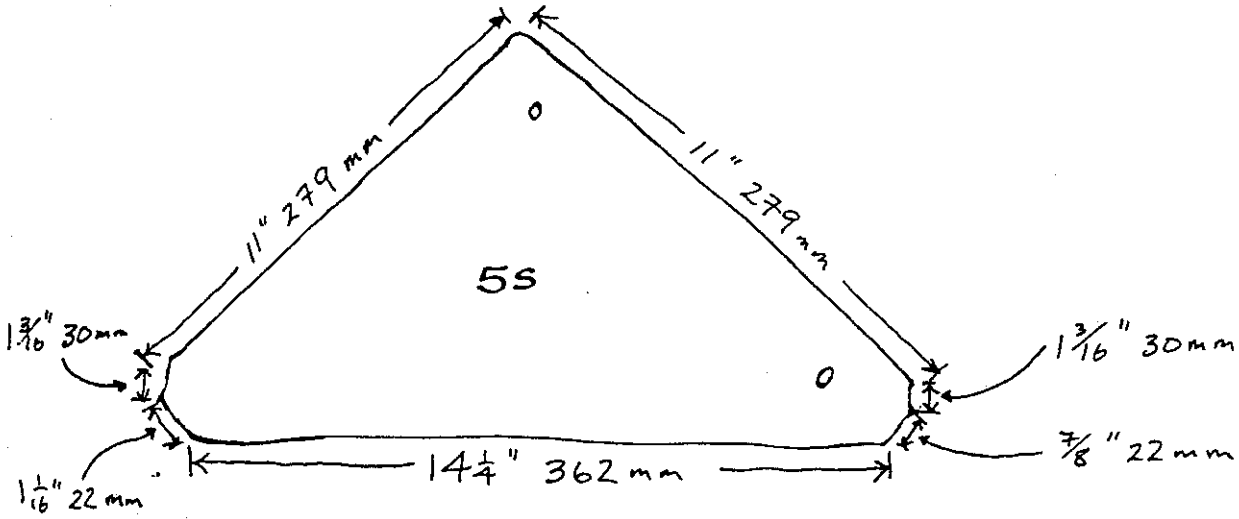
Kempul beater is a 3/4" 19 mm dowel 9 3/4" 248 mm long, head is wrapped with layers of rubber and felt & wrapped finally in felt. Head about 2" 51 mm high with the same diameter.

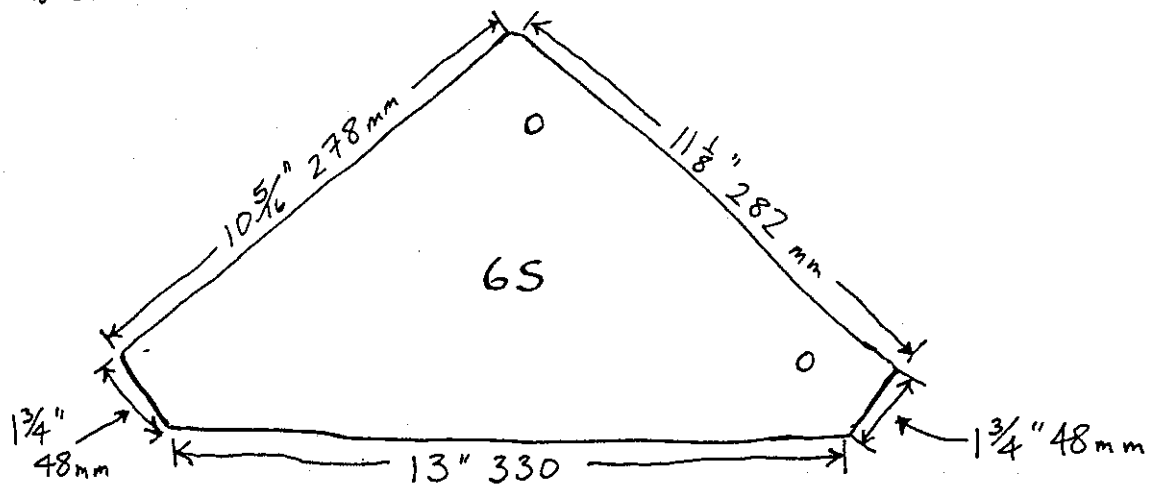
* 1x2's = 3/4" 19 mm x 1 5/8" 41 mm; 2x2's = 1 5/8" square

SLENDRO KENONG TRIANGLES

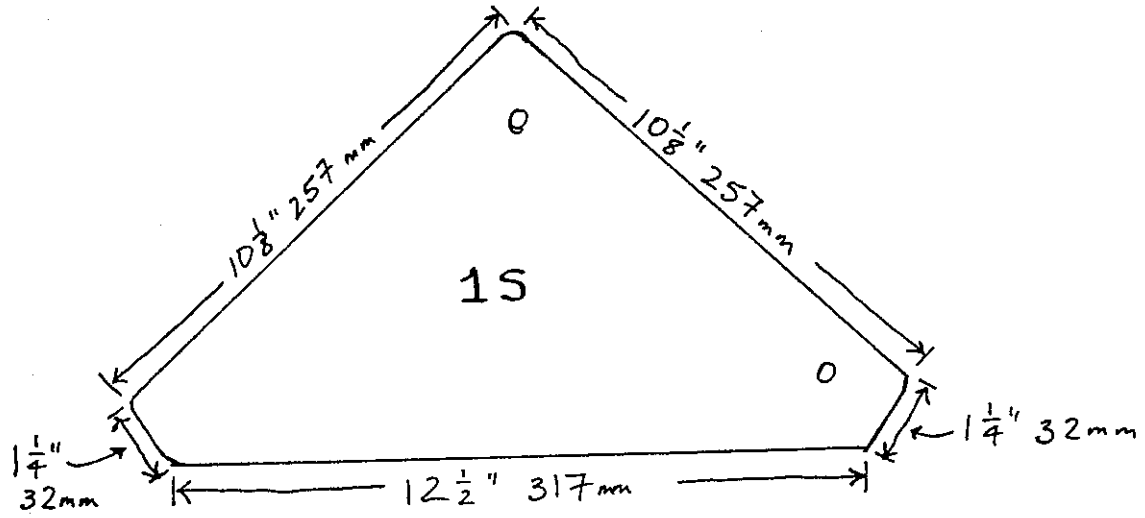
ALL KENONG SLABS
3/8" 9mm THICKNESS

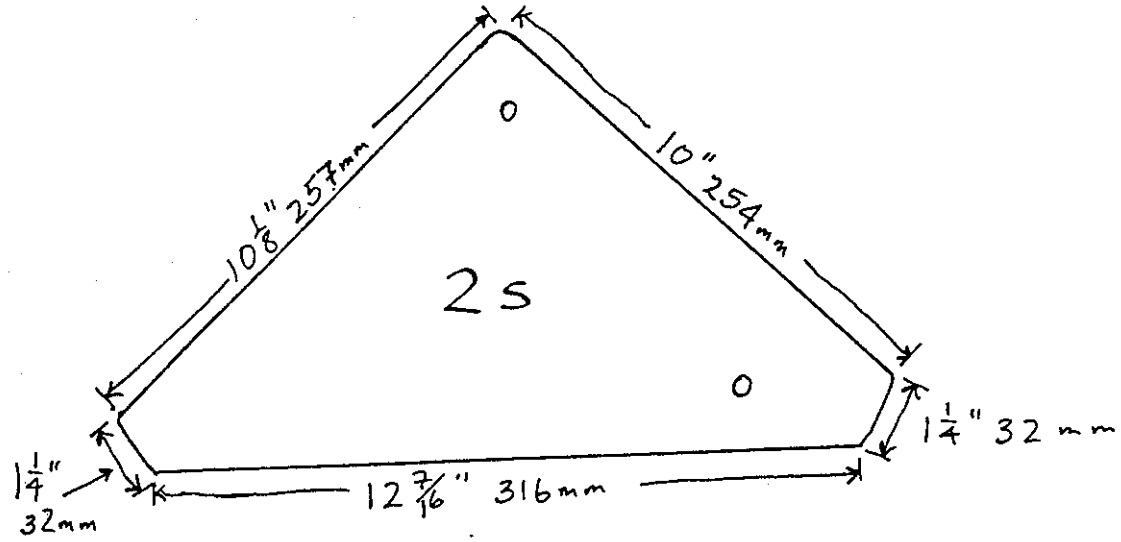




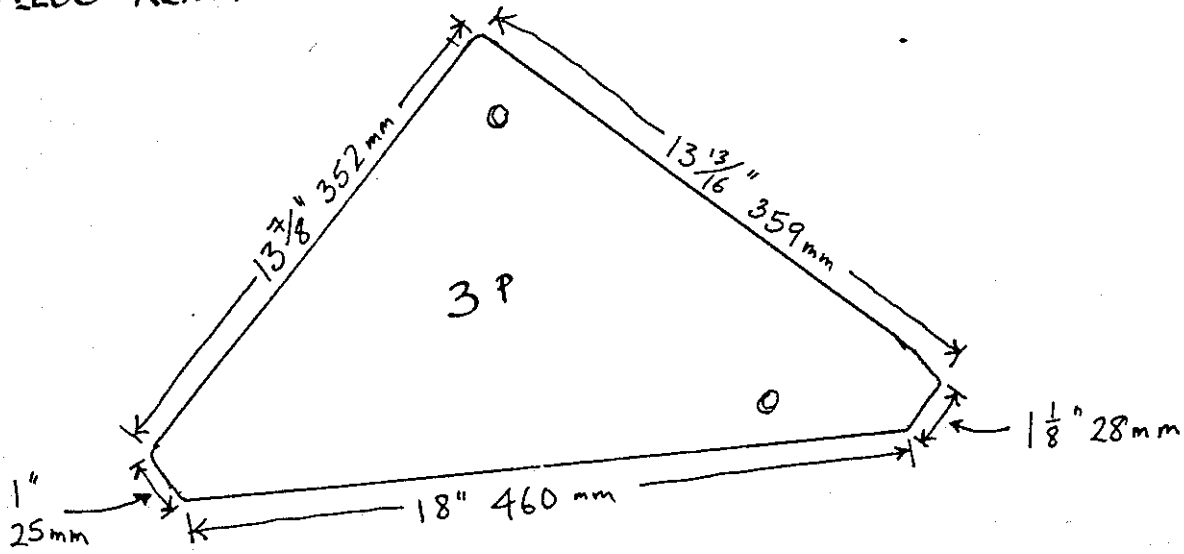


SLENDRO KENONG

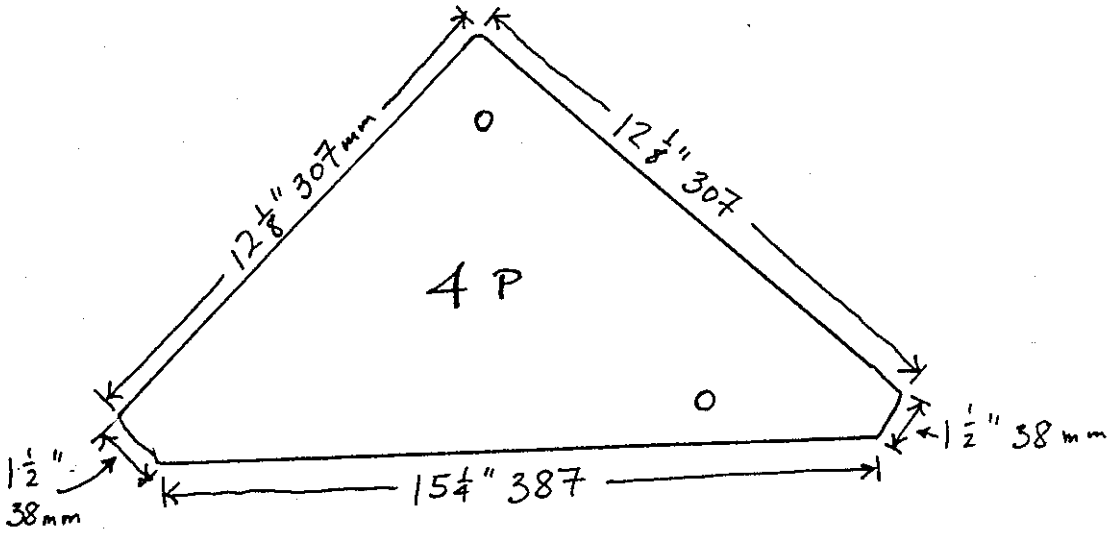


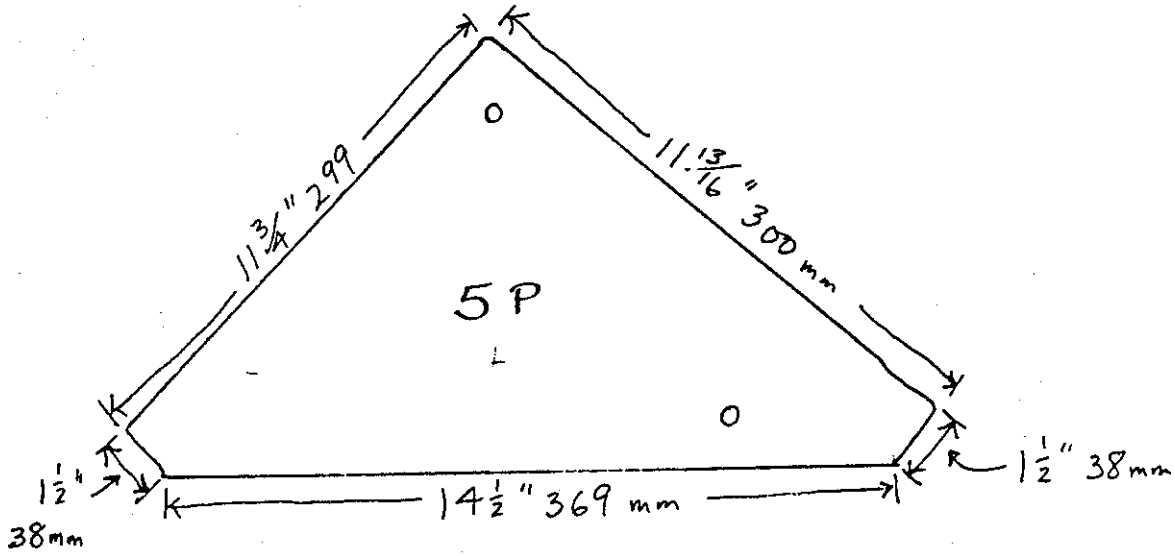


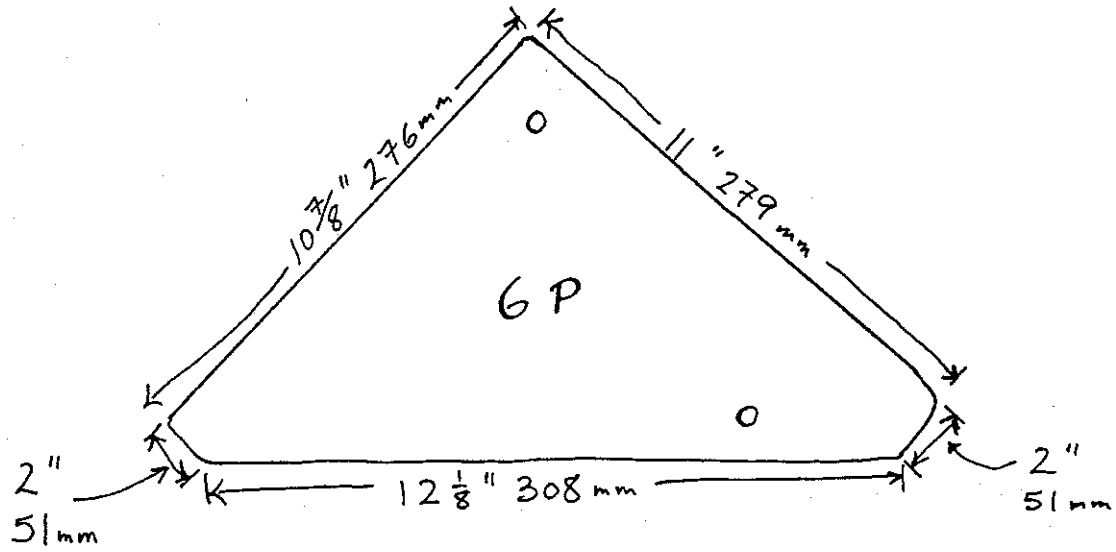
PELOG KENONG



PELOG KENONG







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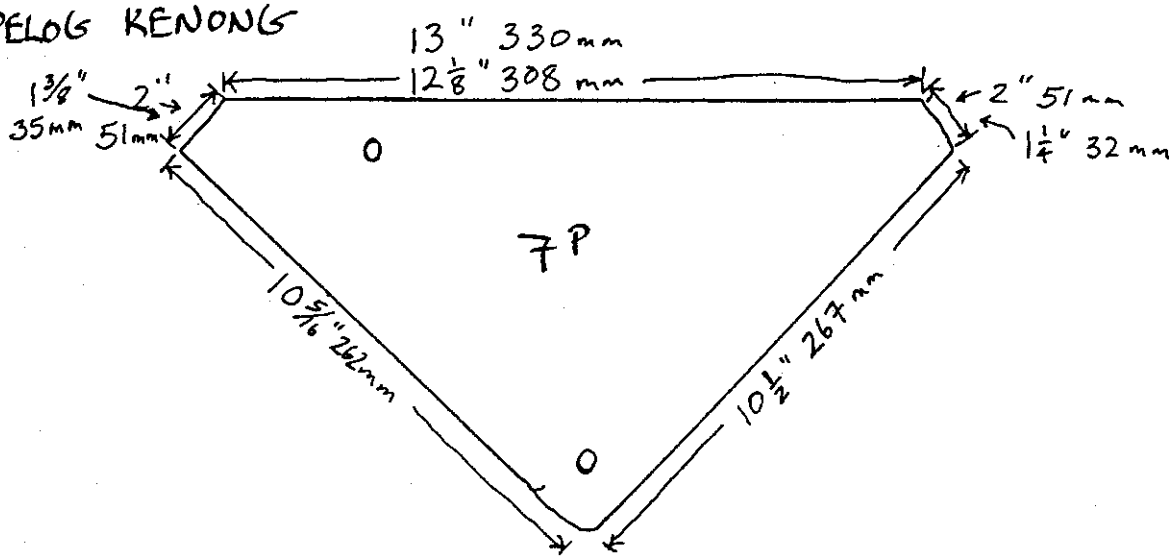
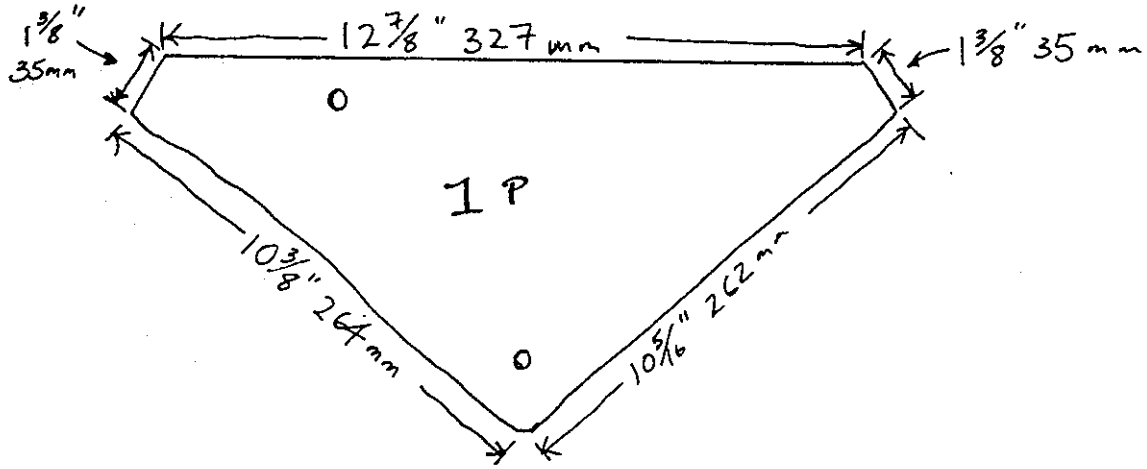
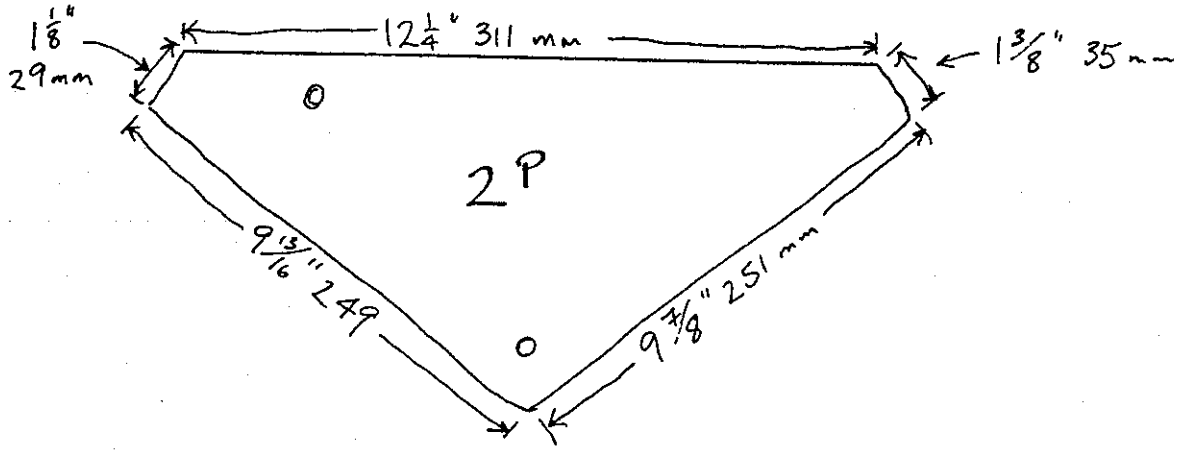
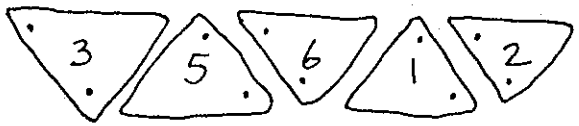


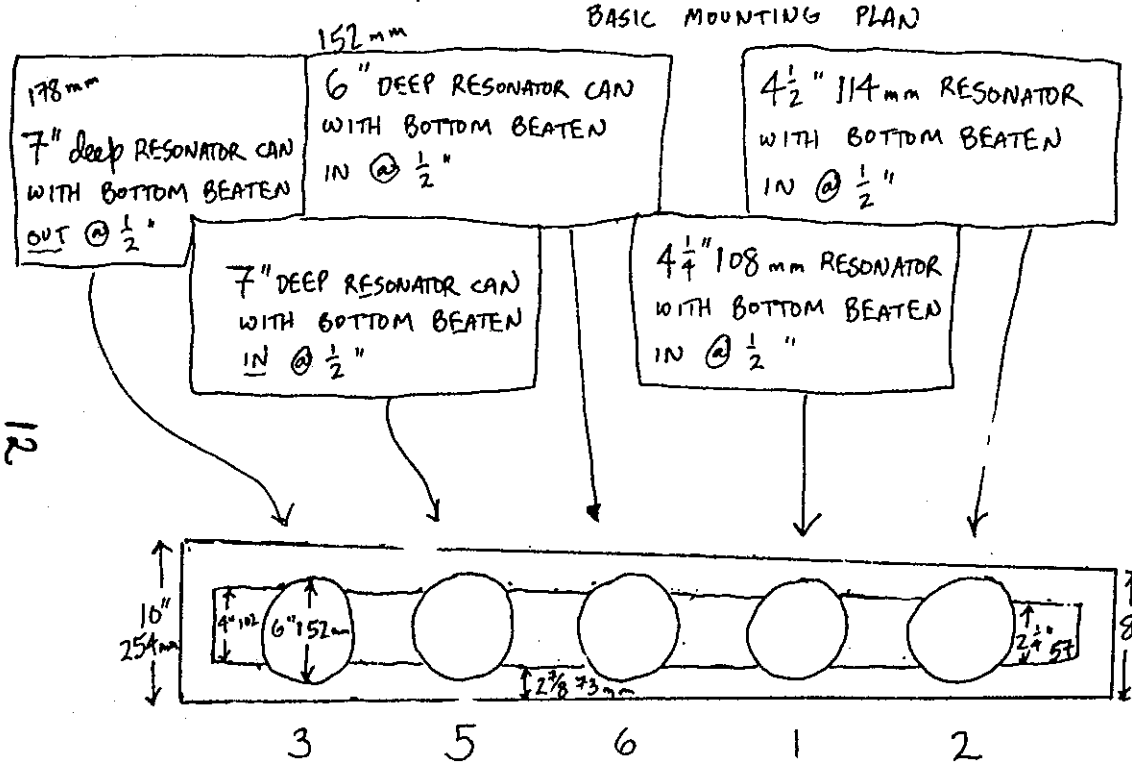


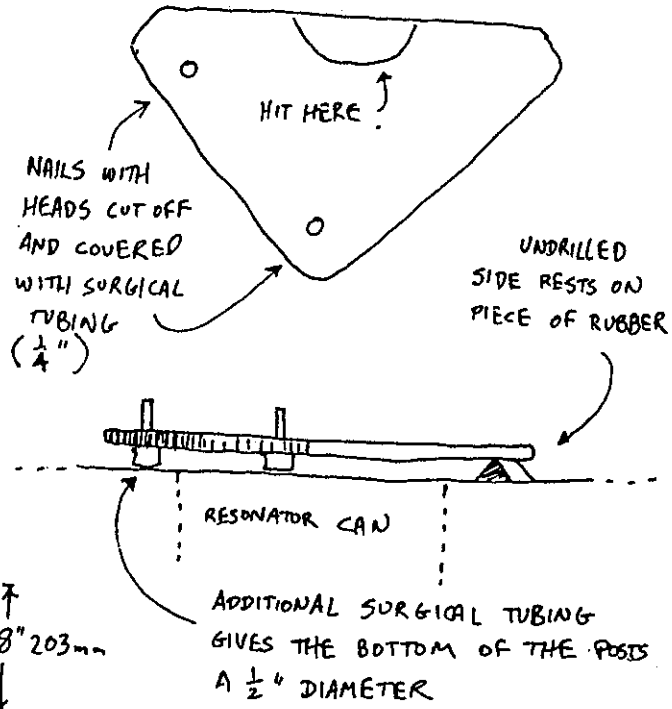


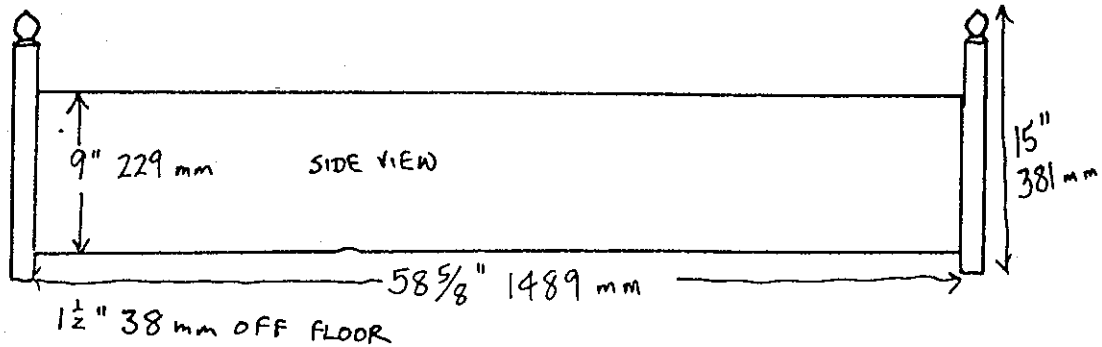
SLENDRO KENONG

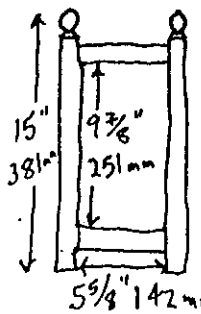


BASIC MOUNTING PLAN







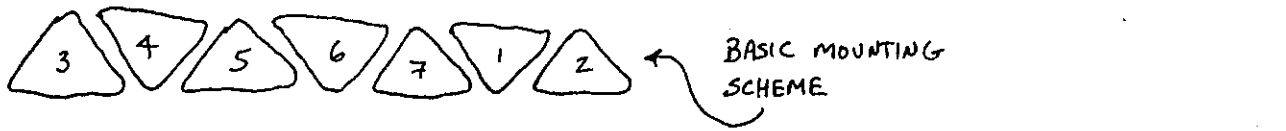


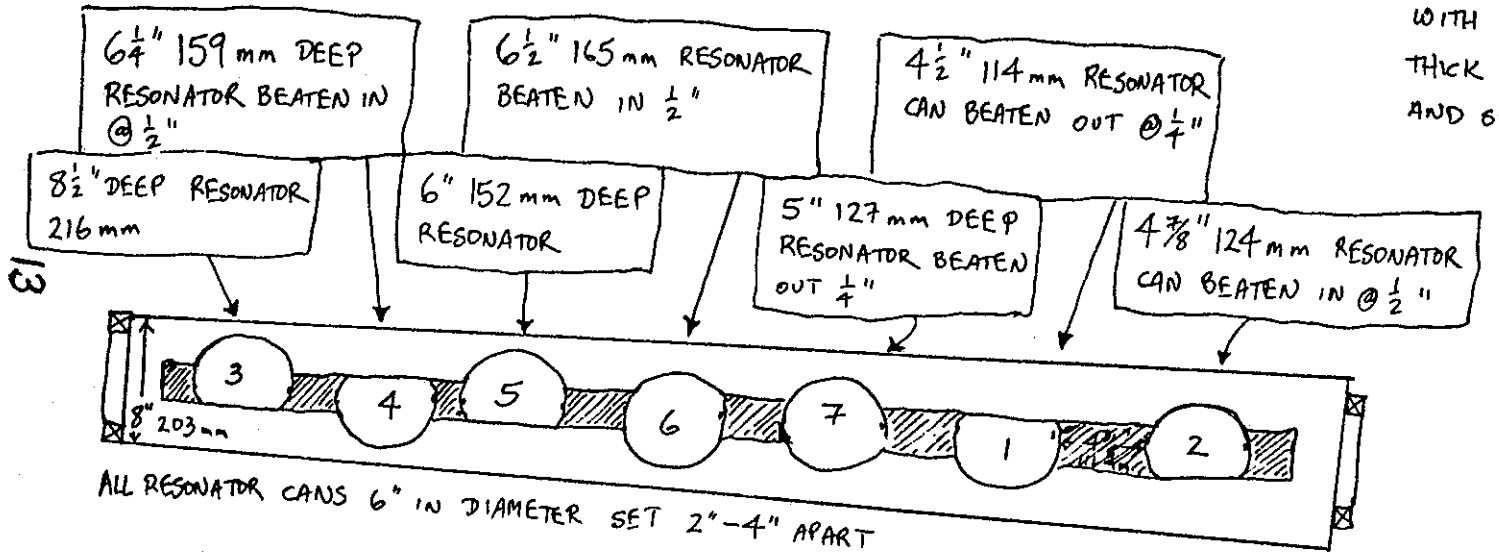
END PIECE (2) MADE OF 2X2's

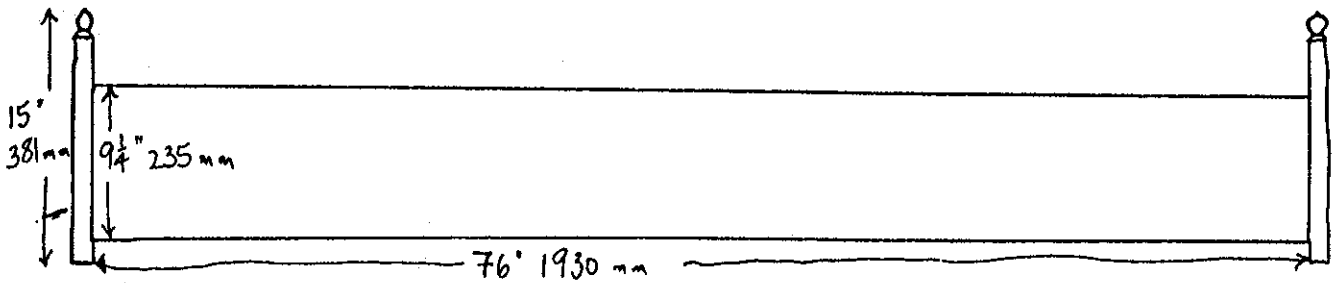
PELOG KENONG

BOTH KENONGAN ARE MADE OF ½" 13mm PLYWOOD, WITH THE BOTTOM OF ⅛ 3/8" 9mm PRESSBOARD OR PLYWOOD: THE RIMS ARE MADE OF 1x3's (¾" 19mm x 2¾" 70mm PINE STRIPS). THE END PIECES ARE 2x2's.

THE KENONG BEATER HAS AN 11¾" 298mm X ½" 13mm HANDLE WITH A HEAD 6" 152mm IN DIAMETER OF ¾" 19mm PLYWOOD. THIS IS WRAPPED WITH 2 LAYERS OF ⅛" 3mm THICK FELT WHICH IS GLUED AND SEWN.

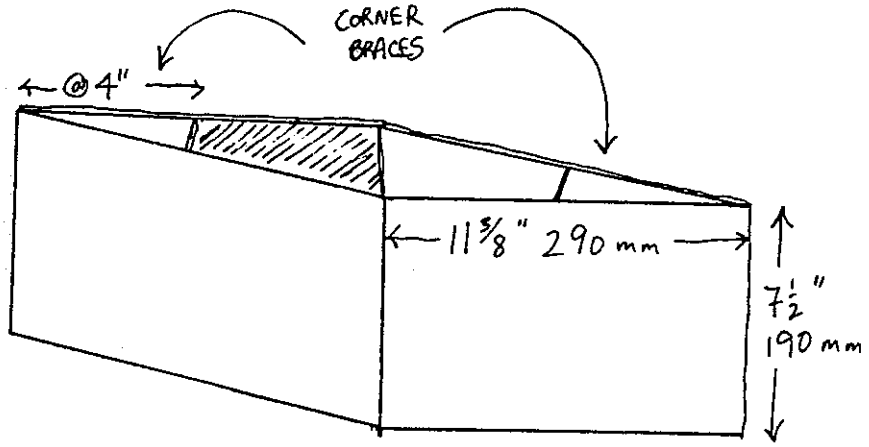






END PIECES SAME AS SLENDRO KENONG

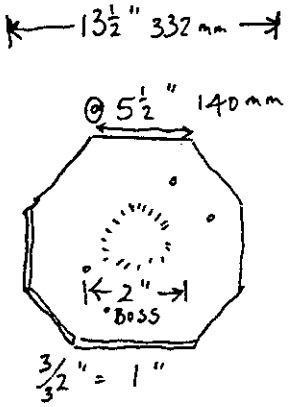
SLENDRO & PELOG KETUKS



PELOG KETUK RESONATOR

3/16" = 1"

PELOG KETUK IS PITCH 6



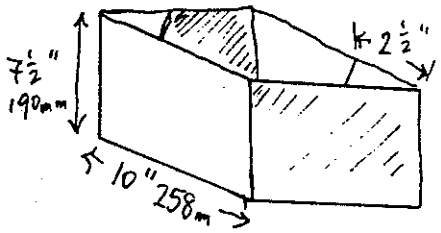
REJECT BONANG PLATE USED FOR KETUK

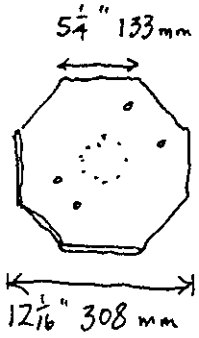
BOTH KETUK PLATES 1/8" ALUMINUM @3mm

KETUK RESONATORS MADE OF 1/2" 13 mm PLYWOOD. THE BEATER IS A 8 1/2" 216 mm X 3/4 19 mm WOODEN DOWEL WITH COTTON ROPE WRAPPED AND GLUED AROUND THE END FOR 3 1/2" 89 mm.

SLENDRO KETUK RESONATOR

3/32" = 1"

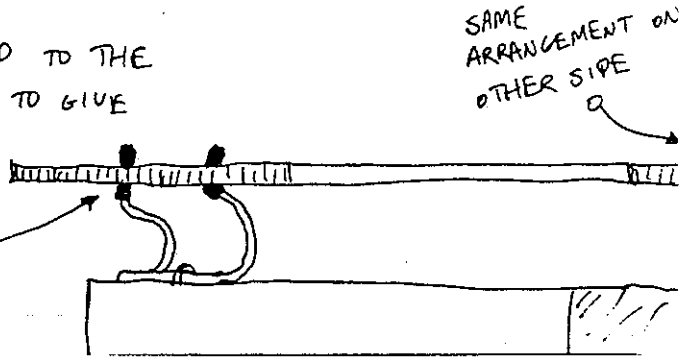




SLENDRO KETUK IS PITCH 2

PLATES ARE MOUNTED ON WIRES ATTACHED TO THE TWO CORNER BRACES. THIS METHOD TENDS TO GIVE YOU A RATTLING PROBLEM. IT MAY BE BETTER TO SUSPEND THE KETUK FROM DOWELS.

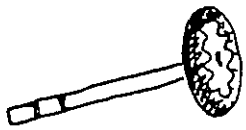
INDUSTRIAL RUBBER TUBING COVERS THE WIRES



PELOG DEMUNG

KEY	LENGTH		WIDTH		THICKNESS
5	15¼"	388 mm	3 3/16"	80 mm	¼" 6 mm
6	14½"	375 mm	3 5/16"	84 mm	"
7	14 1/16"	360 mm	3¼"	83 mm	"
1	13 13/16"	351 mm	3¼"	"	"
2	13¼"	337 mm	3¼"	"	"
3	12 13/16"	325 mm	3¼"	"	"
4	12 5/16"	313 mm	3¼"	"	"
5	11 15/16"	303 mm	3¼"	"	"
6	11 9/16"	293 mm	3 3/16"	82 mm	"
7	11⅛"	284 mm	3 3/16"	"	"
i	10 13/16"	275 mm	3 3/16"	"	3/8" 9mm
2	10 7/16"	265 mm	3¼"	83 mm	"
3	9 15/16"	252 mm	"	"	"
4	9½"	240 mm	"	"	"
5	9"	228 mm	"	"	"

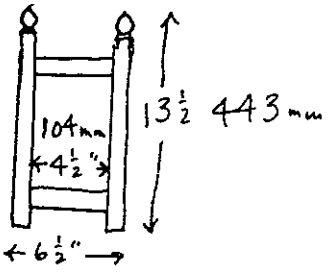
CABINET IS OF ¼" 6mm PLYWOOD WITH A RIM OF 1X2 PINE STRIPS (LIT. ¾" x 1½"). END POSTS ARE 2X2's. DEMUNG BEATER HAS A 8½" 216 mm HANDLE TOOLED OUT OF ¾" 19 mm DOWEL. THE HEAD IS ½" 13 mm THICK AND 3½" 89 mm IN DIAMETER. RUBBER TUBING FROM MOTORCYCLE TIRES IS WRAPPED AROUND THE RIM, AND THIS IS COVERED BY TWO LAYERS OF FELT STAPLED ON.



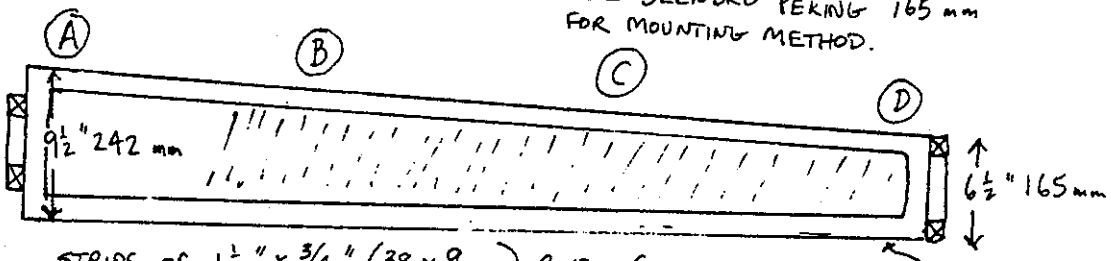
APPROXIMATE DEPTHS AT
(A): 7⅜" 182 mm
(B): " "
(C): 5¾" 146 mm
(D): 2¾" 70 mm

TROUGH RESONATOR SHOULD BE ADJUSTED FOR BEST RESONANCE. HERE ARE SAMPLE DEPTHS. USE ⅛" 3mm HARDBOARD FOR THIS. (SEAL TIGHTLY!)

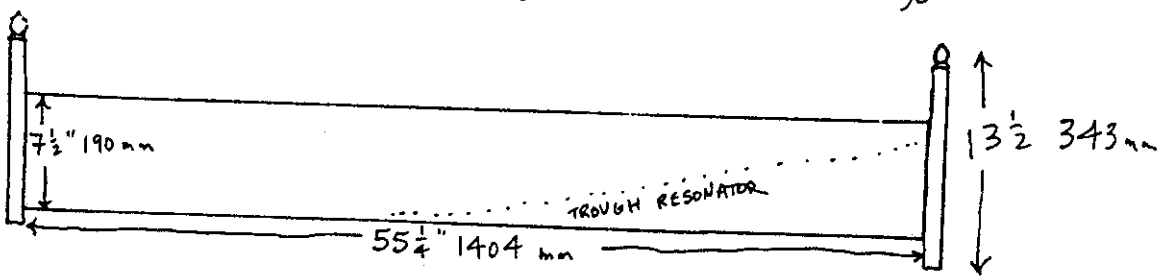
END PIECES:



KEYS ARE SPACED ¼" 6mm APART. SEE SLENDRO PEKING FOR MOUNTING METHOD.



STRIPS OF 1½" x ¾" (38 x 9 mm) PINE FOR MOUNTING KEYS

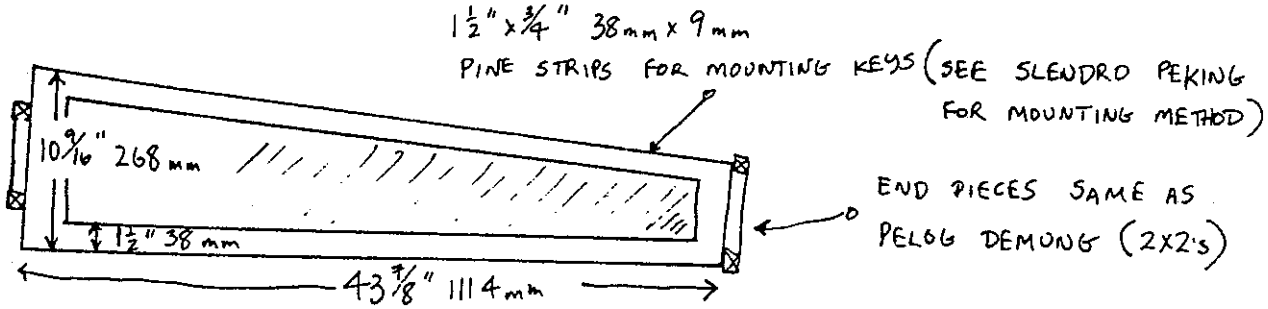


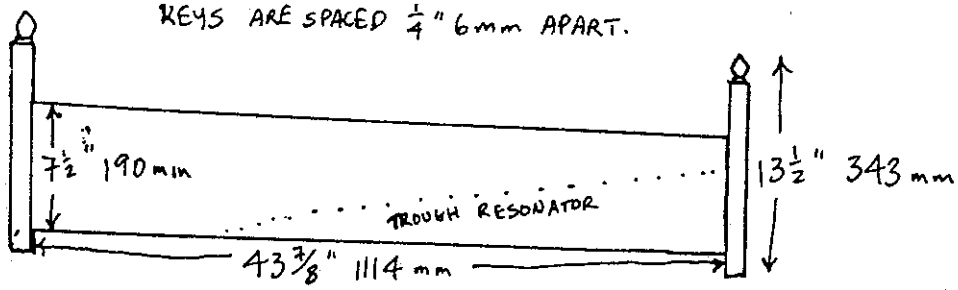
SLENDRO DEMUNG

KEY	LENGTH	WIDTH	THICKNESS
5	$16\frac{1}{32}$" 408mm	$3\frac{1}{2}$" 90mm	$\frac{1}{4}$" 6mm
6	$15\frac{3}{8}$" 390mm	" "	" "
1	$14\frac{3}{4}$" 375mm	" "	$\frac{5}{16}$" 7-8mm
2	$14\frac{1}{8}$" 358mm	" "	" "
3	$13\frac{1}{2}$" 344mm	" "	" "
5	$12\frac{7}{8}$" 327mm	" "	" "
6	$12\frac{1}{4}$" 311mm	" "	" "
1	$11\frac{1}{2}$" 293mm	" "	$\frac{3}{8}$" 9mm
2	$10\frac{5}{8}$" 270mm	" "	" "
3	$9\frac{15}{16}$" 253mm	" "	" "
5	$9\frac{3}{8}$" 238mm	" "	" "

CABINET & BEATER SAME AS PELOG DEMUNG.
CABINET USES $\frac{1}{2}$" 13 mm PLYWOOD WITH 2X2 END PIECES. 1X2'S ARE USED FOR RIM.

TROUGH RESONATOR
DEPTH TAPERS UP FROM $7\frac{1}{2}$" 190 mm
TO $2\frac{3}{4}$" 70 mm (USE $\frac{1}{8}$" 3mm HARDBOARD)



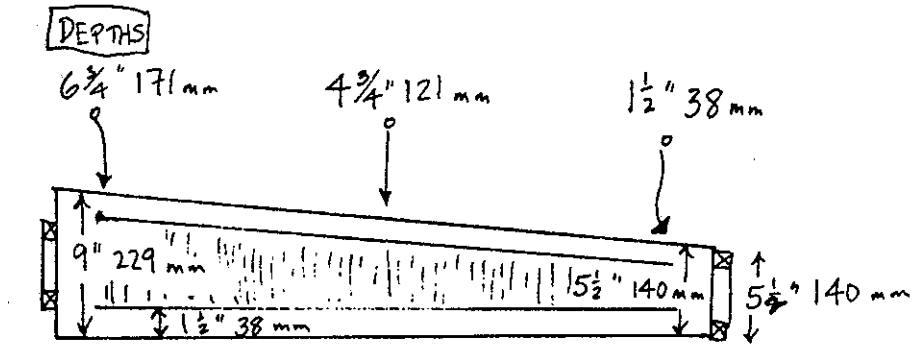


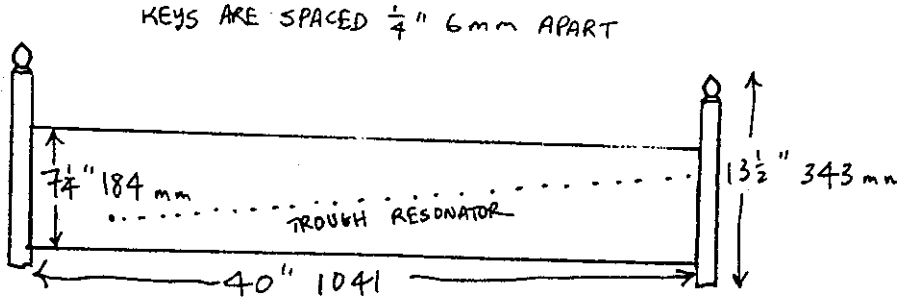
PELOG SARON

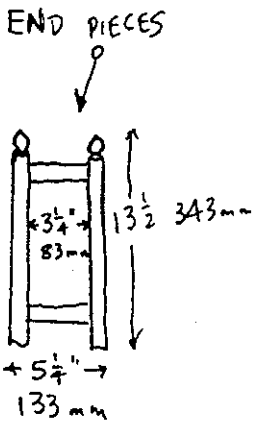
KEY	LENGTH	WIDTH	THICKNESS
5	13 11/16" 348 mm	2 1/4" 57 mm	3/8" 9 mm
6	12 15/16" 329 mm	" "	" "
7	12 13/16" 310 mm	" "	" "
1	11 5/8" 294 mm	" "	" "
2	11" 280 mm	" "	" "
3	10 1/2" 268 mm	" "	" "
4	10" 258 mm	" "	" "
5	9 7/8" 251 mm	" "	1/2" 13 mm
6	9 9/16" 243 mm	" "	" "
7	9 1/4" 235 mm	" "	" "
1	8 15/16" 224 mm	" "	" "
2	8 5/8" 219 mm	" "	" "
3	8 1/4" 210 mm	" "	" "
4	7 15/16" 198 mm	" "	" "
5	7 1/2" 191 mm	" "	" "

CABINET MADE OF 1/2" 13 MM PLYWOOD. END POSTS ARE 2X2'S. SARON HAS TROUGH RESONATOR LIKE DEMUNG, WHICH SHOULD BE ADJUSTED FOR BEST RESONANCE. 1/8" 3mm HARD-BOARD IS USED FOR THIS, SEALED TIGHTLY. KEYS ARE SPACED 1/4" 6mm APART. SEE SLENDRO PEKING FOR MOUNTING METHOD.

SARON BEATER IS 8" 203 mm LONG TOOLED OUT OF 3/4" 19mm DOWEL. THE HEAD IS 1/2" 13mm THICK AND 3" 76 mm IN DIAMETER. THIS IS COVERED BY A LAYER OF MOTORCYCLE INNER TUBE RUBBER AROUND THE RIM AND ONE LAYER OF FELT STAPLED ON.



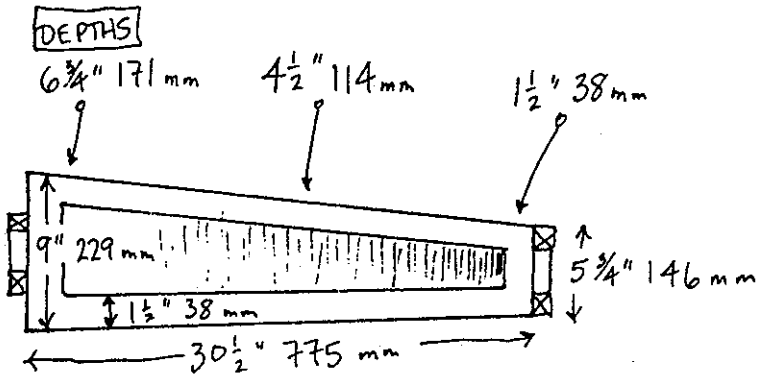




SLENDRO SARON

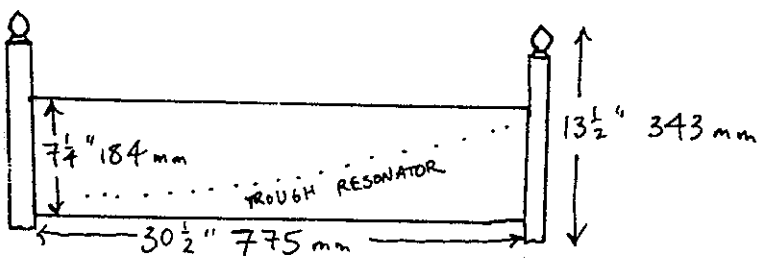
KEY	LENGTH	WIDTH	THICKNESS
5	13¼" 332 mm	2¼" 57 mm	⅜" 10 mm
6	12¼" 311 mm	" "	" "
1	11½" 292 mm	" "	" "
2	10¾" 273 mm	" "	" "
3	10 1/16" 256 mm	" "	" "
5	9 3/16" 240 mm	" "	" "
6	8 15/16" 228 mm	" "	" "
1	8⅜" 213 mm	" "	½" 13 mm
2	7 15/16" 198 mm	" "	" "
3	7 9/16" 193 mm	" "	" "
5	7 1/16" 180 mm	" "	" "

CABINET WOODS AND BEATER SAME AS PELOG SARON.



SAME END PIECES AS PELOG SARON

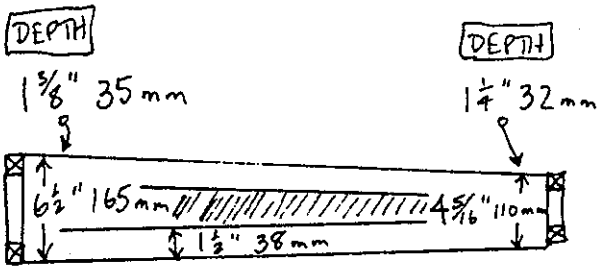
KEYS ARE SPACED ¼" 6mm APART



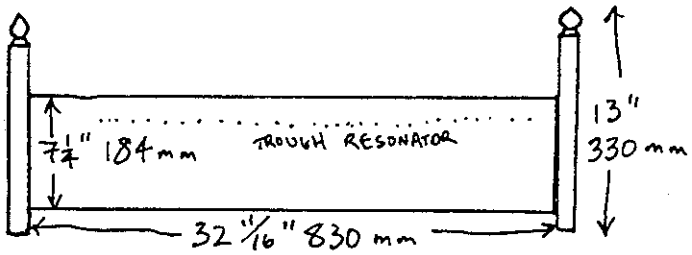
PELOG PEKING

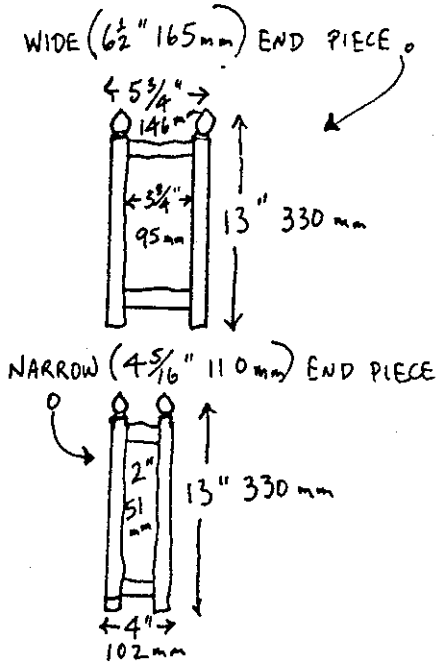
KEY	LENGTH		WIDTH		THICKNESS	
5	9 3/16"	233mm	1 9/16"	40mm	3/8"	10mm
6	8 11/16"	220mm	1 3/4"	45mm	"	"
7	8 1/2"	215mm	"	"	"	"
1	8 1/4"	209mm	"	"	"	"
2	7 7/8"	201mm	"	"	"	"
3	7 7/16"	189mm	"	"	"	"
4	7 7/16"	189mm	"	"	1/2"	12mm
5	7 1/4"	183mm	"	"	"	"
6	7 1/32"	179mm	"	"	"	"
7	6 13/16"	172mm	"	"	"	"
1	6 5/8"	169mm	"	"	"	"
2	6 7/16"	162mm	"	"	"	"
3	6 1/4"	158mm	"	"	"	"
4	6"	153mm	1 7/8"	40mm	5/8"	15mm
5	5 7/8"	198mm	1 3/4"	45mm	"	"

CABINET MADE OF 1/2" 13mm PLYWOOD. END POSTS ARE 2X2'S. TROUGH RESONATOR FOR PEKING IS VERY SHALLOW, AND AGAIN 1/8" 3mm HARD-BOARD IS USED, TIGHTLY SEALED. THE BEATER HAS AN 8 1/2" 216mm HANDLE OF 1/2" 13mm DOWEL. THE BEATER HEAD IS AN OVAL PIECE OF PINE, 4" 102mm LONG, 1 1/2" 38mm WIDE AND 3/4" 19mm THICK. IT HAS ONLY A LAYER OF MOTORCYCLE INNER TUBE RUBBER AROUND ITS RIM. THE RIM OF THE CABINET FOR KEY MOUNTING IS 1X2's.



KEYS ARE SPACED 1/4" 6mm APART.



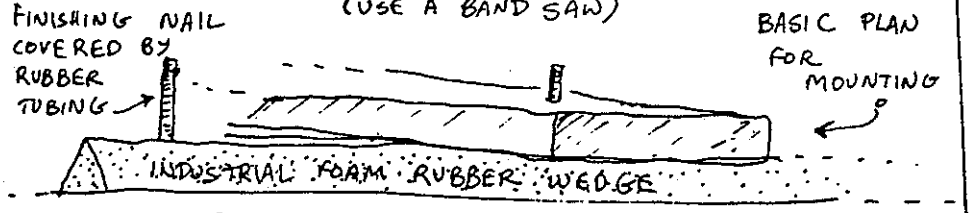


SLENDRO PEKING

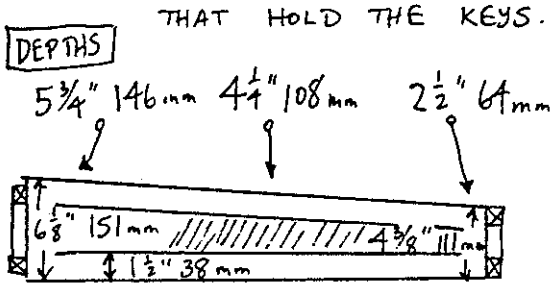
KEY	LENGTH		WIDTH		THICKNESS	
5	8 3/4"	222 mm	1 13/16"	41 mm	3/8"	10 mm
6	8 5/8"	213 mm	1 3/4"	45 mm	"	"
1	8"	204 mm	"	"	"	"
2	7 11/16"	195 mm	"	"	"	"
3	7 3/16"	188 mm	"	"	"	"
5	7 1/8"	182 mm	"	"	1/2"	13 mm
6	7"	178 mm	"	"	"	"
1	6 3/4"	172 mm	"	"	"	"
2	6 5/8"	169 mm	"	"	"	"
3	6 3/16"	164 mm	"	"	5/8"	15 mm
5	6 1/4"	159 mm	"	"	"	"

ALL TROUGH RESONATING METALLOPHONES HAVE RIMS OF 1 1/2" x 3/4" PINE (@ 38 x 19 mm) AROUND THE TOP FOR MOUNTING THE KEYS. ALONG THESE STRIPS OF WOOD ARE LAID STRIPS OF INDUSTRIAL FOAM RUBBER, I.E. REAL RUBBER, NOT STYROFOAM. WE RECOMMEND THIS FOR ALL KEY SUPPORTS.

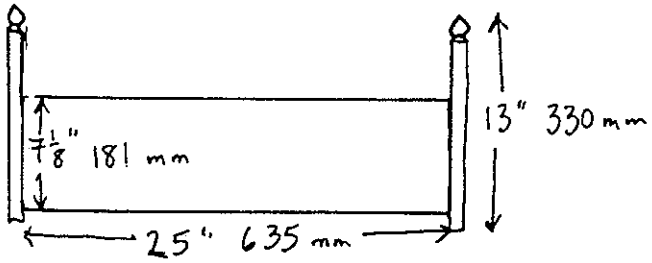
BUY A 3/4" SHEET OF INDUSTRIAL FOAM RUBBER & CUT IT INTO 3/4" STRIPS. THEN CUT THESE 3/4" SQUARE STRIPS AT A 45° ANGLE AND YOU'LL HAVE A PROPER TRIANGULAR WEDGE FOR BASIC KEY SUPPORT. (USE A BAND SAW)

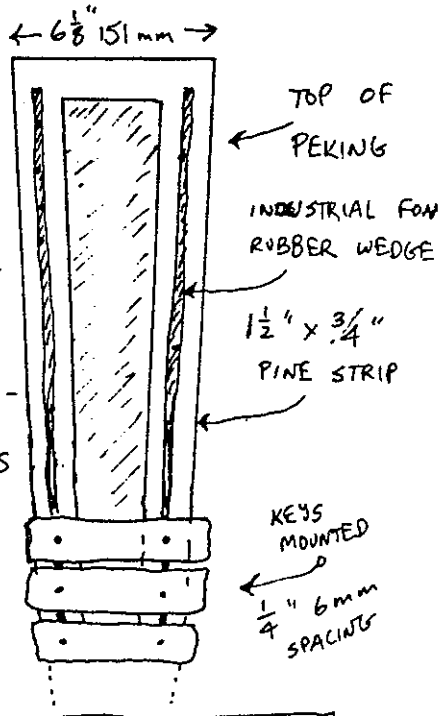


ALSO, WE'VE FOUND THAT REAL RUBBER TUBING IS FAR SUPERIOR TO SURGICAL TUBING FOR COVERING THE NAILS THAT HOLD THE KEYS.



ADJUST TROUGH RESONATOR FOR MAXIMUM RESONANCE





END PIECES SAME AS PELOG PEKING

THE KEY MOUNTING METHOD DESCRIBED ABOVE APPLIES TO PELOG & SLENDRO DEMUNG, SARON & PEKING.

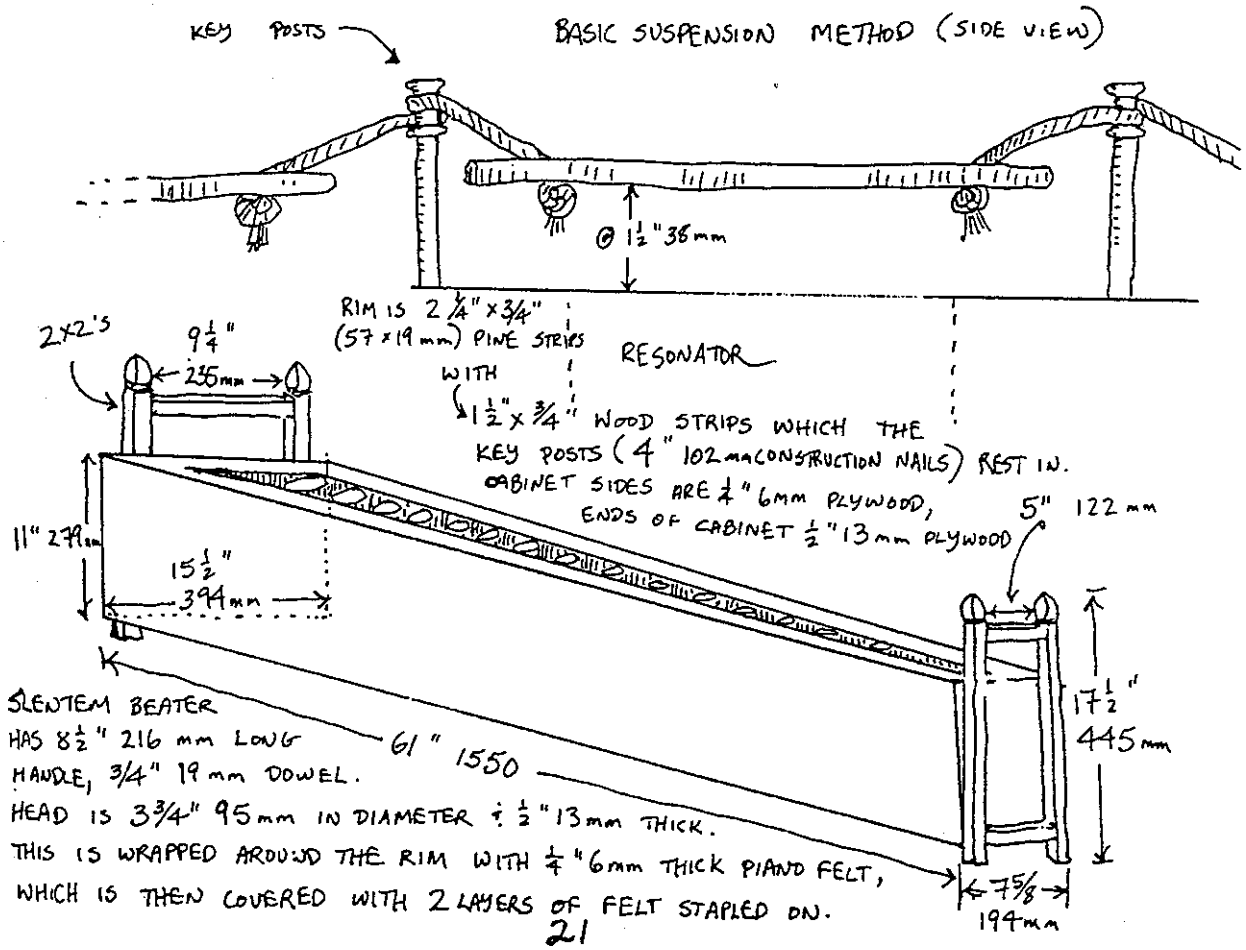
CABINET WOODS SAME AS PELOG PEKING.

PELOG SLENTEM

KEY	LENGTH	WIDTH	THICKNESS	RESONATOR DEPTH	RESONATER DIAMETER
5	18½" 470mm	3 3/16" 81mm	3/16" 5mm	10¾" 273mm	2¾" 70mm
6	17 1/16" 446mm	" "	" "	" "	3½" 89mm
7	16 13/16" 427mm	" "	" "	" "	OVAL 3⅝" x 2¾" 92x70mm
1	16" 410mm	" "	" "	" "	4⅛" x 3¼" 105x83mm
2	15¼" 388mm	3 5/16" 84mm	" "	" "	4½" x 3" 114x76mm
3	14¾" 374mm	3⅝" 86mm	" "	10⅜" 264mm	5¼" x 3⅛" 134x80mm
4	14 1/32" 358mm	" "	" "	8¾" 222mm	6⅜" x 3½" 162x89mm
5	13 11/16" 351mm	3 5/32" 80.5mm	" "	2½" 215mm	4¼" x 3½" 113x89mm
6	13¼" 336mm	3¼" 82mm	" "	7⅜" 188mm	5⅞" x 3½" 148x89mm
7	13" 332mm	3 5/16" 84mm	" "	6⅞" 175mm	3⅝" x 5½" 90x142mm
1	12 11/16" 322mm	3 3/16" 81mm	" "	5⅝" 142mm	5 5/16" x 3½" 135x89mm
2	12 7/16" 316mm	3¼" 82mm	¼" 7mm	5⅛" 130mm	5" x 3⅝" 127x93mm
3	12⅛" 308mm	3 3/16" 81mm	" "	7" 178mm	4¾" x 3¾" 121x95mm
4	11 15/16" 303mm	3¼" 82mm	" "	6⅞" 175mm	4½" x 3½" 114x89mm
5	11 9/16" 294mm	3 5/16" 84mm	" "	6" 152mm	4¼" x 3½" 108x89mm

OVALS

BASIC SUSPENSION METHOD (SIDE VIEW)

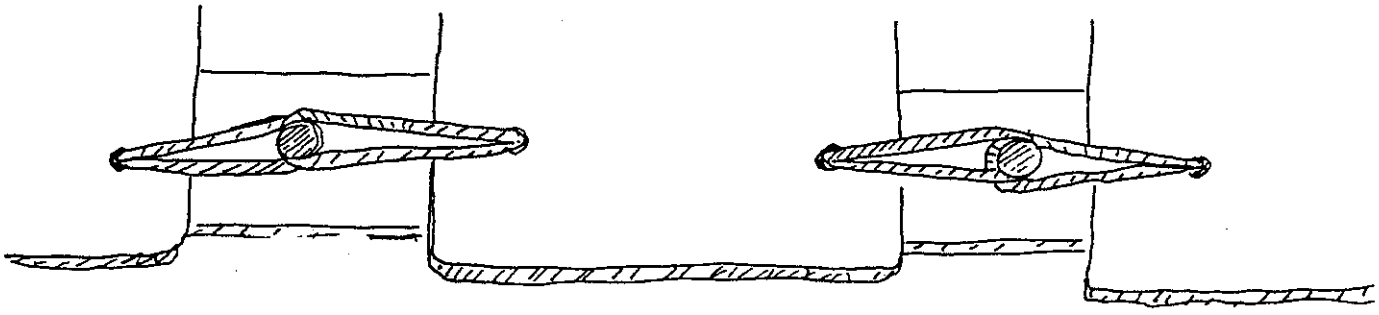


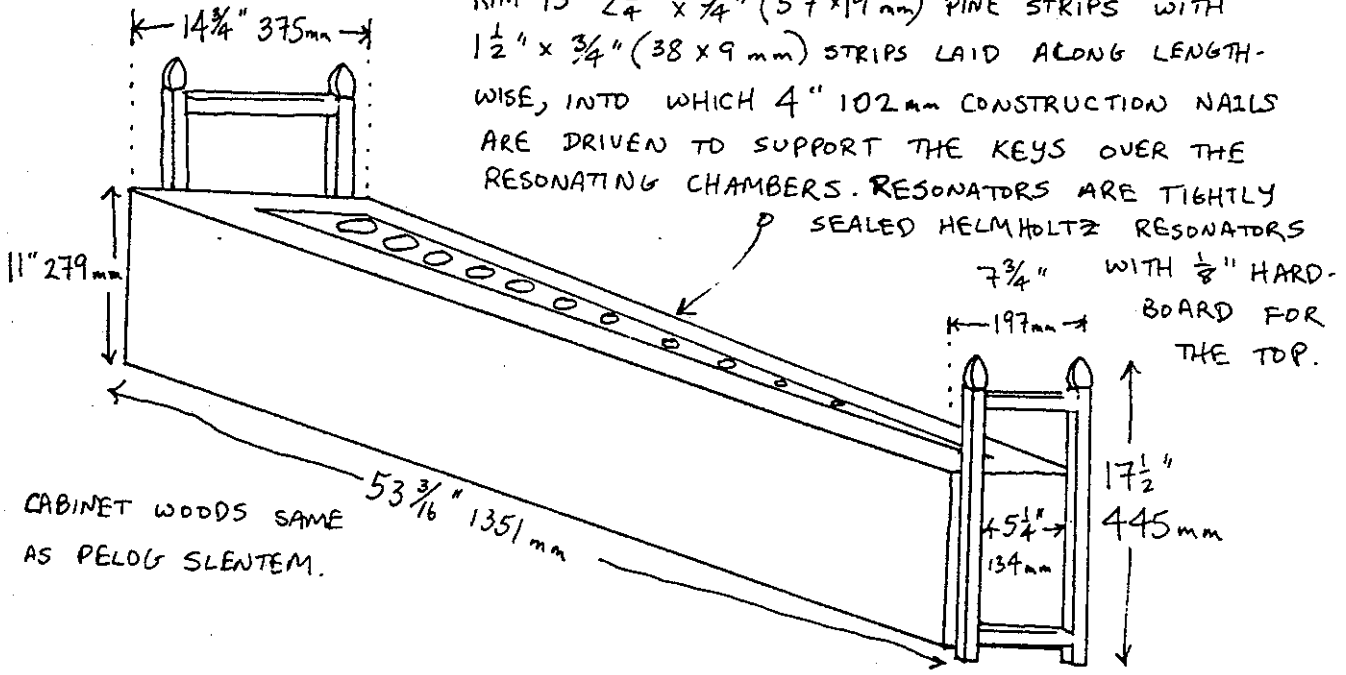
SLENTEM BEATER HAS 8½" 216 mm LONG HANDLE, 3/4" 19 mm DOWEL. HEAD IS 3¾" 95mm IN DIAMETER x ½" 13mm THICK. THIS IS WRAPPED AROUND THE RIM WITH ¼" 6mm THICK PIANO FELT, WHICH IS THEN COVERED WITH 2 LAYERS OF FELT STAPLED ON.

SLENDRO SLENTEM

KEY	LENGTH	WIDTH	THICKNESS	RESONATOR DEPTH	RESONATOR DIAMETER
5	19⅛" 481 mm	4" 102 mm	3/16" 5 mm	10⅝" 270 mm	2¼" 57 mm
6	18 1/16" 458 mm	" "	"	" "	" "
1	17 1/16" 433 mm	" "	"	10¾" 273 mm	3¼" 83 mm
2	16⅜" 409 mm	4⅜" 110 mm	"	10⅝" 270 mm	3½" 89 mm
3	15 5/16" 389 mm	4" 102 mm	"	" "	3¾" 95 mm
5	14½" 369 mm	" "	"	5⅜" 138 mm	1⅜" 48 mm
6	13 13/16" 351 mm	" "	"	" "	2¾" 70 mm
1	13¼" 337 mm	" "	¼" 6 mm	" "	2½" 64 mm
2	12⅝" 321 mm	3 13/16" 97 mm	"	5½" 140 mm	3¼" 83 mm
3	12" 305 mm	" "	"	" "	2¾" 70 mm
5	11 7/16" 292 mm	" "	"	5⅜" 138 mm	3¾" 95 mm

BASIC SUSPENSION METHOD (TOP VIEW)





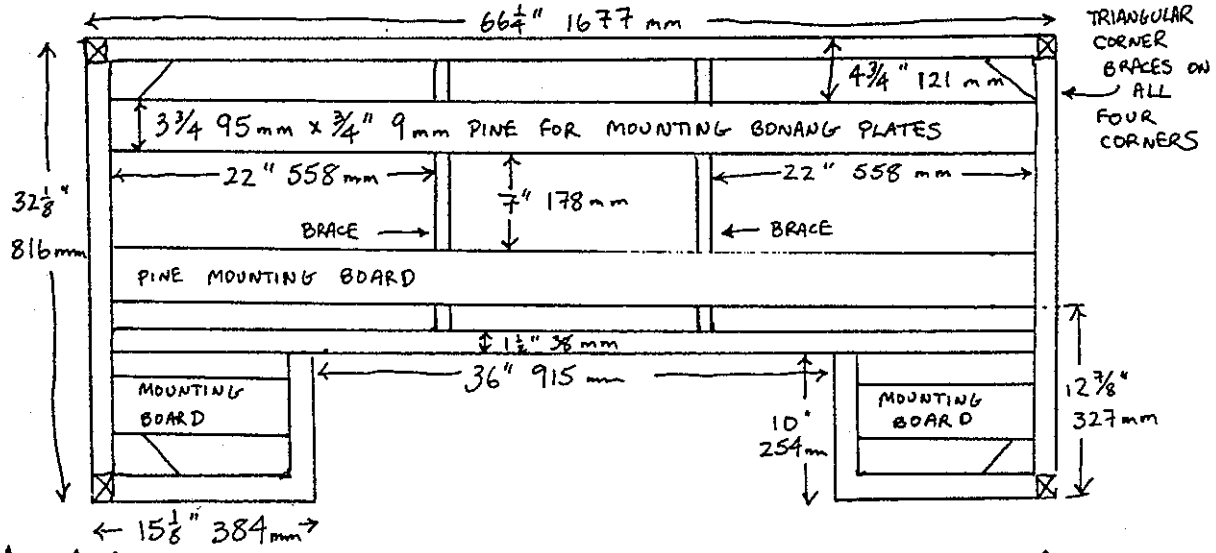
RIM IS 2¼" x ¾" (57 x 19 mm) PINE STRIPS WITH 1½" x ¾" (38 x 9 mm) STRIPS LAID ALONG LENGTHWISE, INTO WHICH 4" 102 mm CONSTRUCTION NAILS ARE DRIVEN TO SUPPORT THE KEYS OVER THE RESONATING CHAMBERS. RESONATORS ARE TIGHTLY SEALED HELMHOLTZ RESONATORS WITH ⅛" HARDBOARD FOR THE TOP.

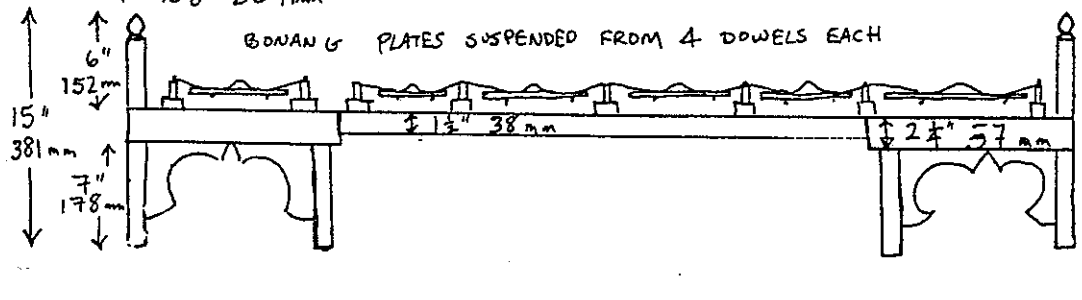
CABINET WOODS SAME AS PELOG SLENTEM.

BONANG BARUNG - SLENDRO

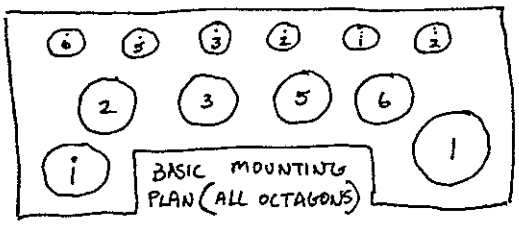
PLATE	SIDE OF OCTAGON		DIAMETER		@ BOSS WIDTH	
1	5 1/4"	134mm	12 1/2"	318mm	2 1/2"	63mm
2	5"	127mm	12 5/16"	313mm	2 1/2"	63mm
3	4 3/4"	121mm	11 7/8"	302mm	2"	51mm
5	"	"	11 1/8"	282mm	2 1/2"	63mm
6	4 3/8"	111mm	10 1/4"	261mm	2 1/4"	58mm
i	4 7/8"	123mm	9 3/16"	233mm	2 1/2"	63mm
2	3 7/8"	98mm	9 1/8"	234mm	3"	76mm
3	3 1/2"	89mm	8 3/4"	222mm	2 1/4"	58mm
5	3 3/8"	86mm	8 1/16"	205mm	"	"
6	3 1/8"	81mm	7"	178mm	1 1/2"	33mm
i	2 3/4"	70mm	6 3/16"	163mm	"	"
2	2 5/8"	62mm	6 1/2"	165mm	"	"

THESE BONANG PLATES ARE NOT PERFECT OCTAGONS, THEREFORE I HAVE GIVEN BOTH THE LENGTH OF A RANDOM SIDE AND THE DIAMETER. AS LONG AS THE GENERAL SIZE IS USED, THE EXACT TUNING CAN BE ADJUSTED WITH THE SIZE AND DEPTH OF THE BOSS. ALL PLATES 1/8" @3m THICK EXCEPT WHERE INDICATED.





MAKE ENDS FLUSH SO THE BONANG CAN STAND ON END FOR EASY STORAGE

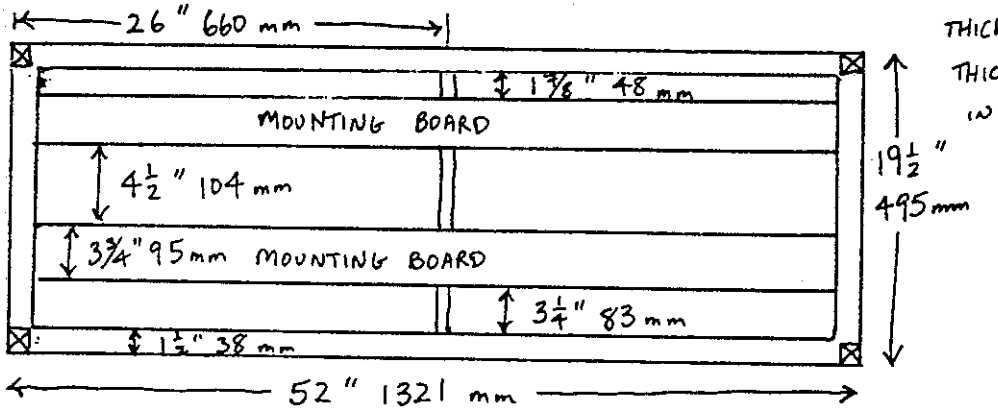


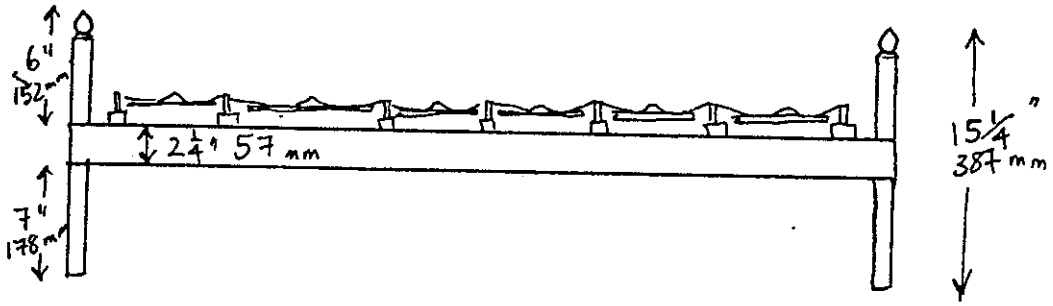
BASIC BONANG FRAME MADE OF 2x2's WITH 1x4's USED FOR MOUNTING BOARDS.

BONANG PANERUS - SLENDRO

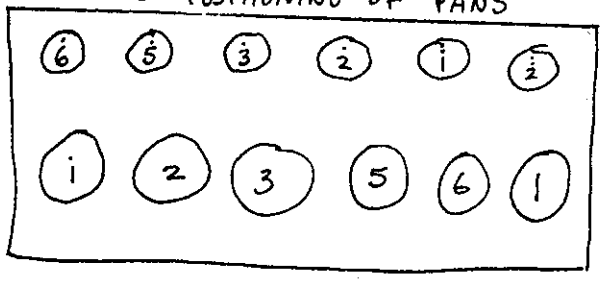
PLATE	SIDE OF OCTAGON	DIAMETER	@ BOSS WIDTH
1	4" 102 mm	9¼" 235 mm	2½" 63 mm
2	2 7 3½" 89 mm	6¾ 8½" 216 mm	" "
3	3¾" 96 mm	8½" 216 mm	2¼" 57 mm
5	3⅜" 85 mm	7⅜" 197 mm	2" 51 mm
6	2⅜" 74 mm	6¾" 172 mm	1½" 38 mm
i	2⅝" 62 mm	6¼" 159 mm	" "
2	2½" 63 mm	6" 152 mm	2" 51 mm
3	2½" "	" "	1¼" 32 mm
5	2¼" 57 mm	5⅝" 144 mm	1½" 38 mm
6	" "	5½" 140 mm	2" 51 mm
i	2⅜" 61 mm	" "	1¾" 45 mm
2	2" 51 mm	5" 127 mm	1" 25 mm

FRAMES FOR ALL BONANG MADE OF MOSTLY 2x2's (1⅝" 41 mm SQUARE) MOUNTING BOARDS ARE 1x4's (LIT. ¾" 19 mm x 3¾" 95 mm) BONANG PANERUS BEATERS ARE 9¾" 248 mm LONG ¼" 6 mm DOWEL HANDLES. BEATER HEADS HRE 2¼" 57 mm IN DIAMETER & ½" 13 mm THICK. THESE ARE WRAPPED WITH RUBBER TUBING AND 2 LAYERS OF BLACK FELT. BONANG BARANG BEATERS HAVE 8½" 216 mm LONG HANDLES 5/8" 16 mm THICK. HEADS ARE ½" 13mm THICK AND 3" 76 mm IN DIAMETER, WRAPPED WITH RUBBER TUBING AND 2 LAYERS OF FELT.



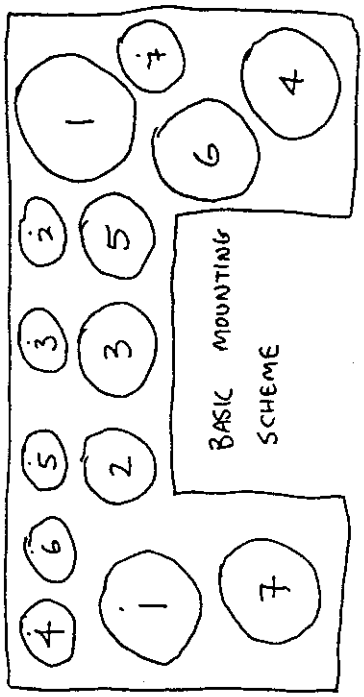


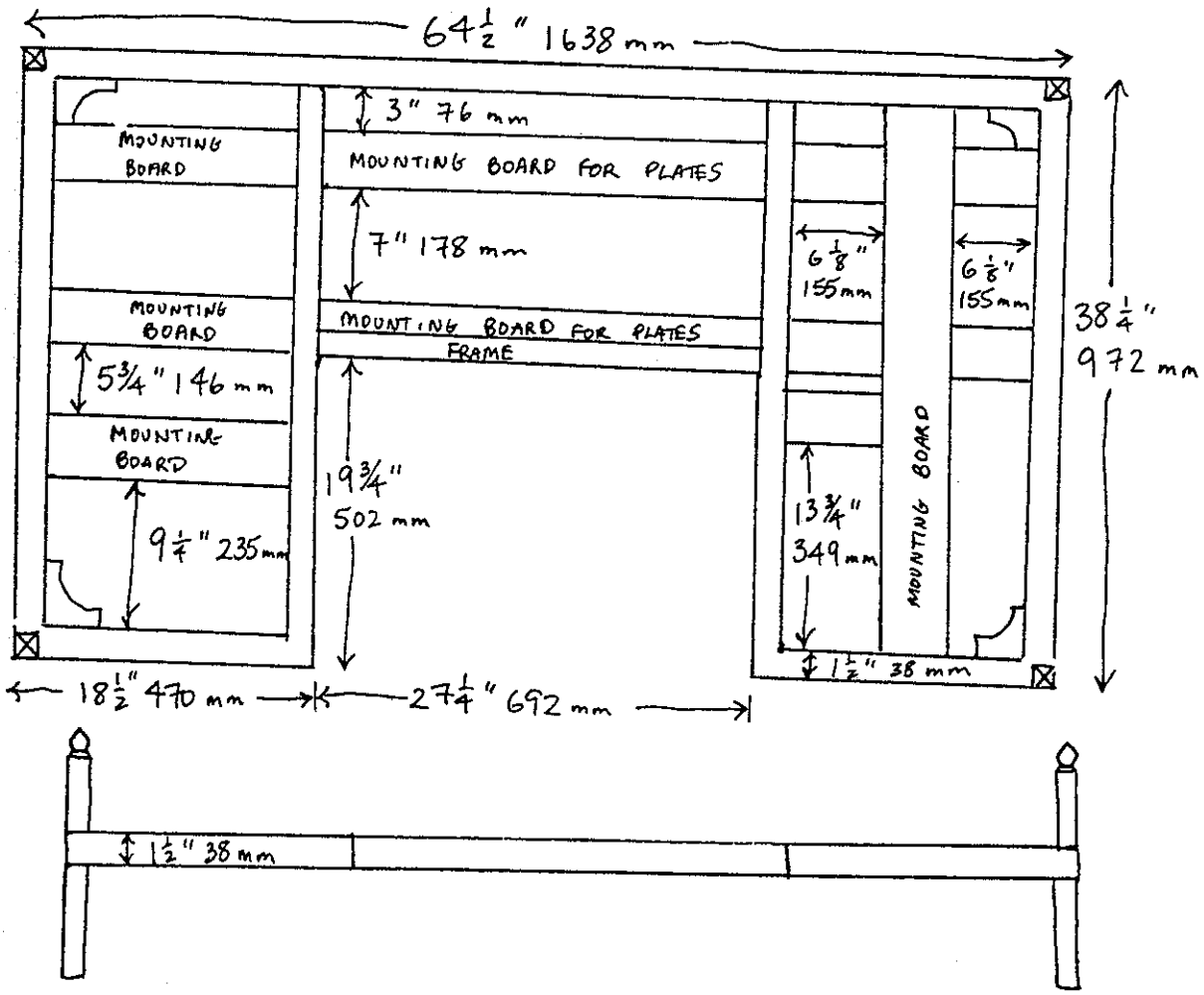
BASIC POSITIONING OF PANS



BONANG BARUNG - PELOG

PLATE	SIDE OF OCTAGON	DIAMETER	@ BOSS WIDTH
1	5 1/8" 130 mm	12 1/2" 317 mm	2" 51 mm
2	5" 127 mm	12" 305 mm	" "
3	4 7/8" 124 mm	12 1/8" 308 mm	2 1/4" 57 mm
4	4 3/4" 121 mm	11 3/4" 298 mm	" "
5	4 1/2" 114 mm	11 1/8" 282 mm	" "
6	4" 102 mm	10 1/8" 257 mm	2" 51 mm
7	" "	9 1/4" 235 mm	" "
i	3 3/4" 95 mm	" "	" "
2	3 7/8" 99 mm	9 5/16" 237 mm	" "
3	3 1/2" 89 mm	8 7/16" 214 mm	1 1/2" 38 mm
4	3 1/8" 79 mm	7 3/4" 197 mm	" "
5	2 3/4" 70 mm	7" 178 mm	2" 51 mm
6	" "	6 7/8" 175 mm	1 1/2" 38 mm
7	3" 77 mm	6 3/4" 170 mm	1 3/4" 45 mm

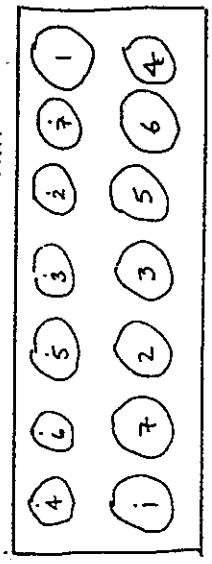


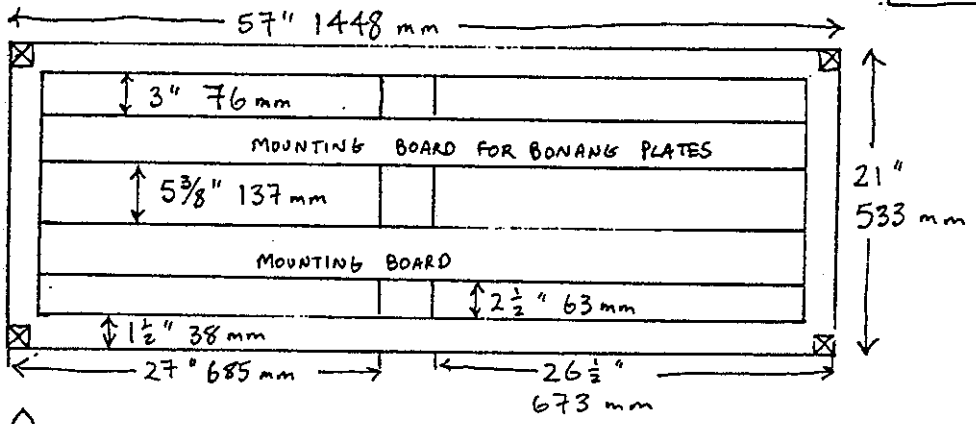


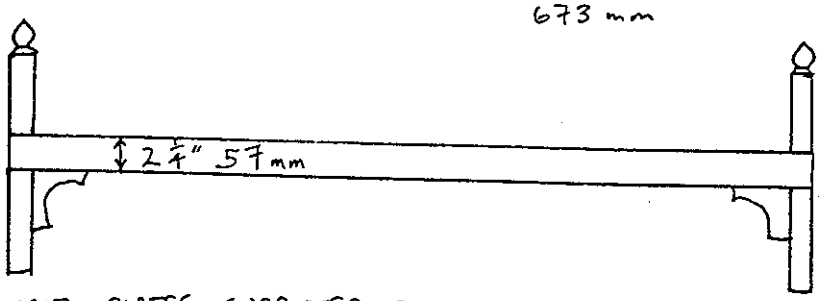
BONANG PANERUS - PELOG

PLATE	SIDE of OCTAGON		DIAMETER		@ BOSS WIDTH	
1	4"	102 mm	9¼"	235 mm	2½"	63 mm
2	3⅝"	92 mm	9"	229 mm	2¾"	70 mm
3	3½"	88 mm	8¼"	210 mm	2"	51 mm
4	3¼"	83 mm	7½"	191 mm	"	"
5	2¾"	70 mm	6⅞"	175 mm	1½"	33 mm
6	"	"	6½"	165 mm	"	"
7	"	"	6⅝"	168 mm	1¾"	44 mm
i	"	"	6 3/16"	164 mm	1½"	33 mm
·2	"	"	6⅜"	163 mm	1¾"	44 mm
·3	2½"	64 mm	6"	152 mm	"	"
·4	2¾"	70 mm	6¼"	159 mm	1½"	33 mm
·5	"	"	6⅜"	162 mm	2"	51 mm
·6	2½"	64 mm	6⅛"	155 mm	1½"	33 mm
·7	2⅜"	60 mm	6⅞"	175 mm	"	"

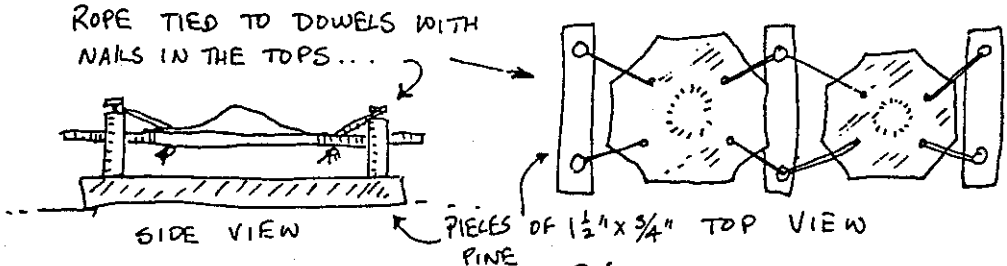
THESE PLATES ARE 3/16" @ 5 mm THICK



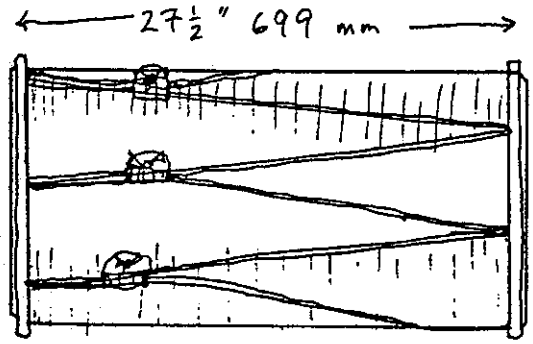




BONANG PLATES SUPPORTED BY FOUR PIECES OF ROPE TIED TO DOWELS WITH NAILS IN THE TOPS...

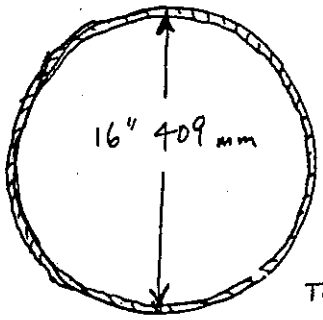


KENDANG INDUNG



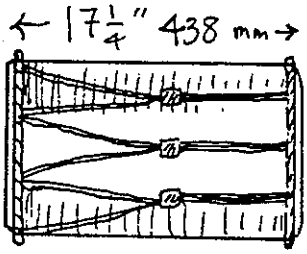
DRUM LACED WITH ELECTRICAL CORD FOR TIGHTENING HEADS

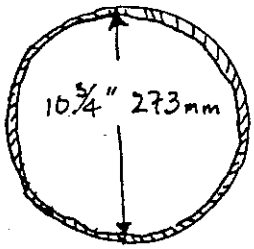
THE DRUM HEAD IS 16" IN DIAMETER, BUT THE ACTUAL BARREL OF THE DRUM IS MADE OF 15" 381 mm DIAMETER PVC SEWER PIPE, THE LARGEST DIAMETER AVAILABLE.



THE INSIDE OF THE BARRELS OF ALL THE DRUMS ARE SANDED AND THEN FELT IS GLUED IN. THIS GREATLY IMPROVES THE TONE.

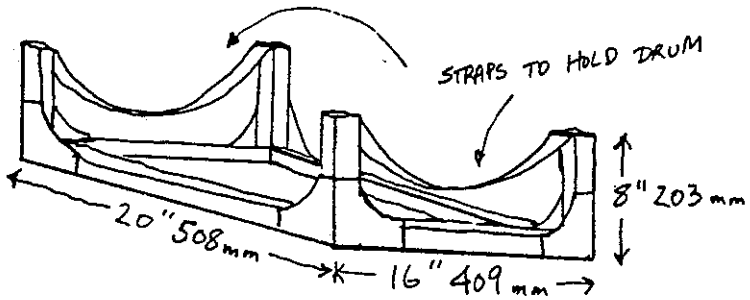
KETIPUNG

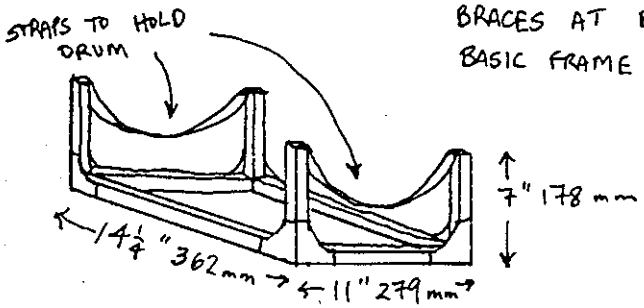




10" 254 mm PVC SEWER PIPE USED FOR KETIPUNG BARREL.

MAKE SURE YOUR DRUM HEADS STICK OUT A LITTLE BIT BEYOND THE RIM OF THE DRUM AS SHOWN HERE. THIS SAVES WEAR & TEAR ON THE FINGERS!

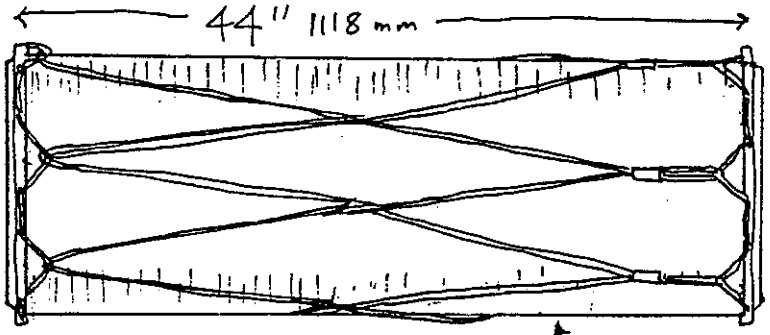


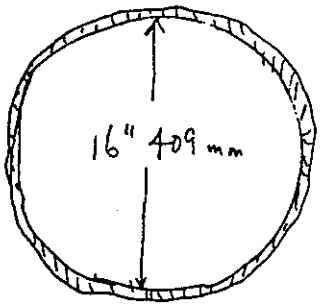


BRACES AT EACH CORNER
BASIC FRAME OF 1x2's.

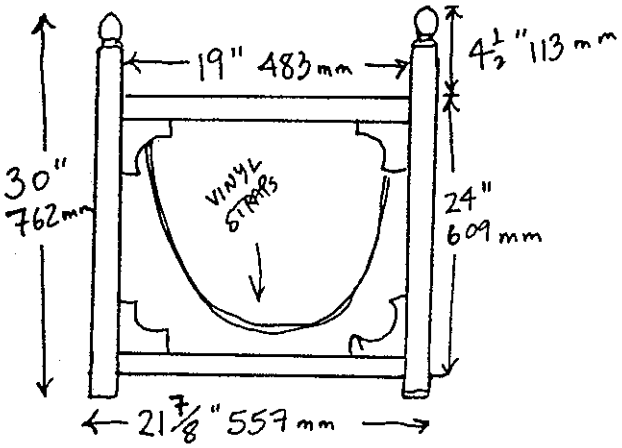
KENDANGAN

BEDUG

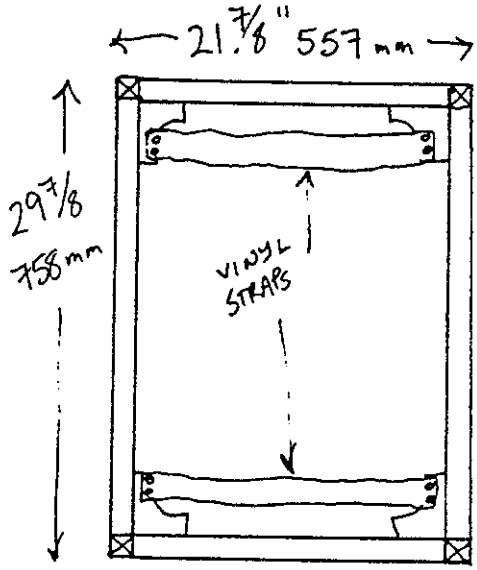




SPECIAL CROSS LACING FOR BEDUG

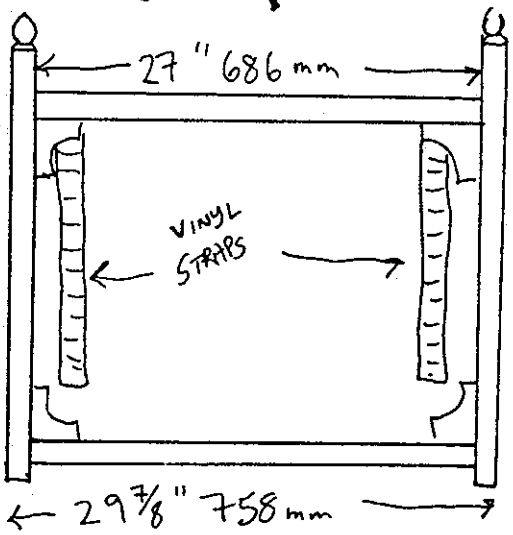


END VIEW



TOP VIEW

SIDE VIEW

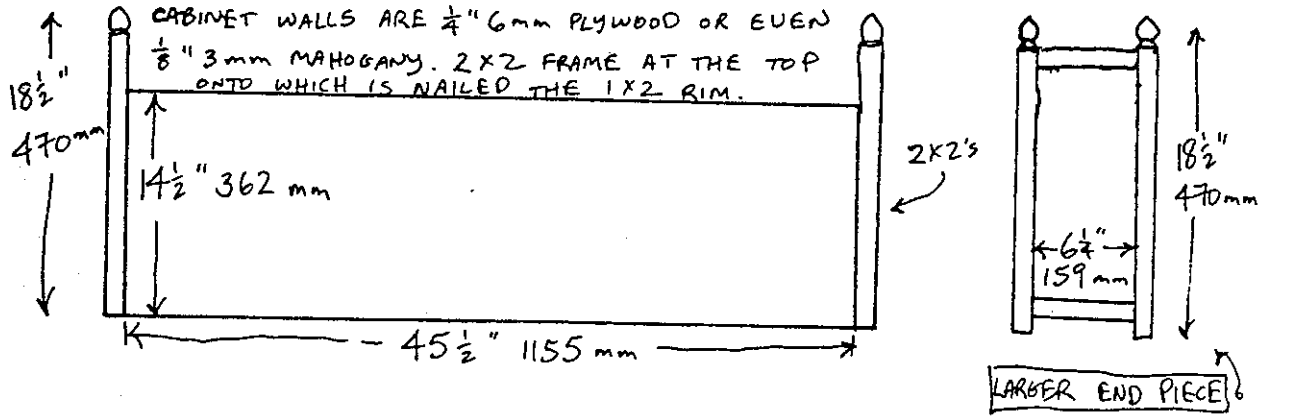


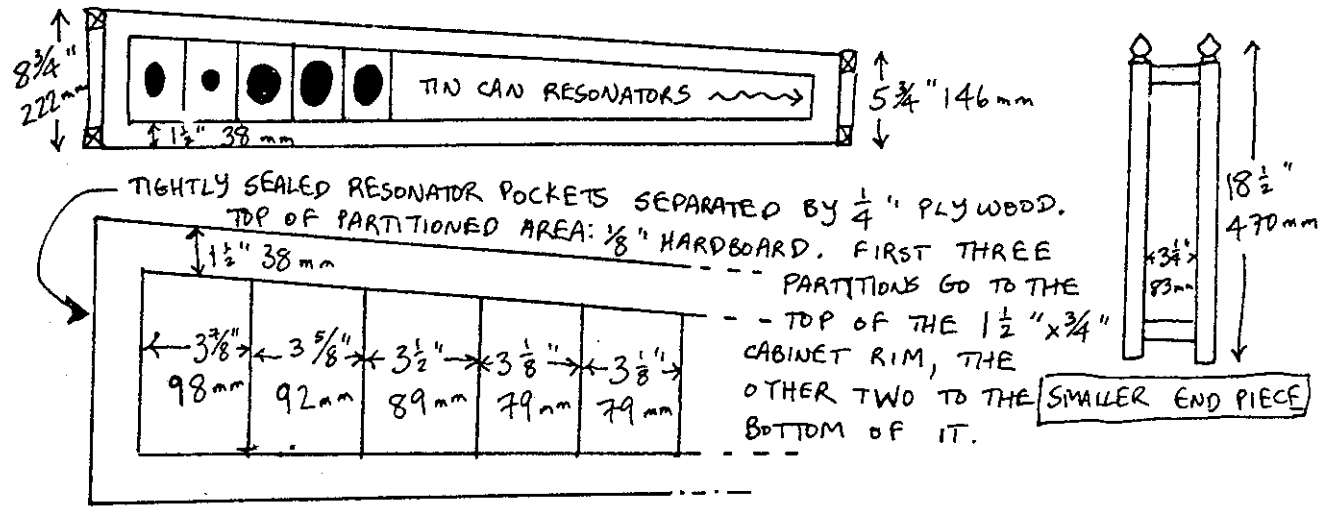
15" 381 mm PVC SEWER PIPE WAS ALSO USED FOR THE BARREL OF THE BEDUG. AS THIS WAS THE LARGEST SIZE AVAILABLE, WE SIMPLY MADE IT LONGER TO GET THE DEEPER TONE.

GENDÉR BARUNG - PELOG LIMA

KEY	LENGTH	WIDTH	THICKNESS	RESONATOR DEPTH	RESONATOR DIAMETER	
5	10¾" 273mm	3" 76mm	3/16" 4mm	14½" 362mm	1½" x 1¼" 38 x 32 mm	WOOD
6	10⅝" 270mm	3 1/16" 78mm	"	" "	1⅝" 41mm	
1	10½" 267mm	" "	"	" "	2½" 64mm	
2	10¼" 260mm	2¾" 70mm	"	13¾" 349mm	2 11/16" x 2⅞" 68x73mm	
3	10 1/16" 255mm	2 13/16" 72mm	"	13¼" 337mm	" " " "	
5	9⅞" 250mm	2¾" 70mm	"	13½" 343mm	4" x 2½" 102x64mm	OVAL
6	9¾" 248mm	2 9/16" 65mm	"	13⅜" 340mm	3¾" x 2⅝" 95x67mm	
1	9 9/16" 243mm	" "	¼" 7mm	11¼" 286mm	3⅜" x 2½" 86 x 64mm	
2	9⅜" 238mm	2 7/16" 62mm	" "	9¾" 247mm	3½" x 2½" 89 x 64mm	
3	9¼" 235mm	2 5/16" 59mm	" "	8⅝" 219mm	3¼" x 2¾" 83 x 70mm	
5	9" 229mm	2 7/32" 57mm	" "	6⅞" 175mm	2¾" x 2" 70 x 51 mm	
6	8 15/16" 227mm	2¼" 56mm	" "	6" 152mm	2½" 64mm CAN 1⅝" 41mm OPEN	
1	8¾" 222mm	2" 51mm	" "	4¾" 121mm	2¾" 70mm	
2	8⅝" 219mm	2 1/16" 52mm	" "	4⅝" 118mm	2½" 64mm	
3	8 29/32" 220mm	2 1/16" 52mm	" "	4½" 114mm	2¼" 58mm	

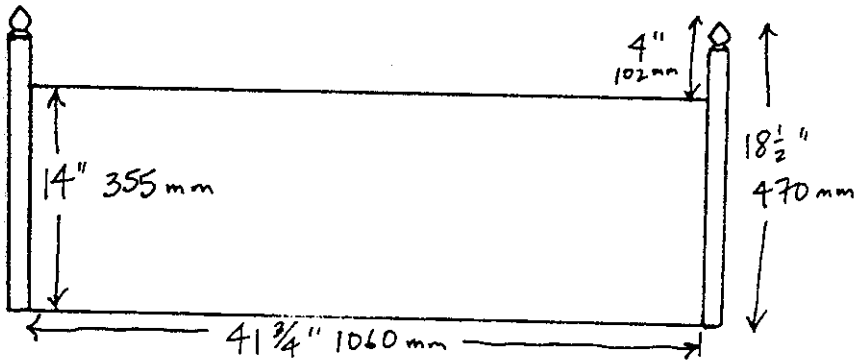
ALL RESONATORS MADE OF ALUMINUM CANS EXCEPT WHERE INDICATED AS WOOD, I.E. CABINET RESONATORS. "OVAL" MEANS THE CANS HAVE BEEN SQUASHED INTO AN OVAL, THE BASIC DIMENSIONS OF WHICH ARE GIVEN (EXCEPT FOR THE FIRST TONE, WHICH IS A CABINET RESONATOR WITH AN OVAL OPENING).

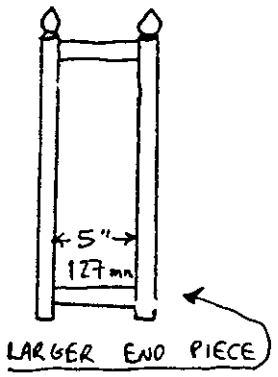




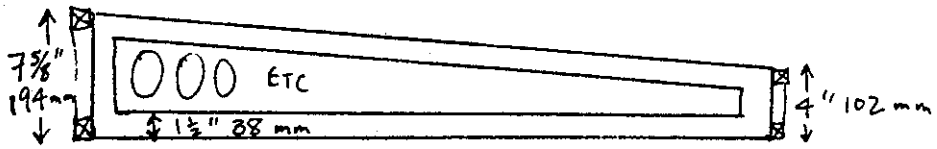
GENDER PANERUS - PELOG LIMA

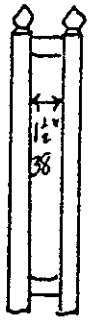
KEY	LENGTH	WIDTH	THICKNESS	RESONATOR DEPTH	RESONATOR DIAMETER	
5	9 3/16" 240mm	2 9/16" 65mm	3/16" 4mm	13 1/2" 343mm	2 3/4" 70mm 1 1/2" 38mm OPEN	
6	9 1/4" 235mm	2 1/2" 63mm	" "	13" 330mm	3" 76mm 2 1/2" 63mm OPEN	
1	9 1/16" 230mm	2 3/8" 60mm	1/4" 6mm	11 3/4" 299mm	3" 76mm × 2 3/8" 60mm	OVAL
2	8 3/4" 223mm	" "	" "	10 1/4" 260mm	3" " × 2 1/2" 63mm	OVAL
3	8 3/32" 218mm	2 1/4" 57mm	" "	9" 229mm	3 1/4" 82mm × 2 3/8" 60mm	OVAL
5	8 3/8" 213mm	2 5/16" 59mm	" "	7 3/16" 183mm	2 3/4" 70mm	
6	8 1/8" 206mm	2 1/8" 54mm	" "	6 3/4" 172mm	" "	
1	7 15/16" 198mm	2 3/16" 56mm	" "	4 1/2" 115mm	2 1/2" 63mm	
2	7 11/32" 192mm	2" 51mm	" "	4 5/8" 117mm	2 3/4" 70mm × 2" 51mm	OVAL
3	7 1/2" 191mm	" "	" "	4" 102mm	3" 76mm × 2" 51mm	OVAL
5	7 5/16" 186mm	1 15/16" 50mm	5/16" 8mm	3 1/4" 83mm	2" 51mm	
6	7 1/16" 180mm	1 13/16" 46mm	" "	2 5/8" 68mm	" "	
1	6 7/8" 175mm	" "	" "	2 1/8" 54mm	2 1/8" 54mm	
2	6 5/8" 168mm	" "	" "	2" 51mm	" "	
3	6 3/8" 162mm	1 5/8" 42mm	" "	" "	" "	
5	6 1/8" 156mm	" "	" "	1 1/2" 38mm	1 3/4" 45mm	





ALL KEYS HAVE TIN CAN RESONATORS.





CABINET WOODS SAME AS GENDER BARUNG.
BOTTOM CAN BE 1/8" 3mm PLYWOOD OR HARDBOARD.
GENDER PANERUS BEATER HAS A 5" 127 mm HANDLE TOOLED OUT OF 1/2" 13mm DOWEL. THE HEAD IS 5/8" 16mm THICK AND 2 3/4" 70mm IN DIAMETER. IT IS WRAPPED WITH INNER TUBE RUBBER AND THEN FELT IS WRAPPED AROUND & STAPLED. THE GENDER BARUNG BEATER HAS THE SAME HANDLE AS THE PANERUS. THE HEAD IS 1/2" 13mm THICK, 2 3/8" 73mm IN DIAMETER AND HAS 1/4" 6mm THICK PIANO FELT GLUED AROUND THE RIM AND SEWN

STANDARD MEASUREMENTS FOR GENDÉR KEYS

GENDÉR BARUNG

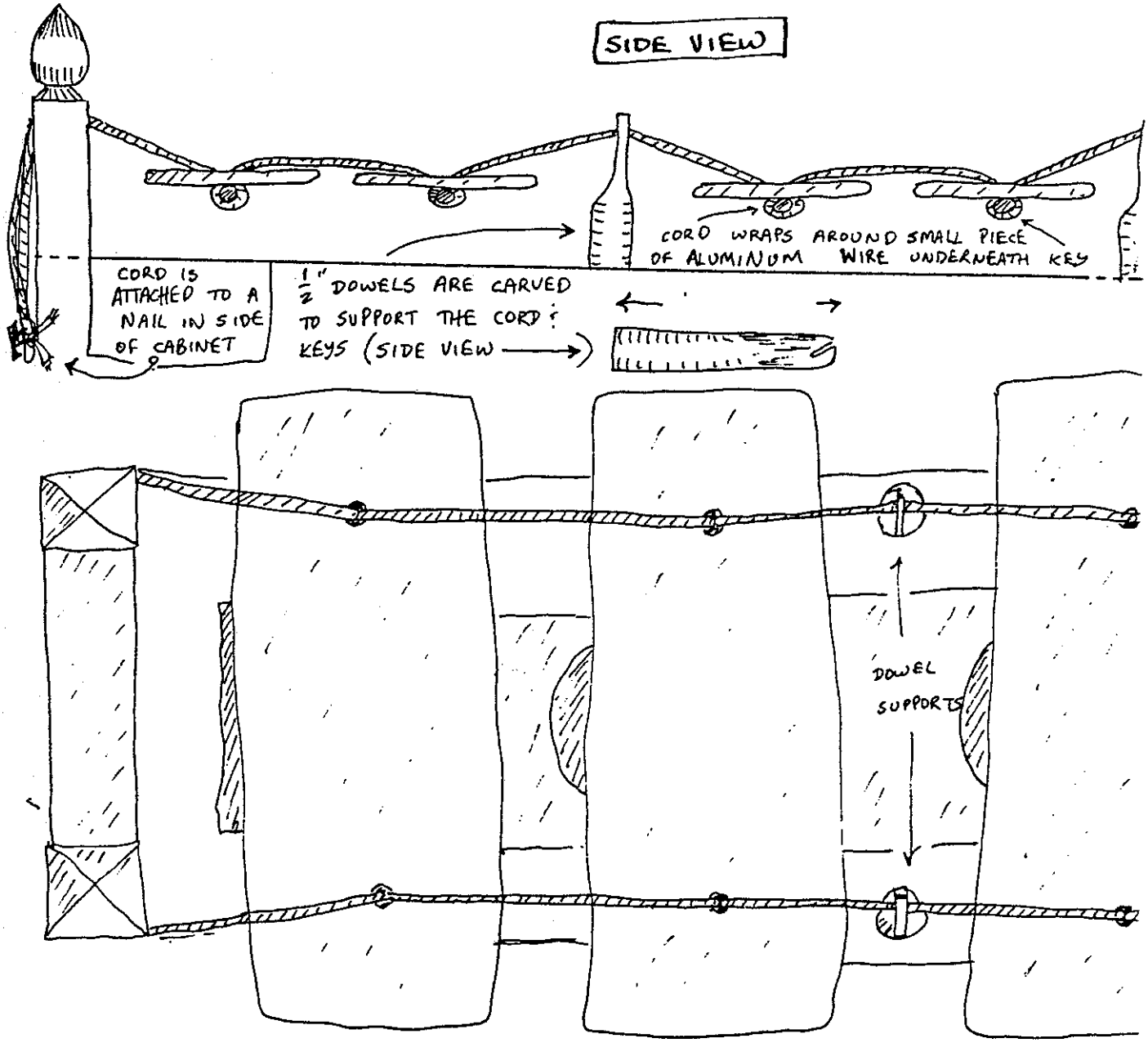
KEY	LENGTH	WIDTH	THICKNESS
5	10 13/16" 274mm	3" 76mm	3/16" 4mm
6	10 5/8" 269mm	" "	" "
1	10 3/8" 264mm	" "	" "
2	10 3/16" 259mm	2 3/4" 70mm	" "
3	10" 254mm	" "	" "
5	9 13/16" 249mm	" "	" "
6	9 11/16" 245mm	2 1/2" 63mm	" "
1	9 1/2" 241mm	"	1/4" 7mm
2	9 11/32" 237mm	"	" "
3	9 3/16" 233mm	2 1/4" 57mm	" "
5	9" 229mm	" "	" "
6	8 7/8" 225mm	" "	" "
1	8 3/4" 221mm	2" 51mm	" "
2	8 9/16" 217mm	" "	" "
3	8 7/16" 213mm	" "	" "

GENDÉR PANERUS

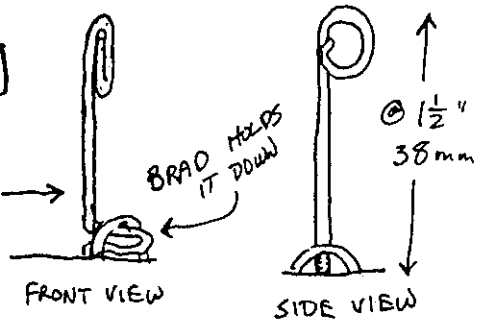
KEY	LENGTH	WIDTH	THICKNESS
5	9 7/16" 240mm	2 1/2" 63mm	3/16" 4mm
6	9 1/4" 235mm	" " "	" "
1	9 1/32" 229mm	2 3/8" 60"	1/4" 7mm
2	8 13/16" 223mm	" "	" "
3	8 19/32" 218mm	2 1/4" 57mm	" "
5	8 11/32" 212mm	" "	" "
6	8 1/8" 206mm	2 1/8" 54mm	" "
1	7 29/32" 201mm	" "	" "
2	7 11/16" 195mm	2" 51mm	" "
3	7 7/16" 189mm	" "	" "
5	7 1/4" 184mm	1 7/8" 48mm	5/16" 8mm
6	7" 178mm	" "	" "
1	6 25/32" 172mm	1 3/4" 45mm	" "
2	6 19/32" 167mm	" "	" "
3	6 11/32" 161mm	1 5/8" 41mm	" "
5	6 1/8" 155mm	" "	" "

THE MEASUREMENTS GIVEN HERE ARE WILLIAM COLUIG'S STANDARDIZATION OF GENDER KEYS WHICH WORK FOR ALL TUNINGS. THE CABINETS ARE ALSO OF STANDARD MEASUREMENTS, FOR BARUNG & PANERUS IN ANY MODE.

SUSPENDING GENDER KEYS



KEYS SHOULD BE SUSPENDED @ 1½" 38mm ABOVE THE RESONATORS. THERE IS ALSO AN ALTERNATE MODEL FOR THE KEY SUPPORTS, MADE OF HEAVY COAT HANGER WIRE, TWISTED INTO THE SHAPE SHOWN HERE: → IT HAS THE ADVANTAGE OF BEING ADJUSTABLE AND VIRTUALLY UNBREAKABLE.



GENDÉR BARUNG - SLENDRO

KEY	RESONATOR DEPTH	RESONATOR DIAMETER
5	14" 356mm	1¼" 32mm
6	" "	1⅝" 41mm
1	" "	1⅞" 48mm
2	13¼" 337mm	2¾" 70mm
3	13⅜" 335mm	3⅛" 79mm
5	12¼" 311mm	4½" 114mm 3" 76mm HOLE
6	12½" 317mm	4½" " 2½" 63mm HOLE
1	10⅞" 276mm	3⅛" 79mm × 2⅜" 60mm w/ 1⅞ 48mm × 1¼" 32mm HOLE
2	10⅝" 270mm	3¼" 82mm
3	9½" 241mm	" "
5	8¼" 210mm	2⅞ 73mm × 2" 51mm
6	6½" 165mm	2¾" 70mm
1	3⅞" 98mm	" "
2	4½" 114mm	2⅝" 67mm
3	3⅞" 98mm	2⅞" 74mm

GENDÉR PANERUS - SLENDRO

KEY	RESONATOR DEPTH	RESONATOR DIAMETER
5	12⅝" 320mm	3" 76mm OPEN 1¼" 32mm
6	13¾" 349mm	3¼" 82mm OPEN 2½" 63mm
1	10⅝" 270mm	3⅛" 79mm OPEN 2" 51mm
2	" "	3⅛" 79mm
3	9½" 241mm	2½" 63mm
5	8" 203mm	" "
6	7" 178mm	" "
1	5⅞" 149mm	2¾" 70mm
2	5" 127mm	2⅜" 60mm
3	4½" 114mm	2⅛" 54mm
5	3 5/16" 100mm	2¾" 70mm
6	3¼" 82mm	2⅜" 60mm
1	2¼" 57mm	2½" 63mm
2	" "	2⅜" 60mm
3	2" 51mm	2¼" 57mm × 2¾" 70mm
5	" "	" " " "

GENDÉR BARUNG - PELOG BARANG

KEY	RESONATOR DEPTH		RESONATOR DIAMETER	
5	14"	356mm	1½"	38 mm
6	13⅜"	352mm	1 7/16"	31 mm
7	14"	356 mm	1 5/8"	41 mm
2	13¼"	337 mm	2 3/32"	53 mm
3	"	"	2¾"	70 mm
5	13⅜"	340 mm	3¾" 95mm OPEN 2⅜"	60mm
6	13½"	343 mm	3 7/16 82 mm OPEN 2¾"	70mm
7	"	"	3½"	89 mm
2	10⅛"	255mm	3¾"	95 mm
3	8½"	216mm	3½" 89mm BLOCKED BY 1½" 38mm PIECE OF WOOD	
5	6¾"	171mm	3"	76 mm
6	6¼"	159mm	3⅛"	79 mm
7	6½"	165mm	3"	76 mm
2	4 5/8"	112mm	3½" 89mm x 2⅛" 54mm } OVAL	
3	4"	102mm	2¾" 70mm x 2¼" 57mm } OVAL	

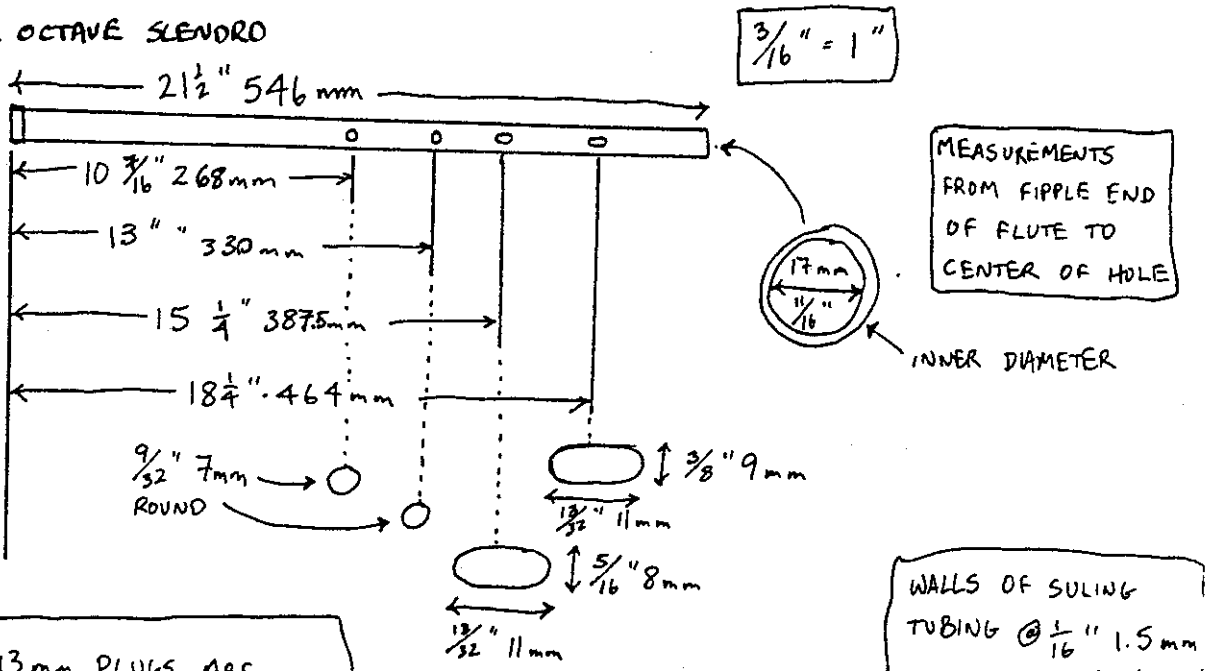
GENDÉR PANERUS - PELOG BARANG

KEY	RESONATOR DEPTH	RESONATOR DIAMETER
5		
6		
7		
2		
3		
5		
6		
7		
2		
3		
5		
6		
7		
2		
3		
5		

BASICALLY THE SAME AS PELOG LIMA. ALL THESE RESONATOR MEASUREMENTS ARE REALLY ONLY GUIDELINES. A GREAT DEAL OF TRIAL & ERROR GOES INTO MATCHING UP THE KEY AND THE RESONATOR.

SULING

LOWER OCTAVE SLENDRO

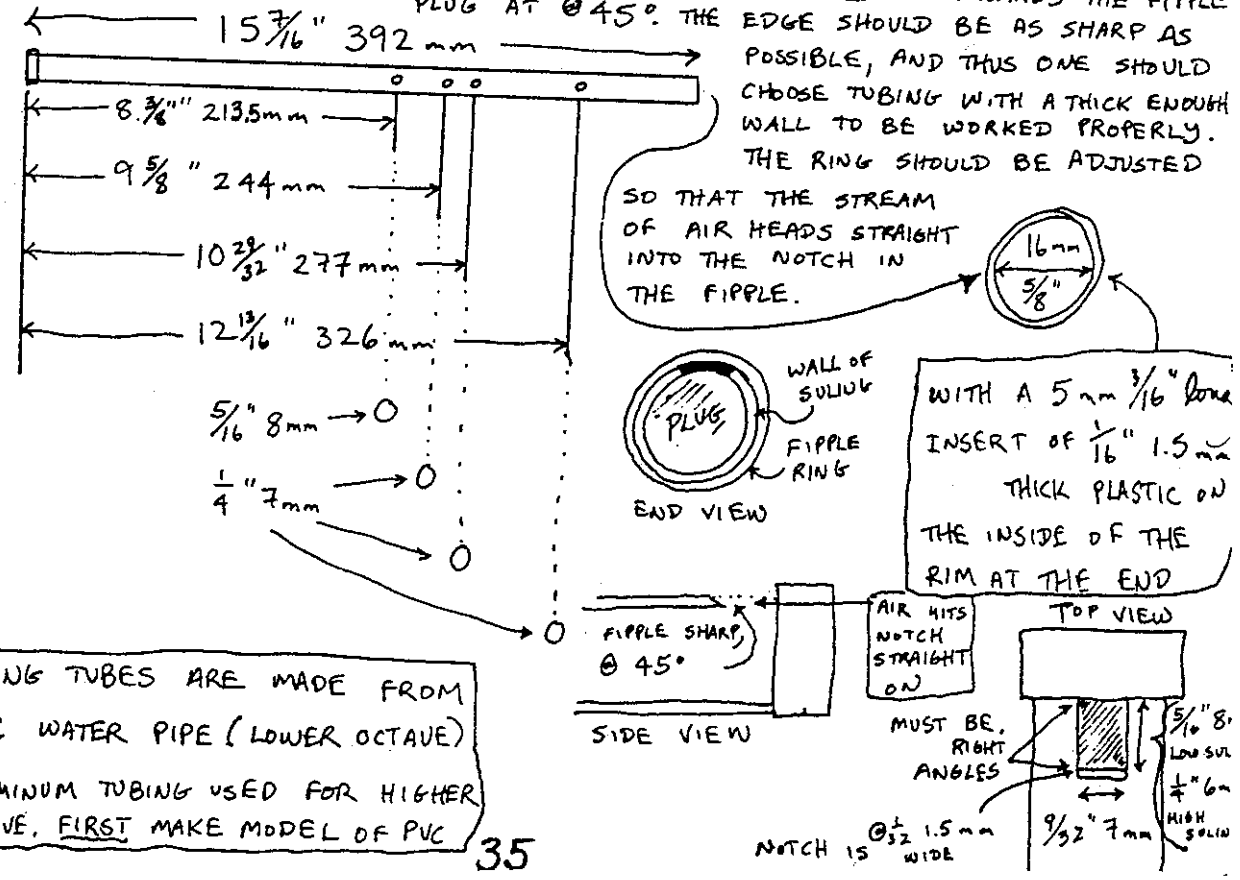


½" 13mm PLUGS ARE USED IN THE FIPPLE ENDS OF THE VARIOUS SULING.

WALLS OF SULING TUBING @ 1/16" 1.5mm THICK

ONE NEEDS TO EXPERIMENT WITH THE PLUG, RING AND THE ACTUAL FIPPLE OPENING TO OBTAIN THE BEST SOUND. THE OPENING SHOULD BE ALMOST PERFECTLY SQUARE, THOUGH A LITTLE LONGER THAN IT IS WIDE. THE ANGLES SHOULD BE SQUARE WHERE THE CUT IS MADE INTO THE TUBE, BUT THE ACTUAL CUT ITSELF SHOULD ANGLE IN TOWARDS THE FIPPLE PLUG AT @45°. THE EDGE SHOULD BE AS SHARP AS POSSIBLE, AND THUS ONE SHOULD CHOOSE TUBING WITH A THICK ENOUGH WALL TO BE WORKED PROPERLY. THE RING SHOULD BE ADJUSTED SO THAT THE STREAM OF AIR HEADS STRAIGHT INTO THE NOTCH IN THE FIPPLE.

HIGHER OCTAVE SLENDRO

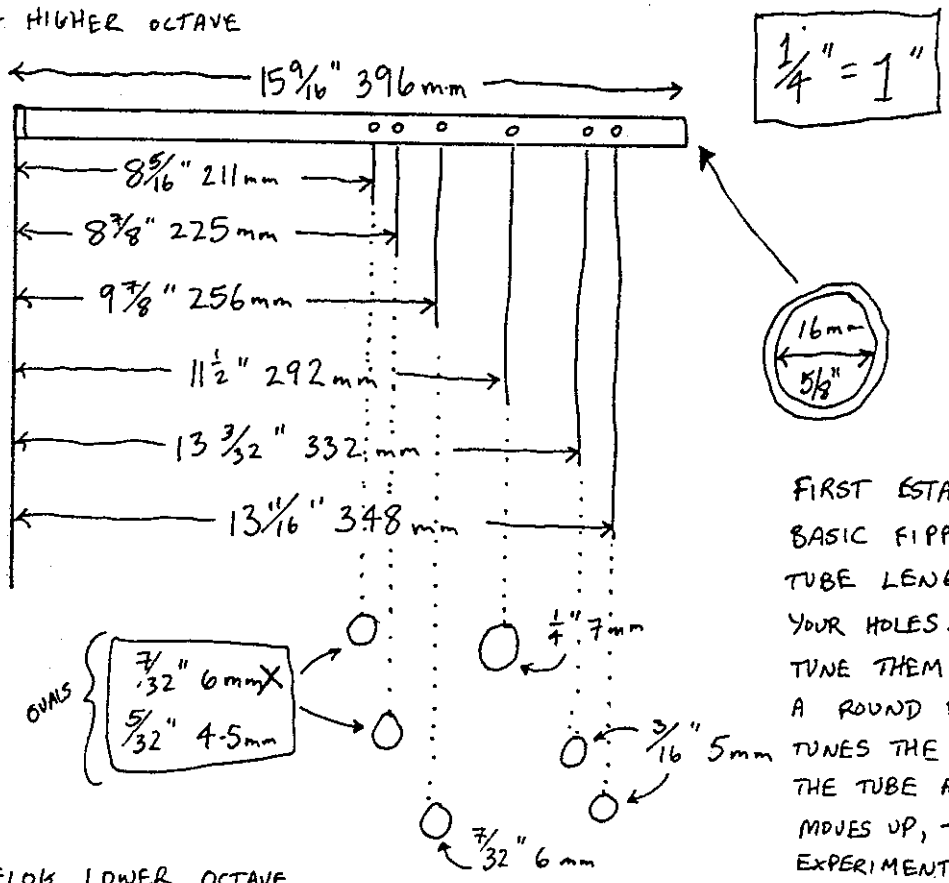


SULING TUBES ARE MADE FROM PVC WATER PIPE (LOWER OCTAVE)

ALUMINUM TUBING USED FOR HIGHER OCTAVE. FIRST MAKE MODEL OF PVC

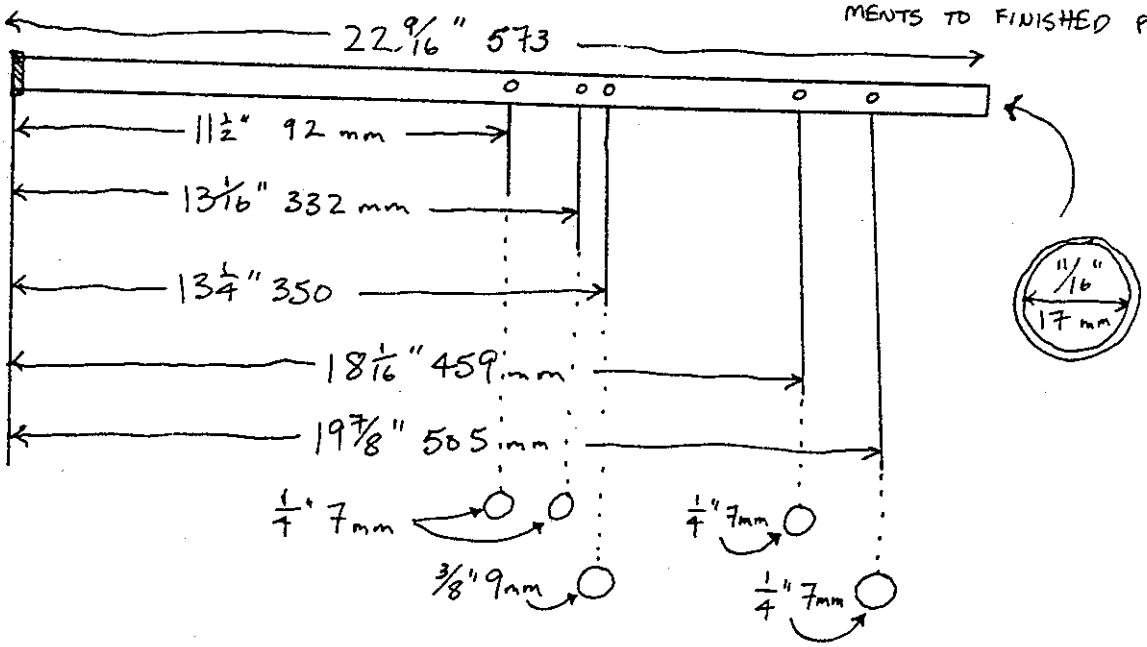
SULING

PELOG HIGHER OCTAVE

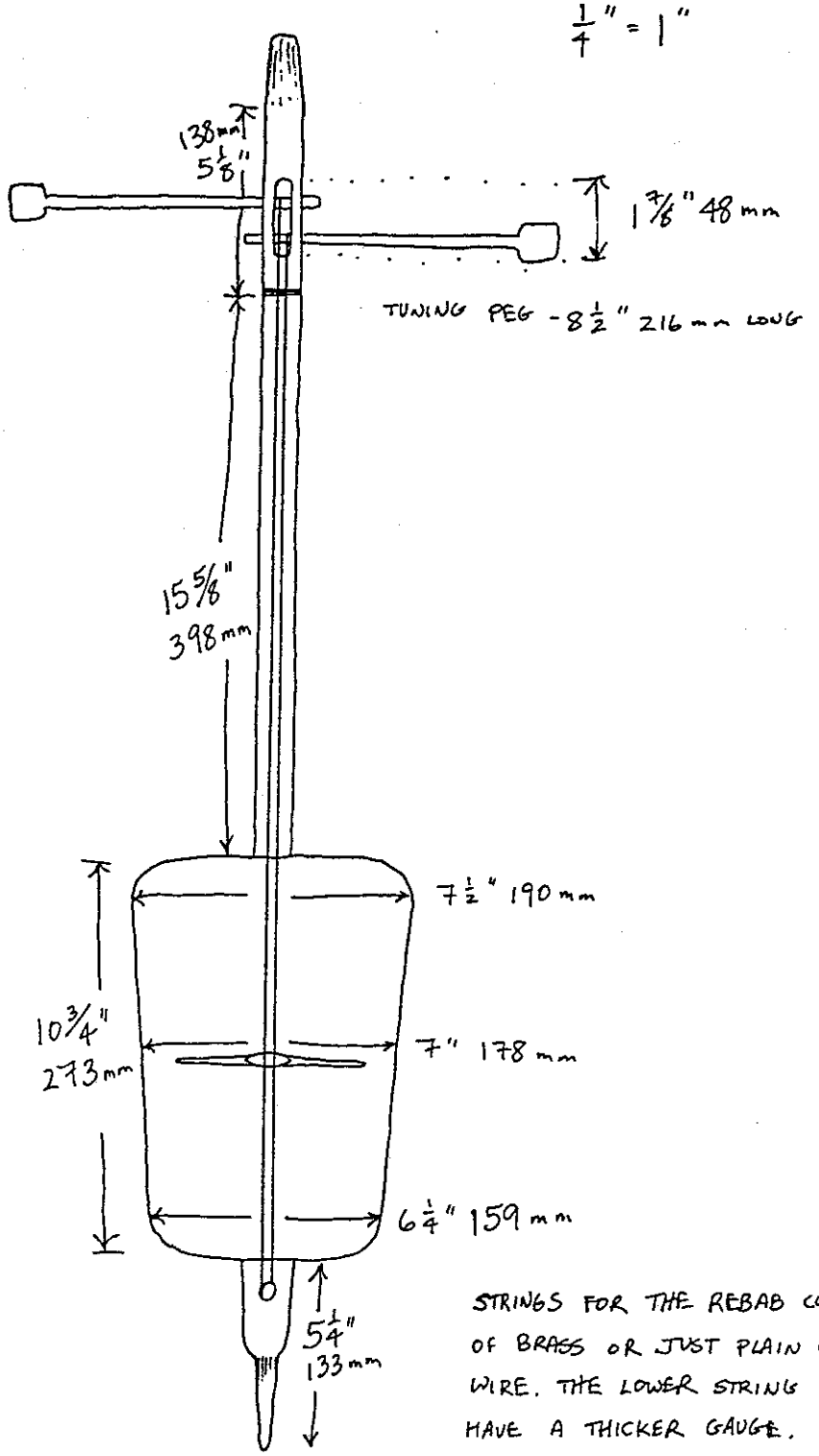


FIRST ESTABLISH YOUR BASIC FIPPLE AND THE TUBE LENGTH. THEN POSITION YOUR HOLES. START SMALL & TUNE THEM BY FILING WITH A ROUND FILE. ONE FIRST TUNES THE FULL LENGTH OF THE TUBE AND GRADUALLY MOVES UP, TONE BY TONE. EXPERIMENT FIRST ON A MODE AND THEN TRANSFER MEASUREMENTS TO FINISHED PRODUCT

PELOG LOWER OCTAVE



REBAB

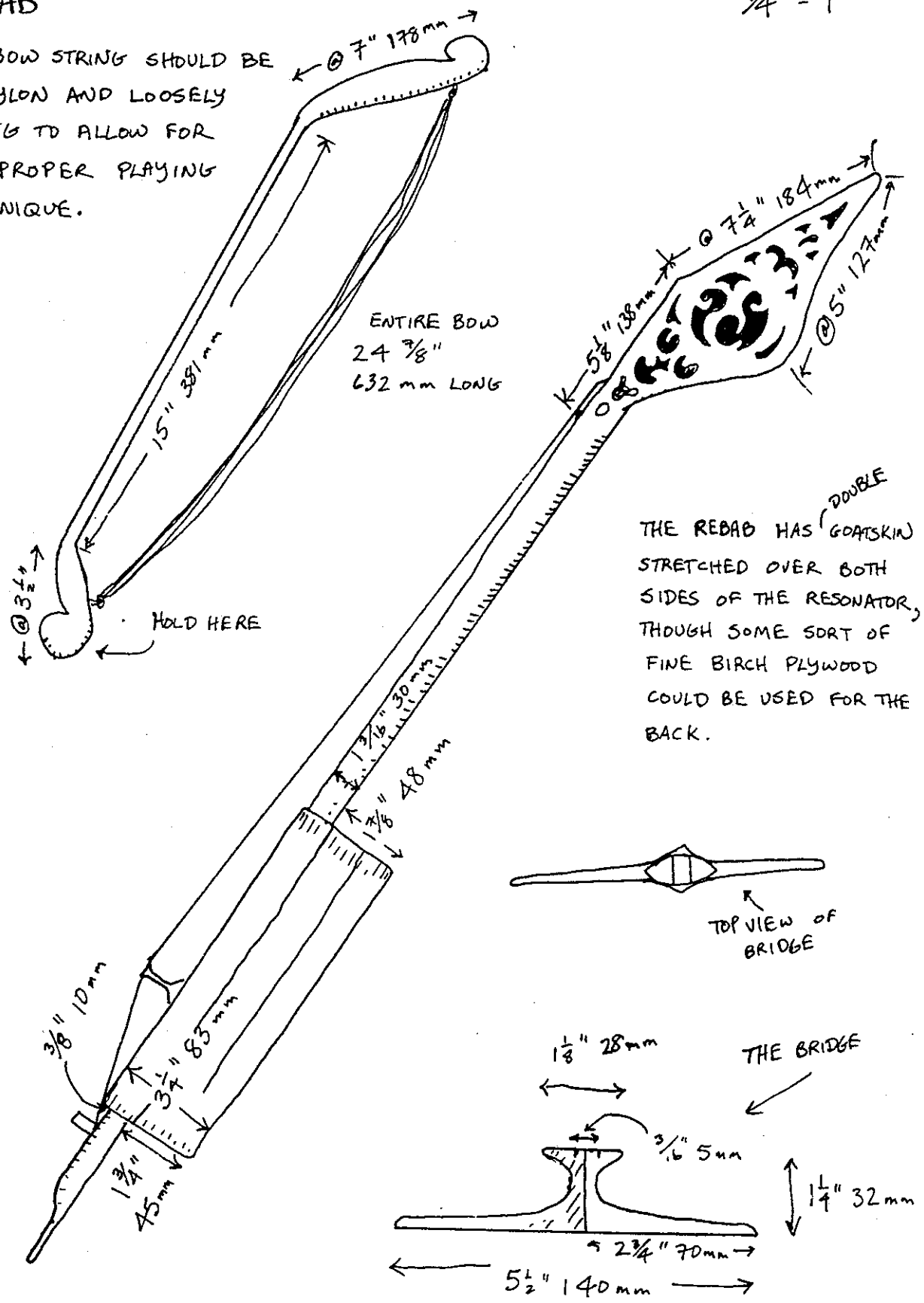


STRINGS FOR THE REBAB COULD BE OF BRASS OR JUST PLAIN MUSIC WIRE. THE LOWER STRING SHOULD HAVE A THICKER GAUGE.

REBAB

1/4" = 1"

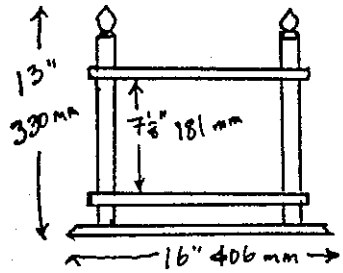
THE BOW STRING SHOULD BE OF NYLON AND LOOSELY STRUNG TO ALLOW FOR THE PROPER PLAYING TECHNIQUE.

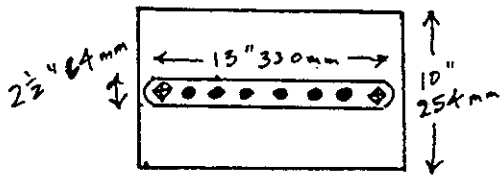


THE REBAB HAS (DOUBLE GOATSKIN) STRETCHED OVER BOTH SIDES OF THE RESONATOR, THOUGH SOME SORT OF FINE BIRCH PLYWOOD COULD BE USED FOR THE BACK.

TOP VIEW OF BRIDGE

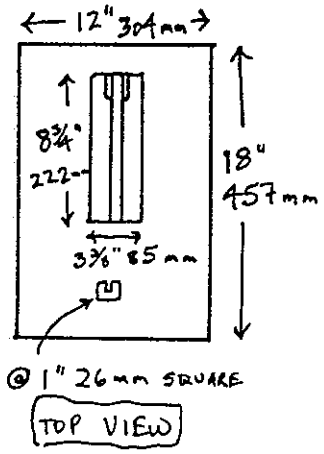
SULING STAND

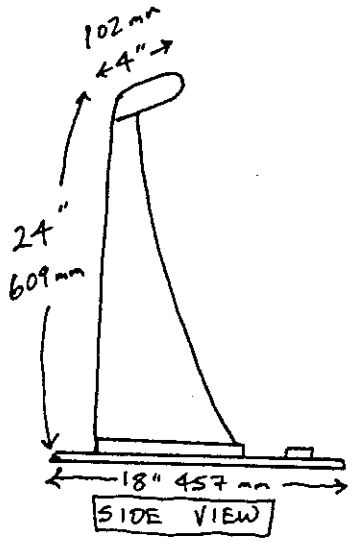




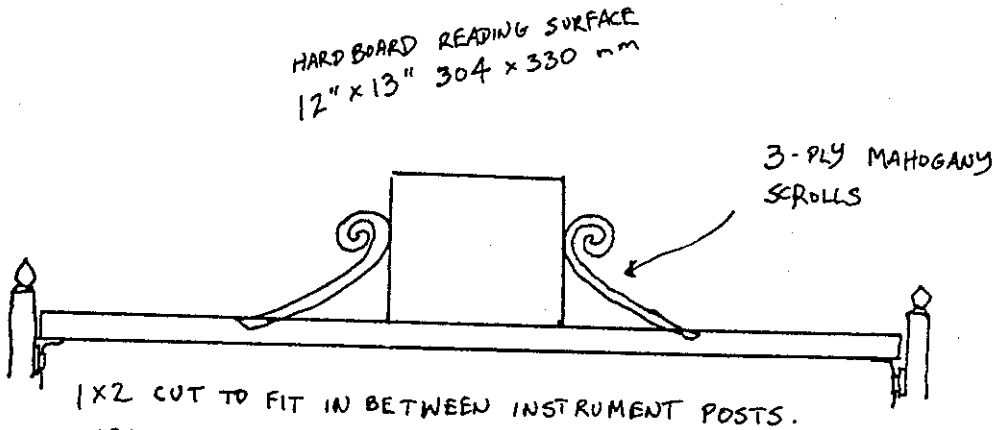
BASE IS OF ½" 13mm PLYWOOD. UPRIGHTS ARE 2X2'S WITH ¾" 19mm PINE STRIPS RUNNING BETWEEN THEM, IN WHICH SIX 1" 25 mm HOLES HAVE BEEN DRILLED.

REBAB STAND



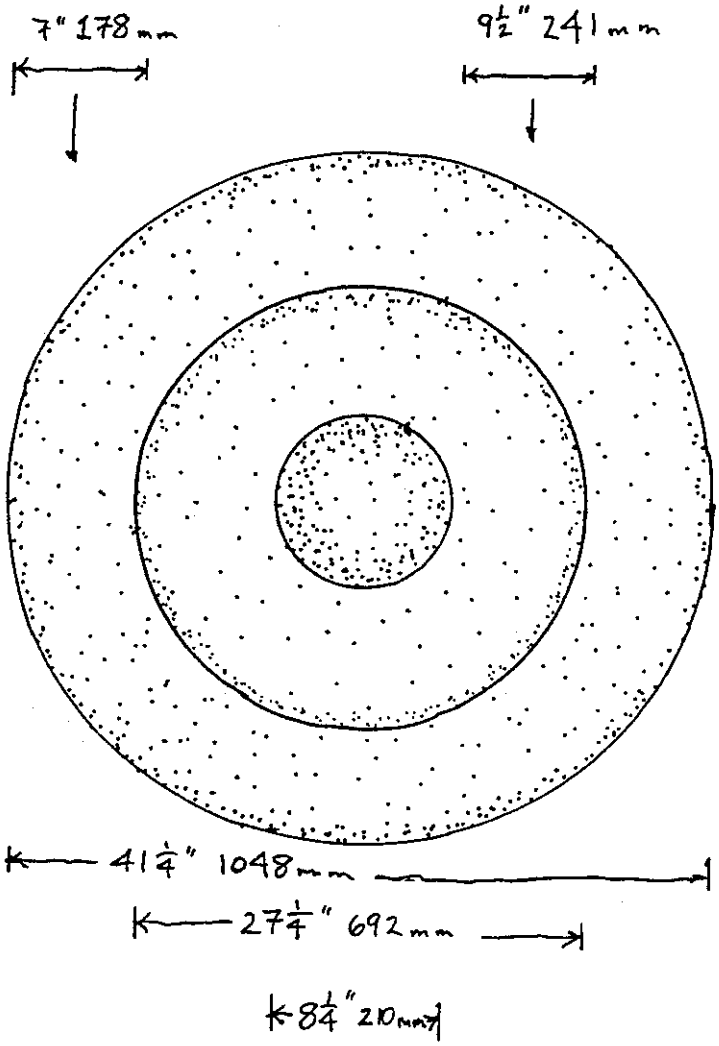


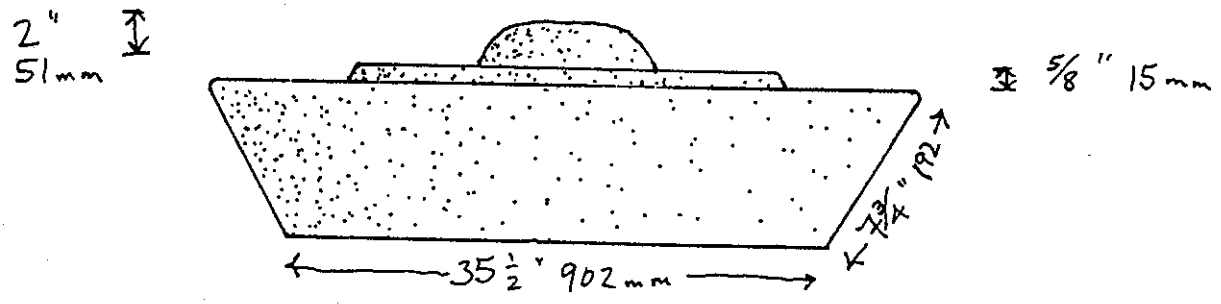
MUSIC STAND



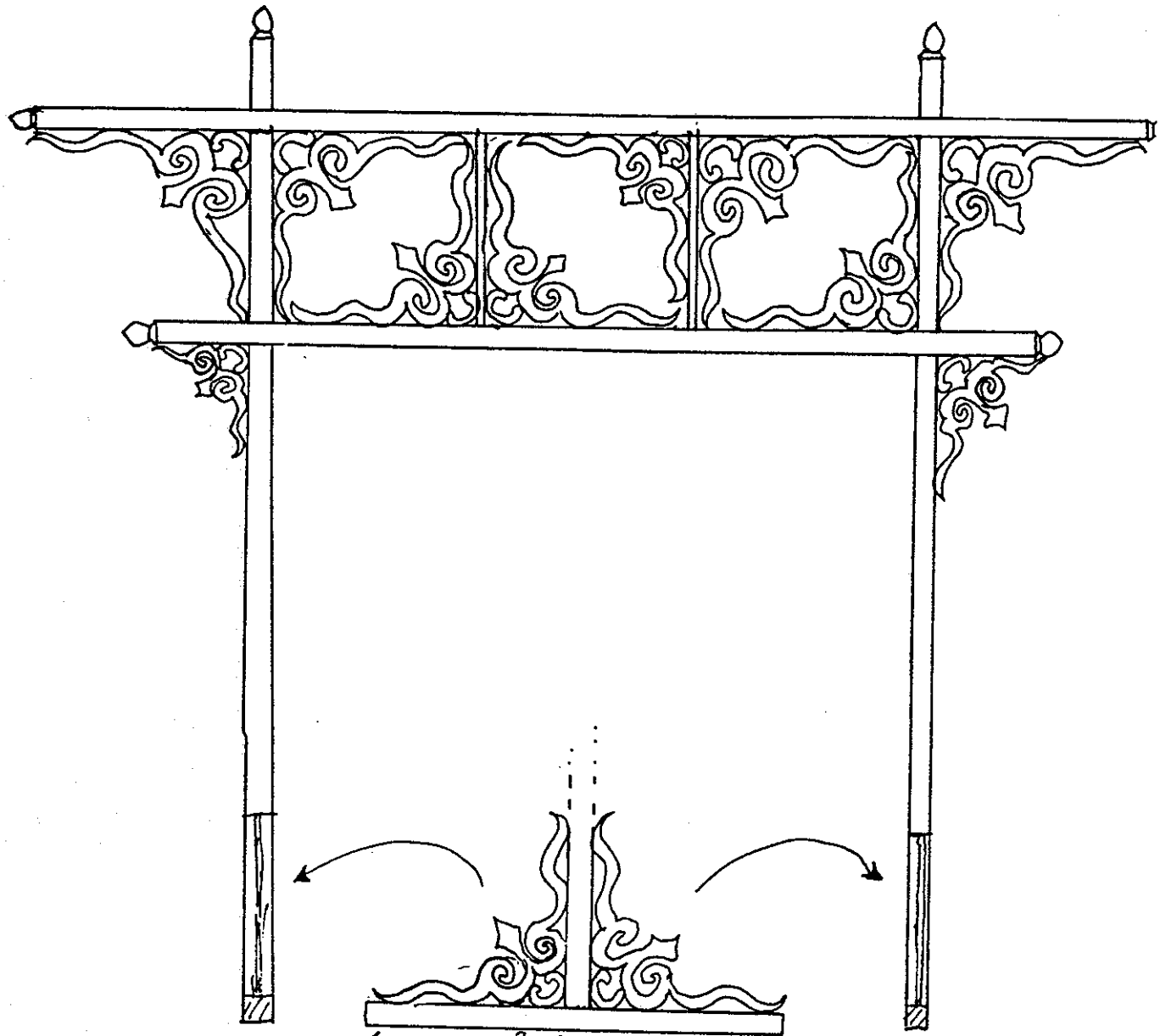
1X2 CUT TO FIT IN BETWEEN INSTRUMENT POSTS. WIRES ATTACHED TO 1X2 GO INTO HALF HINGES SCREWED INTO POSTS.

GONG AGUNG





GONG MADE OF MILD STEEL. SEE "GONG TECHNOLOGY"



SIDE VIEW OF GONG STAND BASE* (ONE FOR EACH POST)

STAND FOR GONG AGUNG

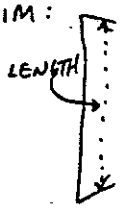
GAMBANG

ONE MODEL FOR SLENDRO & PELOG.

#	KEY	LENGTH		WIDTH		THICKNESS	
1	5	23 5/8"	600 mm	2 3/4"	70 mm	@ 13/32"	10 mm
2	6	22 23/32"	580 mm	2 11/16"	68 mm	"	"
3	1	22 1/16"	560 mm	2 9/16"	65 mm	15/32"	12 mm
4	2	21 1/4"	540 mm	2 1/2"	63 mm	1/2"	13 mm
5	3	20 15/32"	520 mm	2 13/32"	61 mm	"	"
6	5	19 13/16"	503 mm	2 7/32"	58 mm	19/32"	15 mm
7	6	19 3/16"	487 mm	2 7/32	56 mm	"	"
8	1	18 1/2"	470 mm	2 1/8"	54 mm	"	"
9	2	17 29/32"	455 mm	2 1/16"	52 mm	5/8"	16 mm
10	3	17 5/16"	440 mm	1 15/16"	50 mm	"	"
11	5	16 3/4"	425 mm	1 29/32"	49 mm	11/16"	17 mm
12	6	16 1/8"	410 mm	1 27/32"	47 mm	23/32"	18 mm
13	1	15 5/8"	397 mm	1 13/16"	46 mm	25/32"	20 mm
14	2	15 3/16"	386 mm	1 25/32"	45 mm	7/8"	22 mm
15	3	14 11/16"	373 mm	1 23/32"	44 mm	29/32"	23 mm
16	5	14 3/16"	360 mm	"	"	1"	25 mm
17	6	13 5/8"	346 mm	1 11/16"	43 mm	1 1/16"	27 mm
18	1	13 9/32"	337 mm	1 21/32"	42 mm	1 1/8"	29 mm
19	2	12 13/16"	325 mm	"	"	1 7/32"	31 mm
20	3	12 13/32"	315 mm	1 19/32"	41 mm	1 5/16"	33 mm
21	5	11 13/16"	300 mm	1 9/16"	40 mm	1 3/8"	35 mm
22	6	11 7/32"	285 mm	"	"	1 15/32"	37 mm

KEY SPACING: 5 mm 3/16"

LENGTH GIVEN IS MEDIAN LENGTH OF KEY; CUT AT RIGHT ANGLES 20 mm (25/32") OR SO LONGER. TRIM:



ONE 1/8" HOLE (3 mm) IN EACH KEY, 22 1/2 % ± OF LENGTH FROM END (KEY #1 135 mm, KEY #22 64 mm)

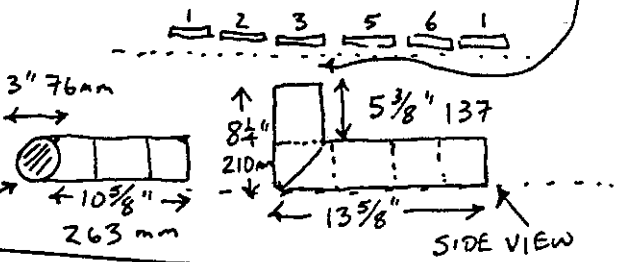
MOUNT KEYS ON 1/2" INDUSTRY FOAM RUBBER (NOT POLYURETHANE OR SOFT ROPE.

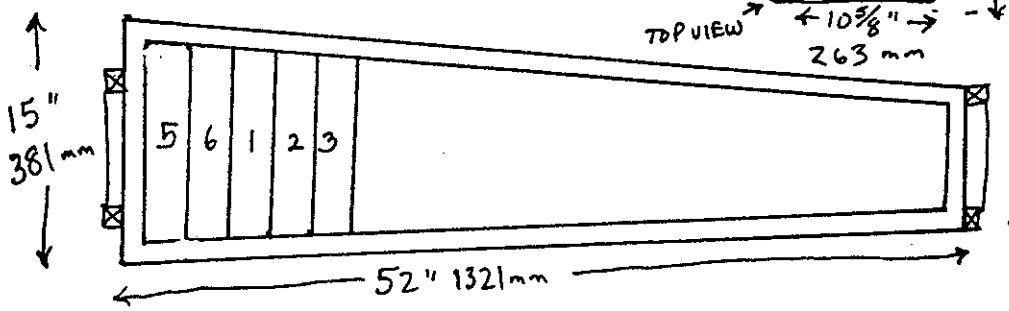
THE FIVE LOWEST NOTES OF PELOG AND THE FOUR LOWEST NOTES OF SLENDRO ARE RESONATED WITH "POCKETS". PARTITIONS SEALED TIGHTLY TOP IS 1/8" HARDBOARD.

DIMENSIONS OF SEALED "POCKETS"

KEY	WIDTH		DIAMETER OF HOLE		
5	2 3/8"	60 mm	1 3/8"	35 mm	PELOG
6	2 1/2"	64 mm	1 1/4"	32 mm	PELOG
1	2 3/8"	60 mm	1 1/2"	38 mm	PELOG
2	2 1/4"	57 mm	2"	51 mm	PELOG
3	2 3/8"	60 mm	"	"	PELOG
5	2 1/2"	64 mm	1 1/2"	38 mm	SLENDRO
6	2 3/4"	70 mm	1 5/8"	41 mm	SLENDRO
1	2 1/2"	64 mm	1 13/16"	45 mm	SLENDRO
2	2 1/4"	57 mm	3" 76 mm x 1 7/8 48 mm		SLENDRO
3	SPECIAL TIN CAN RESONATOR: SEE DIAGRAM				SLENDRO

SPECIAL TIN CAN RESONATOR RESTS ON ITS LONG END WITH THE OPEN TOP END RIGHT UNDER THE 3 KEY





GAMBANG CABINET IS 8 1/2" 216 mm HIGH PLUS 1 1/2" 38 mm FEET (END PIECES LIKE DEMUNG)

GAMBANG

SLENDRO & PELOG MODELS ARE THE SAME. YOU WHITTLE THE KEYS FOR FINE TUNING. HOWEVER, IN PELOG, EXTRA KEYS ARE NEEDED AS FOLLOWS.

KEYS	LENGTH	WIDTH	THICKNESS
4	19¾" 302mm	2¼" 57mm	½" 14mm
4	16¾" 425mm	2" 51mm	¾" 19mm
4	14⅛" 359mm	1¾" 45mm	" "
4	9⅞" 250mm	1½" 38mm	1 3/16" 30mm
1 2 7	SAME AS ONE	SAME AS ONE	⅜" 10mm
7	" "	" "	¾" 19mm

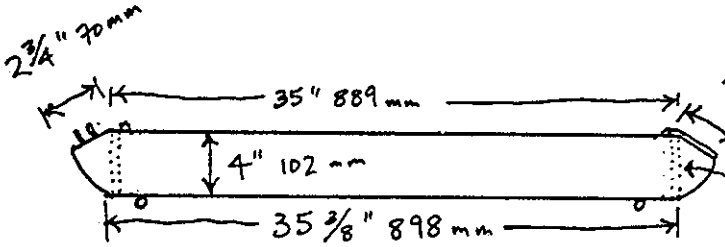
THE HIGHER TWO 7 KEYS ARE THE SAME DIMENSIONS AS THE CORRESPONDIN 1 KEYS.

GAMBANG BEATERS (ONE FOR EACH HAND) HAVE 5½" 139mm LONG HANDLES, ¾" 19mm IN DIAMETER. TO THESE ARE ATTACHED A 9" 229mm FIBERGLASS ROD, ⅛" 3mm IN DIAMETER*. THE HEADS ARE ⅝" 16mm THICK AND 1¾" 44m IN DIAMETER, WRAPPED AND SEWN WITH 2 LAYERS OF FELT, THE INNER LAYER @ ⅛" 3mm THICK AND THE OUTER LAYER OF REGULAR THICKNESS.

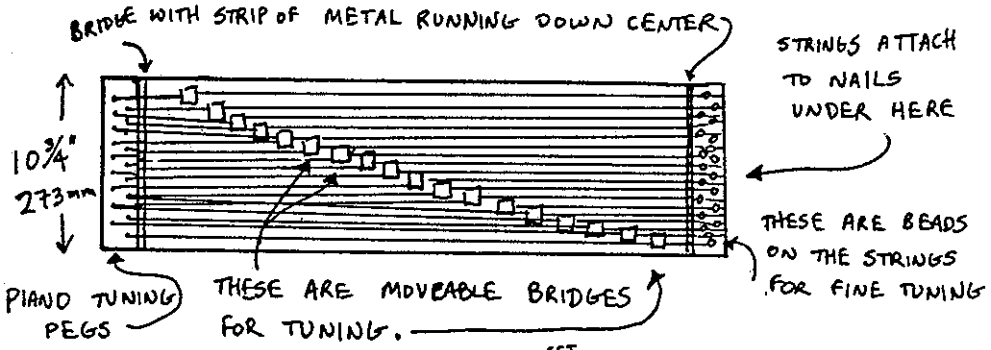
LOU HARRISON & WILLIAM COLVIG RECOMMEND FINE GRAIN REDWOOD FOR THE GAMBANG KEYS, THE FINEST GRAIN YOU CAN GET. MAPLE CAN ALSO BE USED, AS IT WAS FOR THE GAMELAN SI BETTY. K.L. WASITODIPURO, THE FAMOUS JAVANESE COMPOSER & THEORETICIAN, HEREAFTER REFERED TO AS PAK CHOKRO, PREFERS REDWOOD BECAUSE HE LIKES THE CHARACTER OF THE TREE, SO REGAL & TIMELESS.

*WILLIAM COLVIG USED CHILDREN'S FISHING POLES FOR THIS.

SITER

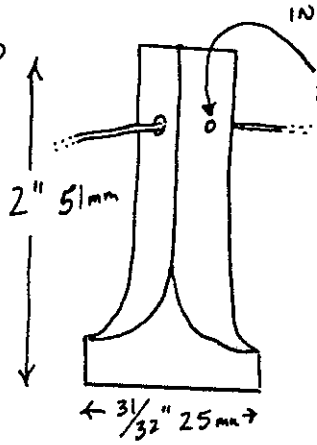


THE TOP AND BOTTOM ARE OF MAHOGANY ⅛" 3mm THE SIDES AND END PIECES OF PINE, ¾" 19mm



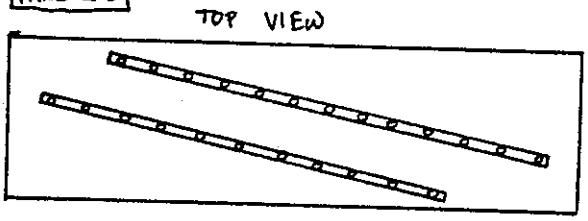
THREE RESONATOR HOLES DRILLED IN THE ENDS

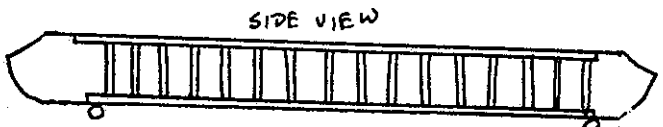
THERE ARE 18 STUDS ALONG THE LEFT BRIDGE, SPACED 13mm ½" APART TO STABILIZE THE STRINGS. THE RIGHT BRIDGE IS NOTCHED TO STABILIZE THE STRINGS.



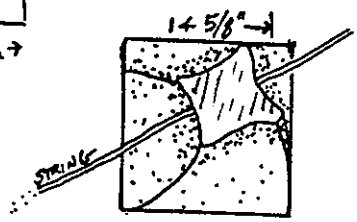
BRASS SCREW BISECTS THE STRING HOLE AT A 90° ANGLE TO PROVIDE A STRING SUPPORT. BRIDGE PICTURED ACTUAL SIZE.

TRESTLES





SITER RESTS ON THREE KNOBS ATTACHED TO THE BOTTOM.

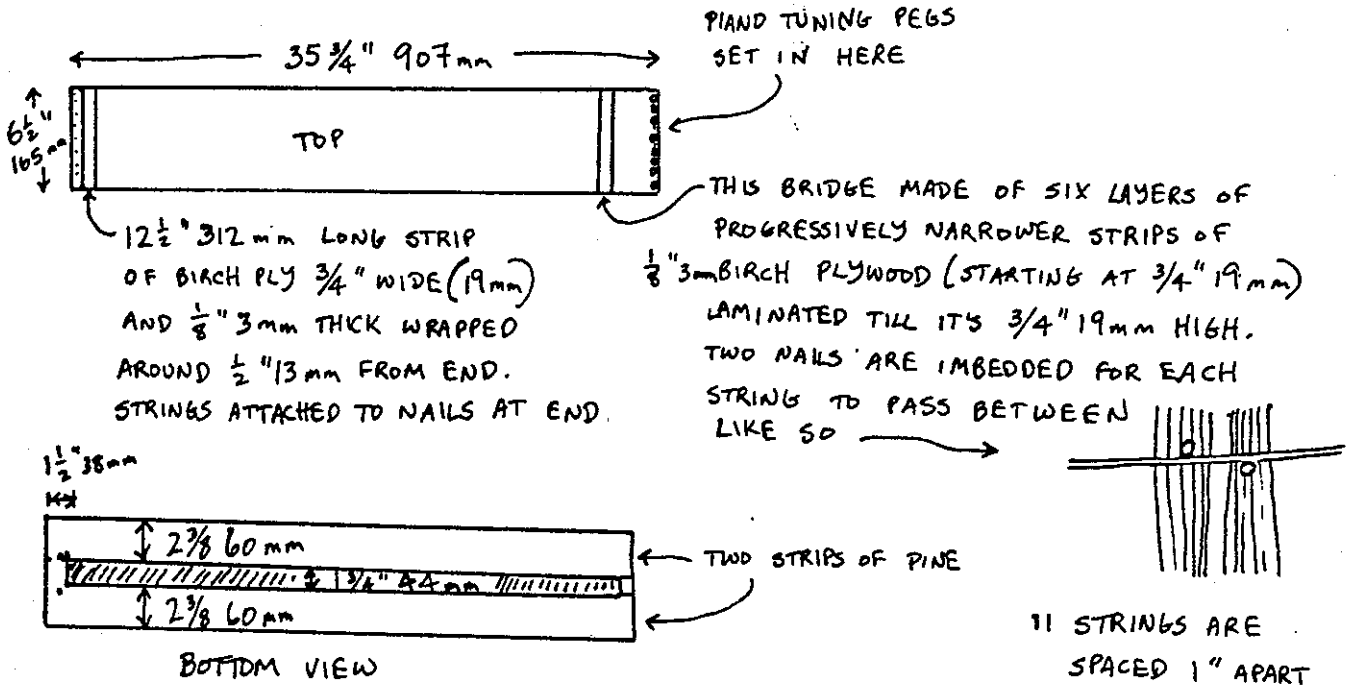


TOP VIEW OF BRIDGE

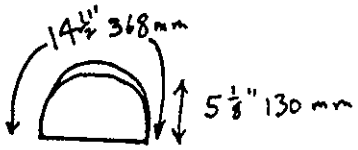
TWO STRIPS of ¼" x ½" (Ø 6mm x 13mm) WOOD ARE GLUED TO THE TOP AND BOTTOM OF THE SITER, PARALLEL TO THE LINE OF THE MOVABLE BRIDGES. THESE ARE CONNECTED BY ¼" DOWELS EVERY Ø 2", THUS JOINING THE TWO VIBRATING SURFACES WITH TWO TRESTLES. THIS INCREASES THE VOLUME AND RESONANCE.

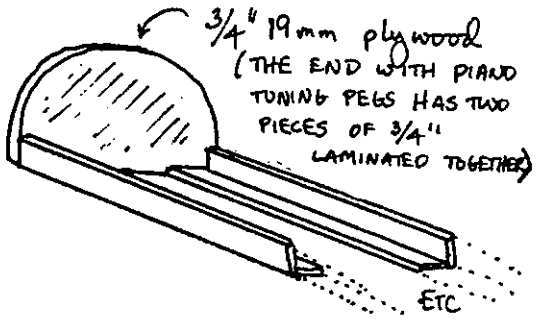
STRING IT UP WITH MUSIC WIRE, AVAILABLE AT HARDWARE STORES. MAKE SURE THAT YOUR BRIDGES ARE NOT DIRECTLY OVER THE END PIECES OF THE BODY. THEY SHOULD HAVE UNIMPEDED CONTACT WITH THE RESONATING SURFACE OF THE SITER.

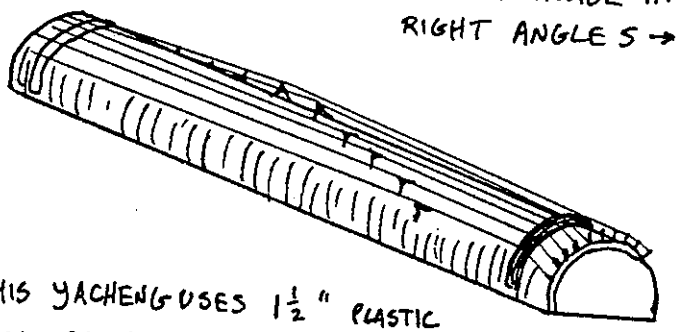
YACHENG



A STRIP OF FLEXIBLE ⅛" BIRCH PLY IS WRAPPED AROUND THE FRAME AND CLAMPED. THE TWO EDGES OF THE FRAME ARE MADE OF TWO PIECES OF 1"x2" PINE (LIT. ¾" x 1⅝" 19x41mm) NAILED TOGETHER LENGTHWISE AT RIGHT ANGLES →

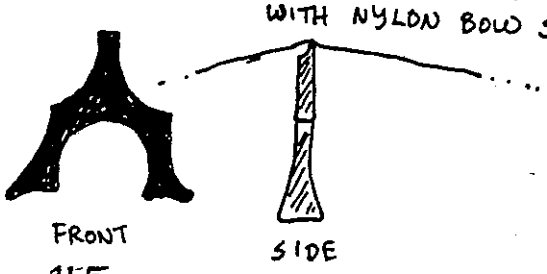






THIS YACHENG USES 1½" PLASTIC BRIDGES FROM TAIWAN, THOUGH THE OUTER STRINGS ON EITHER END USE 1" HIGH BRIDGES.

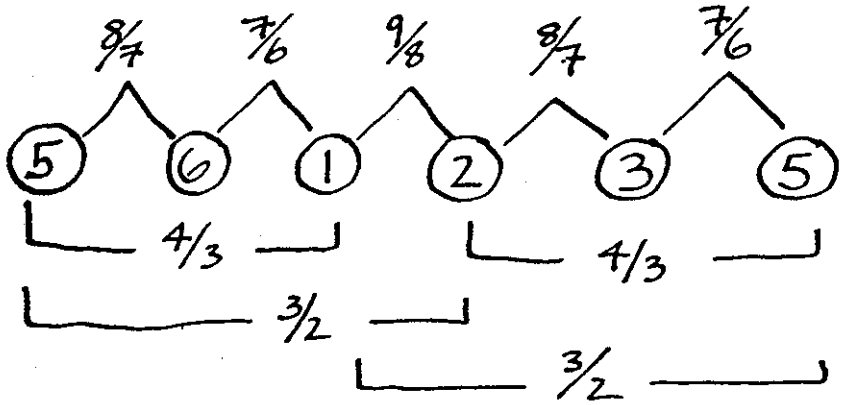
STRING WITH MUSIC WIRE. OUR BOW IS A 29" 732mm CHINESE BAMBOO BOW RESTRUNG WITH NYLON BOW STRINGS.



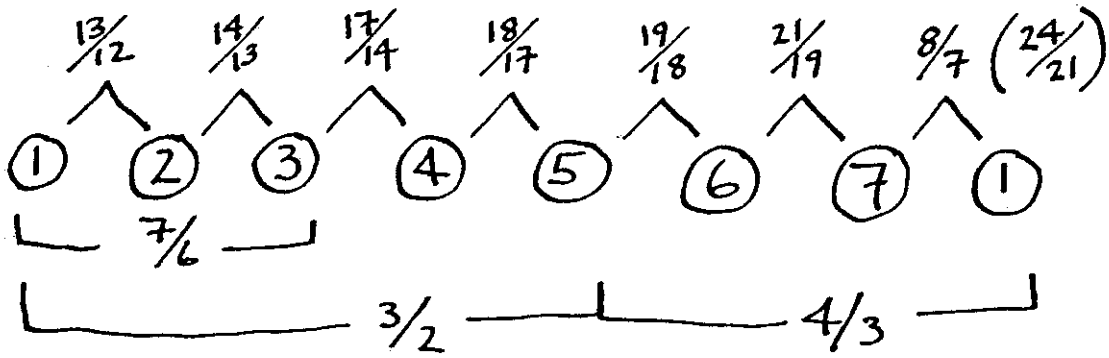
The Tuning of the Mills Gamelan Si Darius Si Madeleine

The Mills Gamelan is tuned in just intonation, meaning that all the intervals used are derived from the harmonic series, or overtone series. Thus none of the intervals are tempered; all are "real events" found in nature. The smallest possible ratio is used to describe a given interval. Here are the tunings for the Mills Gamelan:

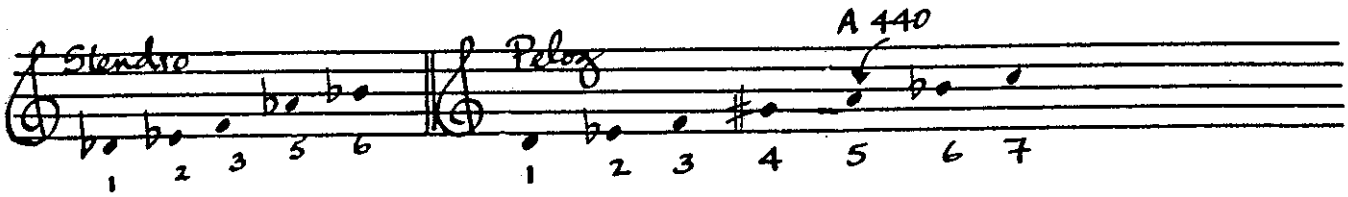
SLENDRO



PELOG



Pitch ⑥ is the same in slendro and pelog and is called the TUMBUK, or shared tone. Pitch ⑤ of PELOG is A 440.

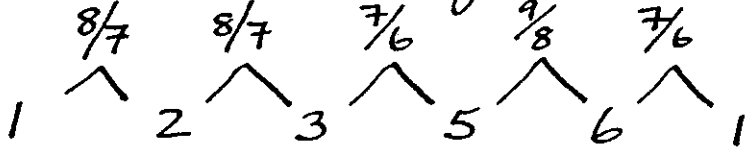


Here are the approximate Western pitches of the two tunings. Lou Harrison worked out the tuning schema by studying modes and tunings of all sorts. One finds that in the framework of just intonation, there are numerous SLENDRO tunings to choose from. The Mills Slendro is a variant of the slendro used by Lou Harrison and William Colvig for the Gamelan Si Betty which they built at San Jose State. The Javanese say every gamelan tuning should be different. There is only one difference between these two slendro tunings: the interval from 6 to 1 in the Gamelan Si Betty is a 19/16, whereas the same interval in the Mills College Gamelan is a 7/6. And yet this subtle difference is enough to give a very different "flavor" for each tuning.

Lou Harrison was assisted in his search for modes in just intonation by William Colvig, who built a metallophone for him of the first 33 tones of the overtone series. This unique and marvelous "tool" allowed Lou to search freely in the higher octaves of the overtone series for various tunings. It was during one of these "searches," in this case a quest for a suitable pelog, that Pak Cokro, Java's foremost composer and theoretician, knocked on the door and asked what Lou was doing.

Lou replied that he was searching for a suitable pelog. Pak Cokro said that the mode he'd been playing with when he knocked was quite good, and would work very well for singing. These tones happened to be the overtones 12, 13, 14, 17, 18, 19 and 21. And thus it was that the Mills pelog tuning was born.

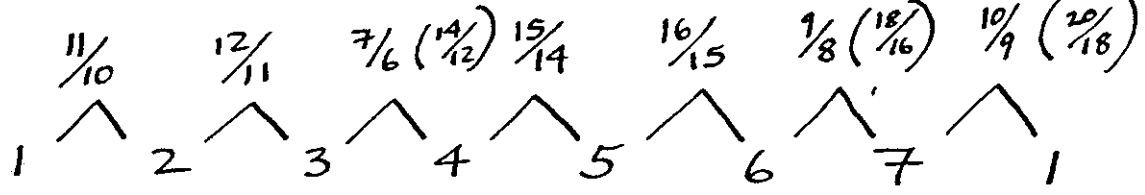
Lou Harrison says that slendro tunings are really more subtle, because the intervals you are juggling within the octave are closer together in size. The Javanese tend to like very large intervals between 1, 2 & 3. However, these three tones should be below a 4/3 (a perfect fourth); if they extend beyond a 4/3, the tuning will "flip" and the ear will tend to hear 1, 2 & 3 elsewhere in the mode. Lou wants to try this slendro in a gamelan:



He feels the large intervals between 1, 2 & 3 will be particularly pleasing to the Javanese ear. It should sound quite similar to the slendro tuning of the gamelan Kyai Kanyut Mesem (Sir Swept Away by a Smile) at the Mankunegaran Palace in Surya Karta, which features large intervals between 1, 2 & 3. This gamelan can be heard on the album "Javanese Court Gamelan Vol. II" (Nonesuch H-7204) recorded by Robert E. Brown (gamelan directed by Raden Tumenggung Soendoro Mitoeno Widjo-atmojo).

Lou Harrison heard a recording of a Javanese composition from Jogyakarta which sounded like slendro sanga (a version of slendro which cadences on 5.) However, when he asked Pak Cokro for a transcription of the piece, it was found to be written out in slendro nem, a slendro version which cadences on 2. Though at first adamant that the piece should be played in nem, Pak Cokro finally conceded that if the nem tuning of the original gamelan sounds like sanga on your gamelan, the piece could in effect be transposed. This is an important precedent for those who would transcribe Javanese pieces for American gamelan tuned in just intonation.

The Mills College Si Madeleine pelog is certainly not the only to be found directly in the overtone series. Gamelan builder Dan Schmidt has found a pelog in overtones 10, 11, 12, 14, 15, 16 and 18 which looks like this:



And of course pelog could be found by transposing and recombining various intervals in the overtone series.

TUNING THE MILLS GAMELAN

William Colvig tuned the Mills Gamelan with an old WWII army surplus oscilloscope. He started with pitch 5 of pelog, which is A 440. Using a microphone and a first-rate tuning bar, he first registered the A 440 on the oscilloscope as a sine wave with a given number of cycles. Then starting with an approximate size key, slightly lower than A 440, he would first strike the tuning bar and then the key. By gradually grinding the key on a grindstone to raise the pitch, he would acheive a perfect unison. This would register on the oscilloscope as a visual unison of the two sine waves. If the sine waves are almost in sync, but are drifting towards the left, then the higher of the tones you're testing is sharp; if it crawls to the right, then it is a bit flat.

A 440 was selected for pelog pitch 5 because it would facilitate playing Western instruments with the gamelan, especially strings and instruments such as trumpet that work with the overtone series. It also happens to be very close to the pelog pitch 5 of most Javanese gamelan.

Now that you have pitch 5 of pelog, pitch 6 is needed. Since it is the tumbuk, or common tone between slendro and pelog, it opens the door to slendro, so to speak.

We can see from our gamut of intervals that the interval we need between 5 and 6 is a 19/18. What we need then, is to tune our pitch 5 on the oscilloscope to 18 cycles per second and then tune our pitch 6 to 19 cycles per second. Since 18 cycles per second is rather hard to count on an oscilloscope, it is easier to first tune down an octave from A 440, or pitch 5. In this case, if A 440 registers on the oscilloscope as a given number of cycles per second, then A 220 will register as a sine wave with exactly half as many cycles (e.g. if you adjust the frequency to show 8 cycles for a A 440, then A 220 will register as 4 cycles per second).

Once you have tuned a key an octave down from the pelog pitch 5 you wish to tune off of, then adjust the frequency on the oscilliscope so that the screen shows 9 cycles per second for this tone. Now play your A 440 an octave up, and it will register as 18 cycles per second. Cut your key so that it is a bit lower than pitch 6. Gradually grind it so that when 5 & 6 are struck consecutively, you get one perfect envelope in your sine wave. This shows that you are in tune, that your higher tone has 19 cycles per second to the lowers 18. Again, if the higher pitch is flat, the sine wave will creep to the right, and if sharp, it will crawl to the left.

In tuning the other pelog intervals, 14/13 will give you a similar envelope effect, whereas 21/19 will register as two envelopes. 17/14 will give you three envelopes.

Once the tumbuk, or common tone has been found, then slendro can be tuned in the same fashion.

Aluminum expands and contracts with temperature. William Colvig has found that 70° is a good temperature for tuning keys. Before the final tuning, he lets everything sit on the table overnight. Everytime you file or grind a bar, you add some heat, which can make it a little low. So keep this in mind.

The kenong triangles are tuned by trimming the corners. This raises the pitch. If you go too high, then gouging out the bottom with a hacksaw will lower the tone.

For the slab keys, it is nice to get a double octave overtone. This is effected by just how you grind the keys. The ideal method is to spread out your grinding surface rather than concentrating it in one spot. Experiment with this to get the overtones you want.

Mathematically, the holes on the slab keys should be exactly 22½% from either end. However, rather than agonizing over this with a calculator, the salt method is recommended.

as when tuning, lay your key out on rubber wedges. Sprinkle salt on either end. Then strike the key. The salt will gather at the nodal points of least vibration. This is where you drill. The same method works for bonang plates and the kenong triangles.

In tuning in just intonation, one tunes "without beats." Lou and Bill say they try to get it down to one beat per millenium. But realistically, one can only be accurate to a certain degree.

For bonang plates, beating up into the boss raises the tone, whereas beating around the outside edges on the top will lower the tone. It is important to beat evenly all the way around the boss. One easy way to keep track of this is to count the sides of the octagon as you go around.

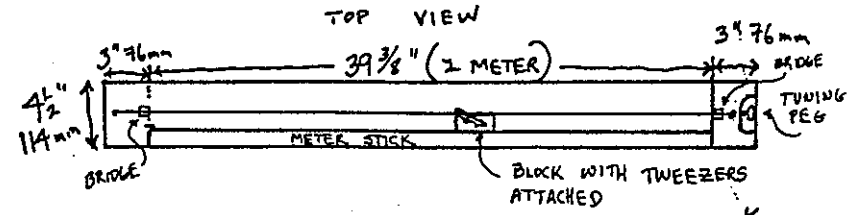
The other half of the tuning process involves the resonators. For gong ouwukan, kenong and gendér, cans are used. This process invariably involves a great deal of trial and error. But you will notice just by rapping on a tin can that they all have their particular tone. William Colvig says he likes this tone to be slightly lower than the key being resonated; others prefer slightly higher. But one cannot have them equal, or they will cancel each other out. Much of the scientific background for this comes from Helmholtz's On the Sensations of Tone.

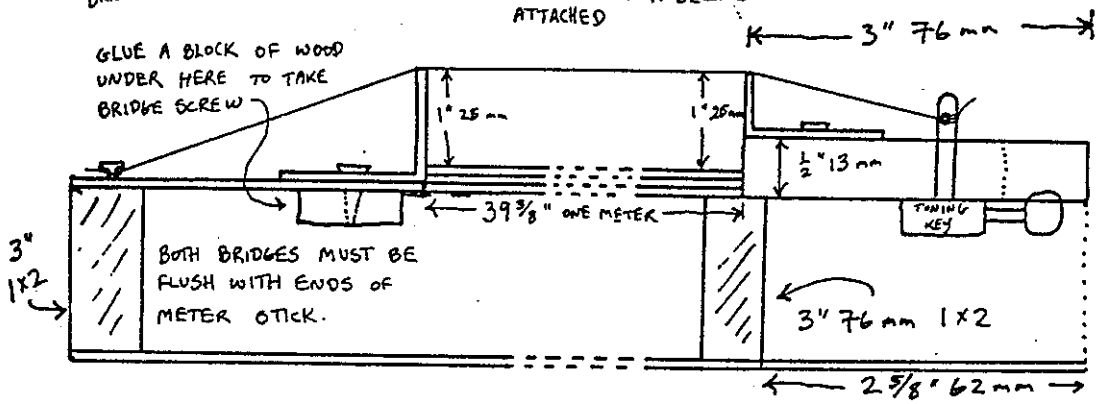
The deeper the resonating cans, the lower the tone, the shallower the higher. However, you will find that, for instance, in a gendér cabinet you only have so much space to extend your cans. This is why the first five keys are cabinet resonated. The cabinets themselves do not have to be the exact dimensions shown. They need be spaced only to be directly under the keys. Once they are tightly sealed, air tight & watertight so to speak, the resonance factor is affected by the size of the hole. The smaller the hole, the deeper the resonance and vice versa. Similar methods are used for the slentem which uses cabinet resonators, and the gembang.

If one is resonating keys with cans and the tone needs to be deeper but there is no more space in the cabinet, one can close in the diameter of the can opening or even lay a strip of wood or hard board across it and this will deepen the tone. This is an especially useful principle for the kempul, so that one does not need to rebuild the entire cabinet to adjust the resonance!

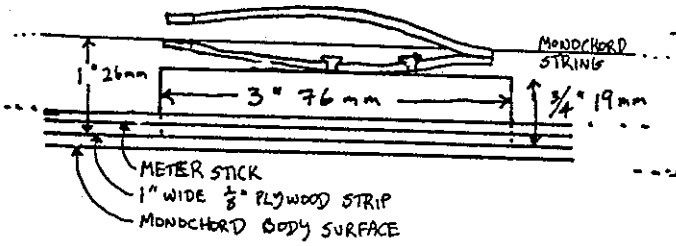
The trough resonating instruments are adjusted in a similar way. The deeper the trough, the deeper the resonance and vice versa. All resonators <u>must</u> be tightly sealed! The gender and gong ouwukan resonators can even be tested by filling them with water.

MILLS MODEL MONOCHORD

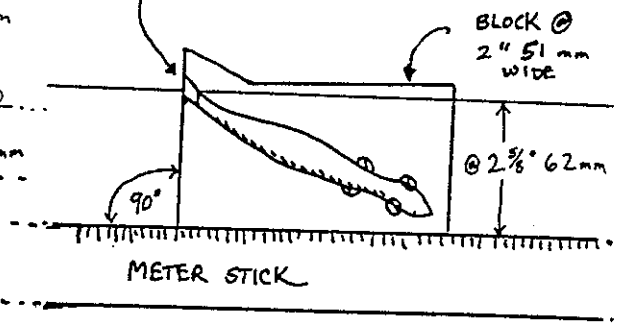




JAWS OF TWEEZERS MUST BE EXACTLY FLUSH TI WITH THE END OF THE BLOCK, AND LOWER JAW OF TWEEZERS MUST BE EXACTLY 1" 26mm FROM BASE OF BLOCK.



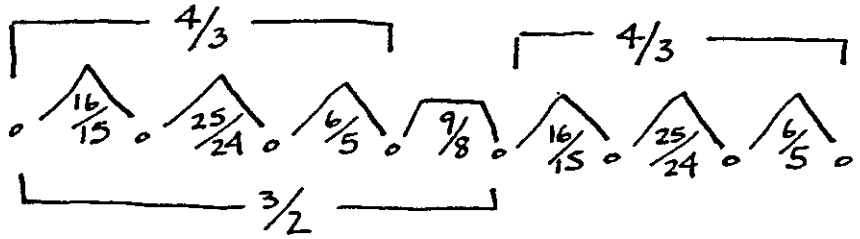
MONOCHORD STRING CENTERED ON TWEEZER JAWS



FIRST MAKE THE MAIN BODY. SIDES ARE TWO 45 3/8" 1152mm "1X2's" (1 1/2" x 3/4" 38x19mm) LENGTHS OF PINE; TOP & BOTTOM SAME LENGTH, 4 1/2" 114mm WIDE 1/8" 3mm PLYWOOD OR MAHAGONY. ONE 3" 76mm 1X2 GOES INSIDE THE LEFT END, THE OTHER 2 5/8" 62mm FROM THE RIGHT END (WHICH IS 3" 76mm FROM CENTER OF BLOCK TO END). A METER LENGTH OF 1" 26mm WIDE X 1/8" 3mm THICK PLYWOOD GOES BETWEEN METER STICK AND SOUNDBOARD. AFTER BODY IS MADE AND METER STICK MOUNTED AS SHOWN, MAKE TWEEZER BLOCK AND MOUNT TWEEZERS. MEASURE FROM CENTER OF TWEEZER JAWS TO OUTSIDE OF METER STICK TO DETERMINE POSITION OF STRING (@ 2 5/8" 62mm). LOWER JAW OF TWEEZERS MUST BE EXACTLY 1" 51mm FROM BASE OF BLOCK. RIGHT STRING SUPPORT (90° ALUMINUM BRACE) MUST BE AT RIGHT ANGLE FROM METER STICK END. LEFT SUPPORT (BRIDGE) EXACTLY 1000 mm FROM THE RIGHT ONE, AND ALSO AT A RIGHT ANGLE TO END OF METER STICK. STRING HEIGHT EXACTLY 1" 51mm, LIKEWISE TWEEZER JAW. LOWER LEFT CORNER OF TWEEZERS MUST BE EXACTLY 90° FROM METER STICK. LUFKIN BRAND ALUMINUM METER STICK QUITE ACCURATE. USE A BOW FOR SUSTAINED TONE WHEN PLAYING.

TRACKING MODES ON A MONOCHORD

First you need a strip of sturdy paper slightly longer than 50 centimeters (the mid-point or octave harmonic of your monochord string). Strathmore 3-ply is the best, though 2-ply is certainly adequate. Anchor your strip along the meter stick and mark the 50 cm point; this is your 2/1 or octave. It is within this space that we will find our mode. For an example, we'll track DIDIMUS' CHROMATIC. It looks like this:



It could also be measured from the tonic and written this way: 1/1 16/15 10/9 4/3 3/2 8/5 5/3 2/1

To find a 16/15, or the relation of a sixteenth of the string to the remaining 15/16's, we divide 16 into 100 (centimeters). This gives us 6.25 centimeters, which we mark on our monochord strip. When we clamp this point with our monochord tweezers, the interval we hear in relation to the whole string is a 16/15. To find a 25/24, or the relation of a 25TH of the remainder of the string to the other 24/25's, we first must find our new string length by subtracting 6.25 from 100. We are left with 93.75; divided by 25, this gives us 3.75, which when added to 6.25 = 10 centimeters. We measure this off from the end, mark it, and when we play it, we hear the 25/24 from the second to third degrees.

Another way to approach this interval would have been to add 16/15 and 25/24 = 10/9 and found this length in relation to the whole string as we did with the 16/15. This method can be used to find our third interval, the 6/5. We can simply measure a 4/3 in relation to our 100 centimeter length which gives us 25 centimeters. Mark this on the strip. For your next interval, measure off a 3/2 in relation to the meter length. This gives us 33.33... cm. Mark this perfect fifth on your monochord strip. To find the lengths of the upper tetrachord, we add each of our intervals to the 3/2 and measure them in relation to the 100 cm length. Thus 3/2 + 16/15 = 8/5. 100 cm. divided by 8 is 12.5 cm. 5 × 12.5 = 62.5 and we want the relation of the remaining three 8THS to these 5, or 100 - 62.5 = 37.5 cm. (or just multiply 3 × 12.5). Measure it and mark it. Now 16/15 + 25/24 = 10/9, added to 3/2 = 5/3. 5 goes into 100 of course 20 times and we want 2 of these lengths, or 40 cm. Mark this on your monochord strip and there you have it. Notice that once you've measured your two 4/3's separated by a 9/8, you can use these measurements for almost every classic mode, so you've saved yourself some work.

GONG TECHNOLOGY

In Java, gong making is a religious ritual. Seven or eight men are needed; they take mythological names and undergo rites of purification. A special bronze alloy is used called gongsa, ten parts copper and three parts tin. However, the preference now is to melt down old gamelan and use this bronze to make gongs; so the exact proportion of the alloy is questionable. A pancake of hot metal is poured, 12" - 18" in diameter and 2" to 3" thick. The men beat on this with sledge hammers in a darkened hut — the metal is kept hot, and the darkness of the hut enables the beaters to perceive the subtleties of light and color in the metal which tell them where to strike. They start from the boss and gradually spread the metal outwards, eventually all the way up the sides. After it is finished, it is hung up and struck, and if it doesn't sound, then they melt it down and start over again. Java's most famous gongs are of bronze. These are considered national treasures, some of them up to seven feet in diameter. Today, any gong over one meter in diameter is not allowed out of the country. The only disadvantage to bronze gongs, if it can be called a disadvantage, is that once they are made, the tuning adjustment is minimal; the most one can do is a little filing, for if you start hammering on bronze, it will shatter.

However, by far the majority of gongs in Java are made of iron, and these are found both with iron and bronze gamelan. It is this iron gong technology that has proven transferrable to the West. The Javanese are quite resourceful, and will for instance open up oil cans and flatten them out, draw a circle with a caliper and cut out the main diaphragm of the gong. Often gongs are welded together from scrap iron.

The gong of the Gamelan Si Betty at San Jose State has a flange which has four corners of the original sheet of metal turned back into it, with four half moon sections of iron dry crimped and then rivited to form the complete flange.

Normally a gong flange is made of three sections welded or dry-crimped together and is conical, i.e. comes off the main diaphragm of the gong inwards at an angle. This is for greater rigidity. It never meets the gong diaphragm at a 90° angle.

The gamelan Si Betty gong was made by Pada Ijja, a famous gong maker outside of Jogyakarta. It is an iron gong that is entirely dry-crimped and rivited, no welding. It has an original shallow iron boss onto which a heavy bronze boss is rivited, thus making a heavy weight in the middle as a kind of impeller. This, and the diaphragm of the gong with its slightly raised cheek and the rigid flange, seems to be the anatomy of a good gong. 60

The surface of an iron gong should be beaten all over to improve the tone. Pak Chokro says, "More beating, more beauty." The umbak of a gong (the deep "wah-wah" effect) can be controlled. It seems to be a function of the exchange between the weighted boss at the middle and the rest of the membrane. By adjusting the weight of the boss and pounding the cheek in or out, you can reach a desirable umbak. The pitch can be regulated this way too. By weighting the boss, you lower the pitch. If you turn it upside down and pound out, you are in effect raising the membrane; this puts more tension on the gong which raises the pitch. If you push it in, the pitch goes down. If you push it too far in, it loses its centricity of tone and starts sounding like a tam-tam

There is another sort of Javanese gong called the kemodong. Two iron slabs 6-8" wide and perhaps 18" long with bosses are tuned slightly apart and suspended next to each other over a huge 2'x2' resonator box, in reality a Helmholtz resonator with a little hole. They are struck together and produce a beautiful umbak Though the tone is not particularly loud, it has great sustain. This gong is prescribed for certain times of the year when use of the gong ageung is forbidden, and is also used with the gamelan klenengan - a gamelan which uses almost exclusively the panerusan instruments.

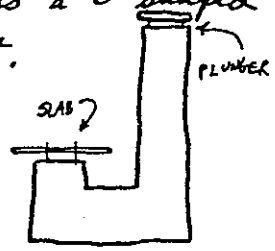
There is also a folk version of the gong agung made of two lengths of bamboo, one smaller and inside the other. In a kecapi-suling ensemble or other small street ensemble, one of the players (often the drummer) will lean over and blow into this bamboo gong, which has a lovely and quite realistic tone.

The gong agung is historically free from the pitch system of the gamelan, but in recent dates, it is said that the best gong is pitch 2 slendro an octave below the sunurkan range. Pak Chokro says that in ancient times, gongs were always 5 & 6 slendro in our sunurkan range, and were used alternately at the end of a balungan cycle. The "modern day" gong agung is pitched a fourth below these two tones. When they aim for a specific pitch, it tends to sound like a low gong sunurkan. However, the other variety is the "honeyed-thunder" kind, which does not relate to the gamelan in pitch, but is more of a deep bass "presence" thick with overtones.

When Lou Harrison and William Colvig first started building gongs, they used the "gong gender" model, i.e. a large slab of aluminum suspended over a resonator, like the gong sunurkan, described at the beginning of this book. This model successfully sounded down to pitch 5 slendro, roughly a low Ab below the cello. The classic gong agung, then, would be a perfect fourth below that, roughly a low Eb a half-step below the contrabass.

They succeeded in making such a gong; it sounded, but it needed support. First they added another slab giving the octave, like on our gong suwukan model, and then another slab giving the fifth above that. So finally they had the first three partials sounding simultaneously.

The resonating chamber for this gong was a V-shaped affair researched and modelled by Dan Schmidt. He found that, working basically in proportions of square blocks that the model pictured at the right works best. The chamber directly under the gong slab and the main resonating chamber must be separated by a cube of fairly equal proportions. This creates the V-shape, which gives the sine wave of the gong a curved path to travel. If the two chambers are side by side, i.e. separated only by one wall, the gong won't sound as well. At the top of the main resonator is added a plunger for adjusting the resonance.



One problem with this gong model is that the resonating chamber is so heavy that you loose the advantage of light weight aluminum. It's also a challenge to make it airtight. In addition, you don't really get shimmer or <u>umbak</u>; all you get is a sine wave, whereas a gong should be dense with overtones. As with any gong, it is essential that it be placed in a hall so as not to interrupt the wavelength, which can be very long (the gong gender Lon & Bill built has a 16 ft. wavelength).

Another gong experiment involved a large 3 ft. octagonal sheet of aluminum. Lou hammered in a @ 6" boss and then found the nodal points and drilled. This gong was just a plate with no flange, in effect a huge bonang plate. The sound is very good but very directional. Extensions of this idea could involve turning up the corners and bolting on a flange. Or one could cut four V-cuts into the corners of the octagon, then bend up those flaps and weld them into a flange. Another idea would be to try a totally hammered aluminum gong, perhaps adding a cheek also. In other words, aluminum should be tested at the full size. However, Lou doesn't think aluminum would deliver the amount of strength necessary for a gong agung, unless it were perhaps a huge unwieldy thing, perhaps ½" thick and 8 ft. across.

Another gong project involved the services of a metal working shop. Lou and Bill bought a large sheet of mild steel, then went and bought toilet floats and cut them in half. They took these to the metal-working shop and asked them to cut a perfect circle of a given diameter, and then a smaller circle the size of the toilet float and weld them together. Then a flange was welded on at a 90° angle to this diaphragm, edge to edge. Sure enough, it worked, but after three or four beatings, it began to buzz.

What they found to be the problem was that the flange had been welded on edge to edge. One must make sure to bend back the edge of the main diaphragm of the gong before the flange is attached. It is a tough job to bend this edge back; it tends to ripple. You just have to persist. Use a monkey wrench and a hammer to pound out the ripples.

The gong agung of the Mills Gamelan is named Kyai Mark, after the sculptor and professional welder Mark Bullwinkle who finished it for Lou Harrison, who had started it several years before. Lou started with a large sheet of mild steel, perhaps 4' square. The boss mold was the end of an oxygen tank dug into the earth. The steel sheet was stabilized over this with a 2×4 frame.

When making the boss, be sure to start at the edge and pound <u>in</u>, so you are pushing the density of the metal <u>in</u> towards the center. In this way you can build up an almost perfect hemispherical boss. Whatever sort of mold you use for the boss, don't forget to round off the edges with a file so that it slips off the gong easily. Lou Harrison finished this boss in about an hour, pounding on the metal cold.

William Colvig then cut off the corners of the steel sheet with an ordinary jig saw — he had a pan of water underneath to cool the blade and kept pouring cutting oil over it. It took time and patience, but he succeeded.

For the cheek of the gong, William Colvig made a bent pipe form which was attached to a heavy frame of 4 x 4's. This was then pounded out cold. There is a problem here, in that the metal tends to want to curl and warp. Lou Harrison says that you simply must persevere, and "bit by bit, you tame it."

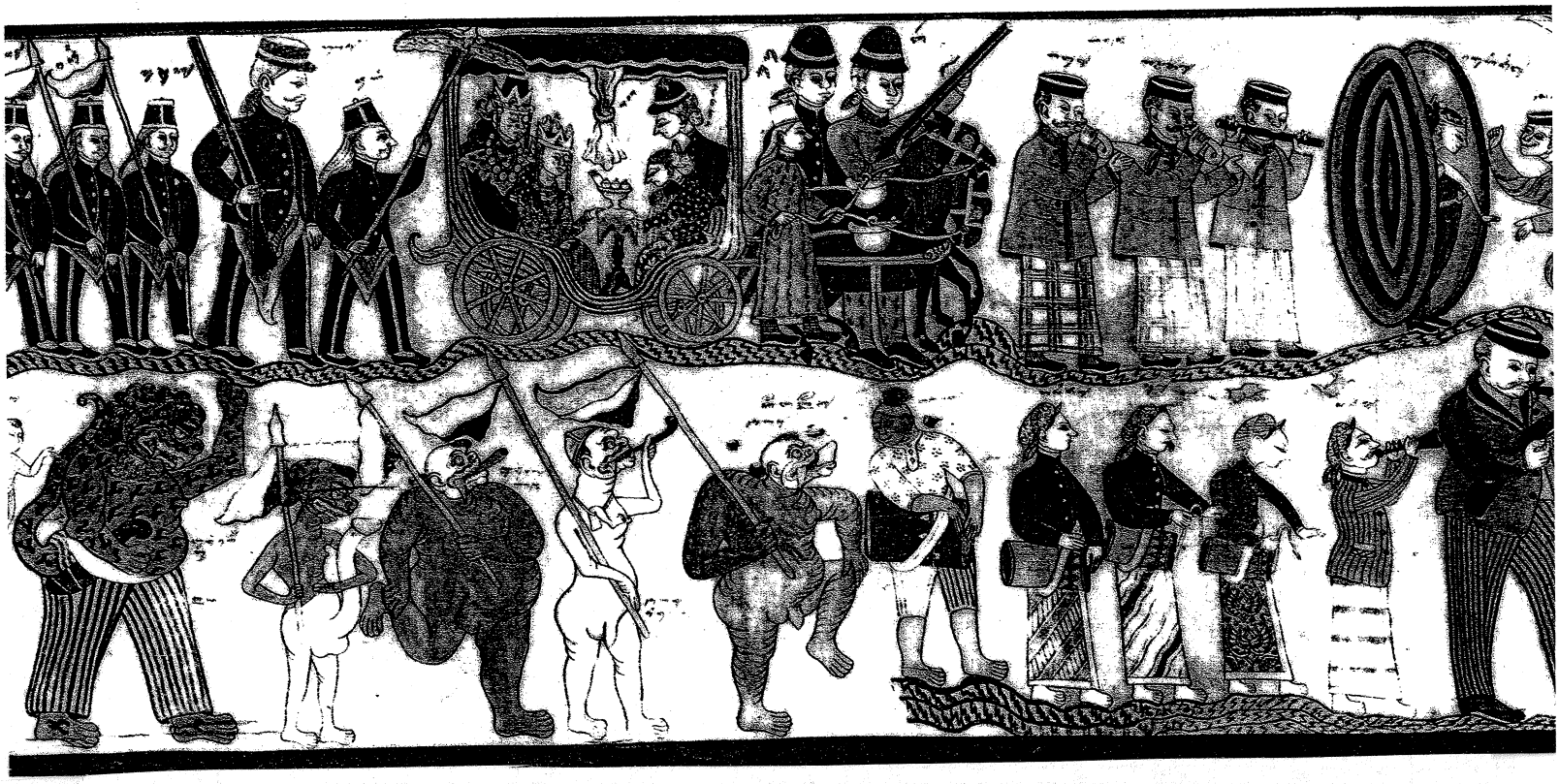
At this point, Paul Dresher returned from Java and asked Lou why he didn't use a torch like the Javanese. This makes the metal working much easier, though Mark Bullwinkle says he prefers working cold for very thin metal, as heat tends to make it curl up unpredictably.

Mark used acetylene welding to attach the flange. He first made a design of cardboard. He decided to use the Javanese method of fashioning the flange in three pieces. After he had his model, he traced the cardboard onto metal and cut it. Then he tacked it onto the gong and shaped it into the proper cone form. He then took it off before he welded it together and <u>then</u> welded the whole flange to the gong diaphragm. It was also found that you can pound and tune after welding. Lou Harrison says that an iron gong is like painting with oils; you can make changes after you're finished. But a bronze gong is like watercolors; you can't change it once it's finished.

after the gong was finished, the beater had to be upgraded. Lou Harrison bought a heavy rubber mallet at a hardware store and rounded off the ends so the head was capsule shaped. He then covered this with felt.

Two days after finishing his first gong, Mark Bullwinkle finished his second gong which he named Kyai Nægling, after the sword of Beowulf. He used thinner steel, and weighted his boss with beeswax melted with large lead pellets in it. It was here he discovered the relation between umbak, pitch and the weight of the boss. It is a handsome gong with a rich mellow tone that would sound lovely with a small gamelan.

The success of Lou Harrison, William Colvig and Mark Bullwinkle shows than we can successfully transfer iron gong technology from Java to the West. It is hoped that others will become involved in this exciting project.



excerpt of a cloth painting called *The Barikan Banner of Gegesik* by Sitisiwan (1865–1948) of Cirebon
from a facsimile scroll published by the Lontar Foundation, *www.gamelan.org/lontar* and *www.lontar.org*