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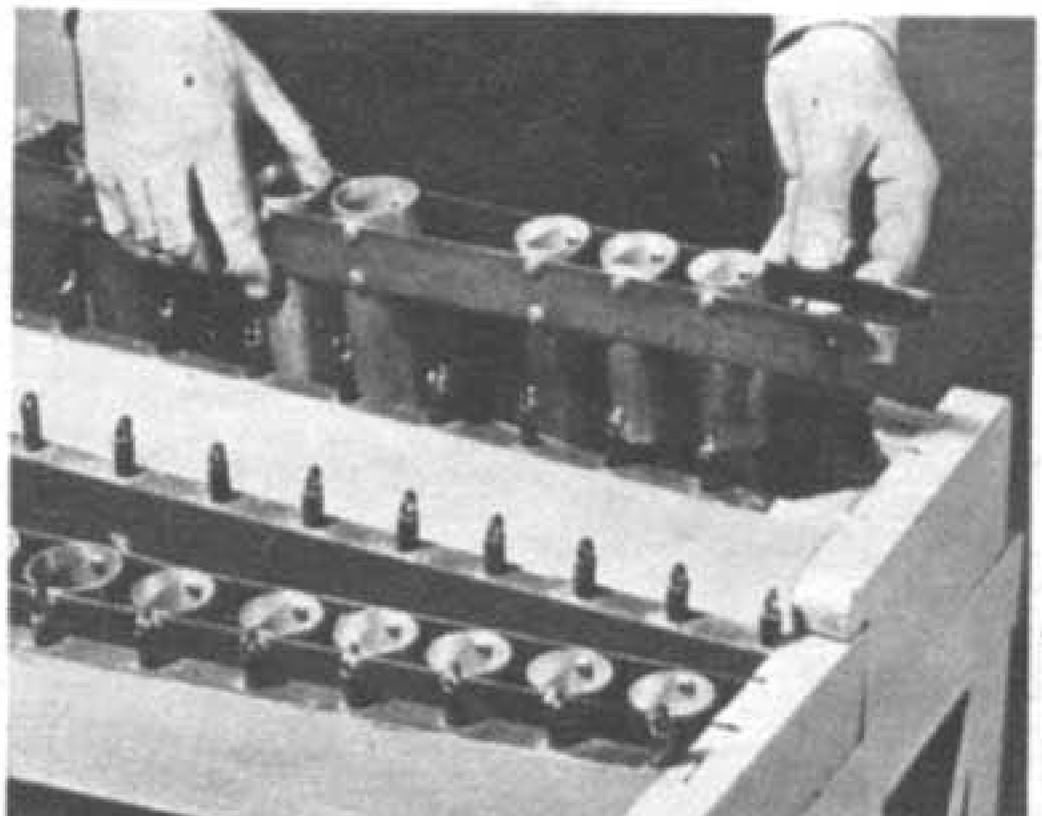
How to Build a Marimba

By H. F. Halenz

Concave undersides of keys. Center thickness is one factor which determines pitch.



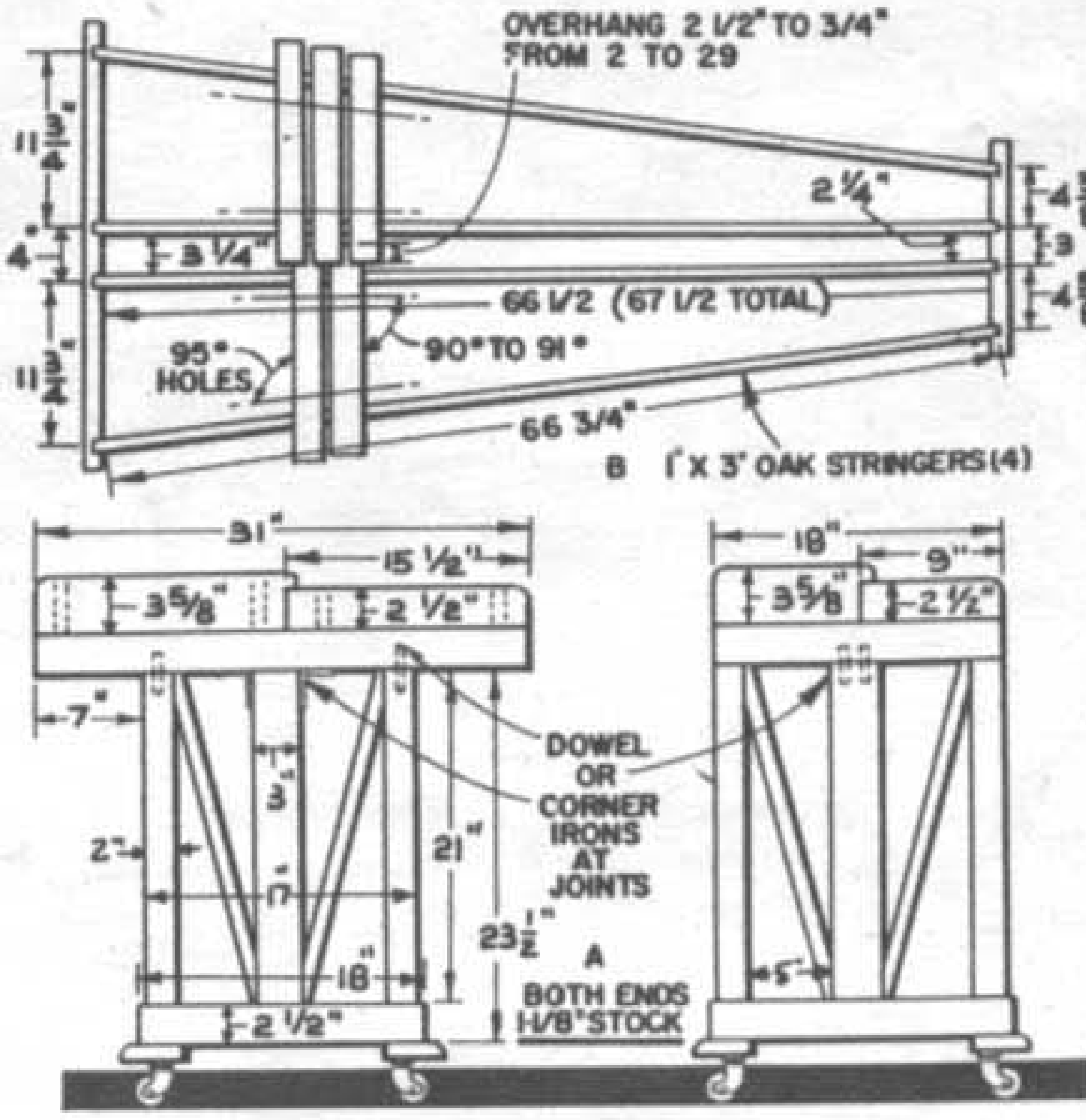
Resonator tubes are bolted between metal strips which rest in slots cut in frames.

A MARIMBA can easily be built by anyone even moderately skilled in the use of the common woodworking tools. It is a most rewarding project; children love to play it, partly because of the physical activity involved, and they become quite skillful with relatively little instruction. In the hands of a more serious student, a marimba can be used to produce really beautiful music, either as a solo instrument or in ensemble work.

Cost is greatly reduced when you build your own marimba. The price of a commercial four octave instrument ranges from about $300 to well over $1,000. The instrument shown was built for less than $50 and even that figure can be materially reduced.

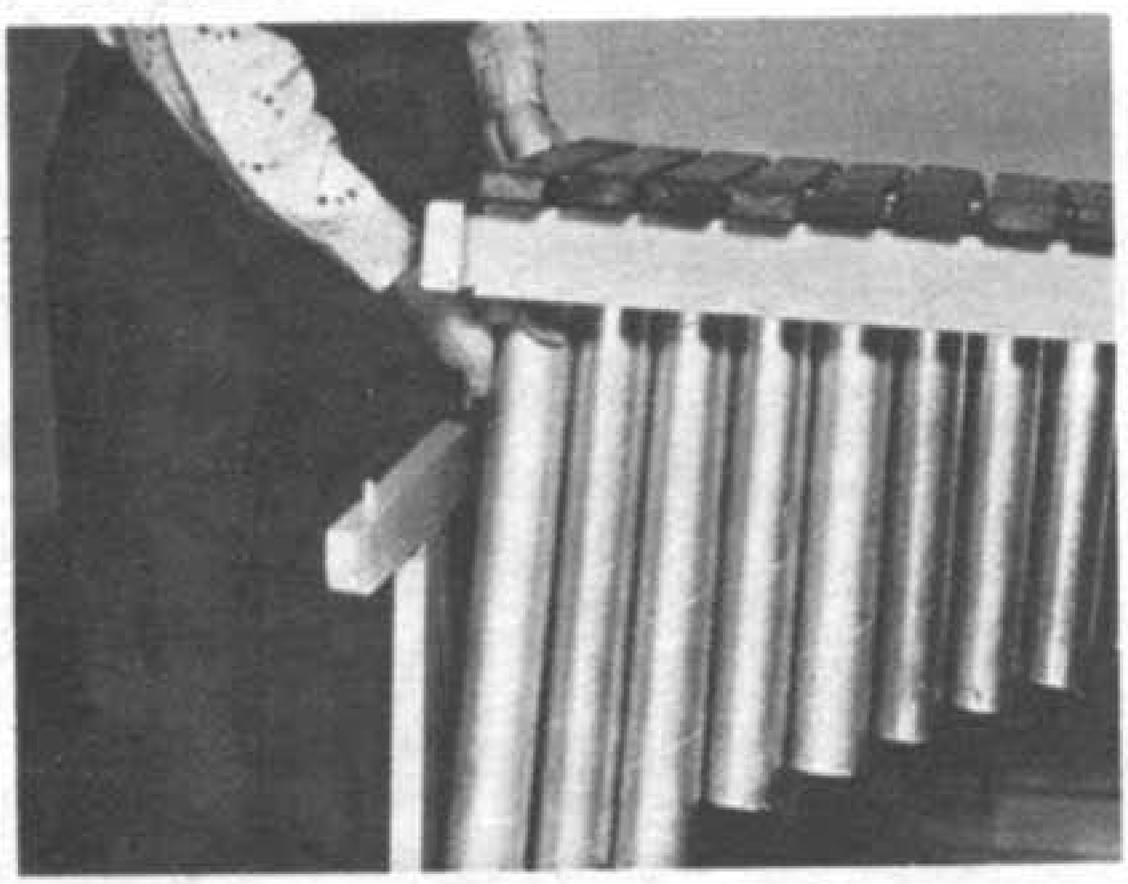
The marimba builder need not be a musician of any sort, but he must be able to distinguish between two tones of slightly varying pitch. In the final adjustment of the tone-producing wooden bars (hereafter called "keys"), a properly tuned piano is very helpful for comparison of pitch. Tuning forks, of course, can also be used.

A marimba consists essentially of a series of wooden keys tuned to proper pitch and suitably suspended over the open ends of resonators. The latter consist of thin-walled tubing, closed at the lower end. Ordinary cardboard mailing tubes, available in all the required sizes, give satisfactory results and cut the cost considerably. If used, they should be given a coat or two of paint



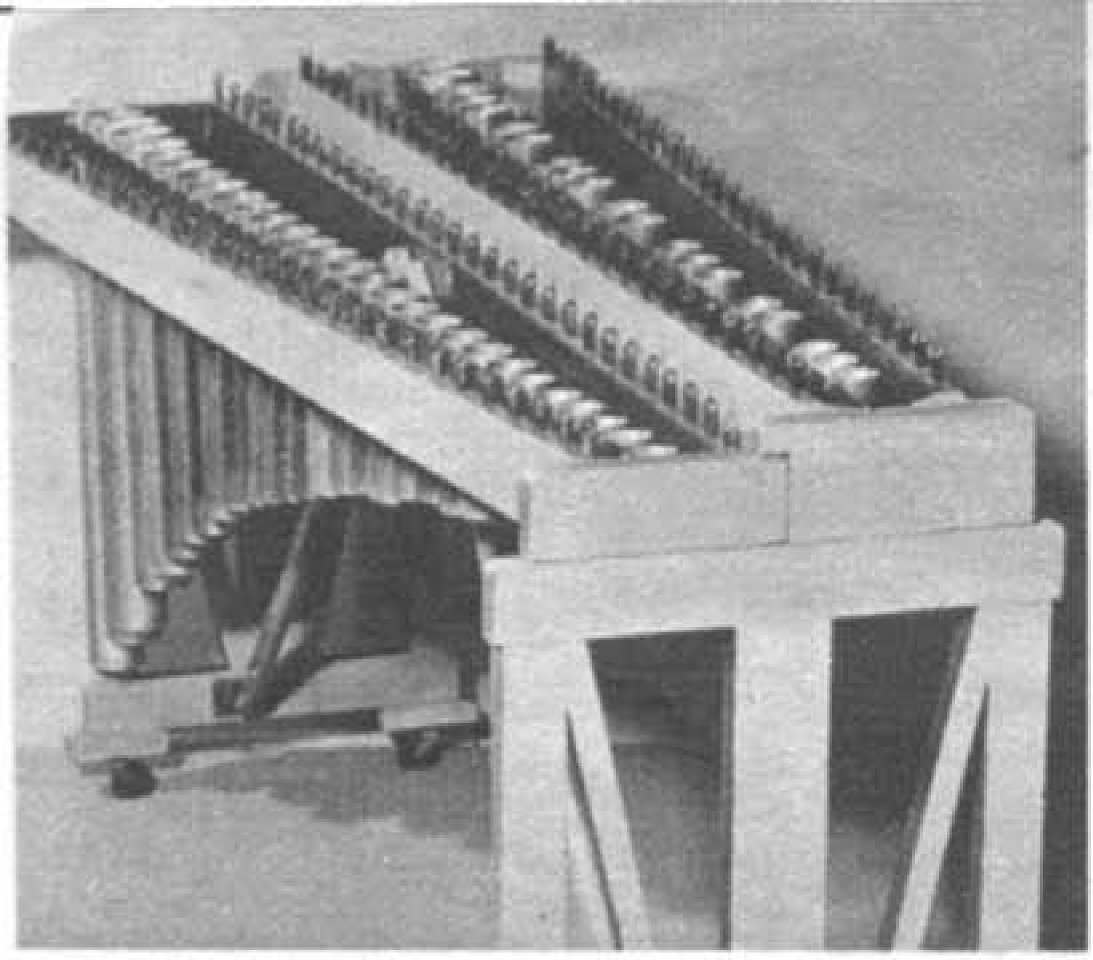
or shellac on the inside. The outside can be finished in aluminum paint. It should be understood that it is the air column enclosed by the tube which fortifies the sound of the key; the material of which the tube is composed is not necessarily a crucial factor. In commercial instruments, brass or aluminum tubing is normally employed. The latter is recommended.

While different woods may be used for the keys, it is best to use Brazilian rosewood. The quality of the keys largely determines the quality of the instrument. For a four octave instrument, 49 keys are needed; 37 are needed for three octaves. For the larger ma-

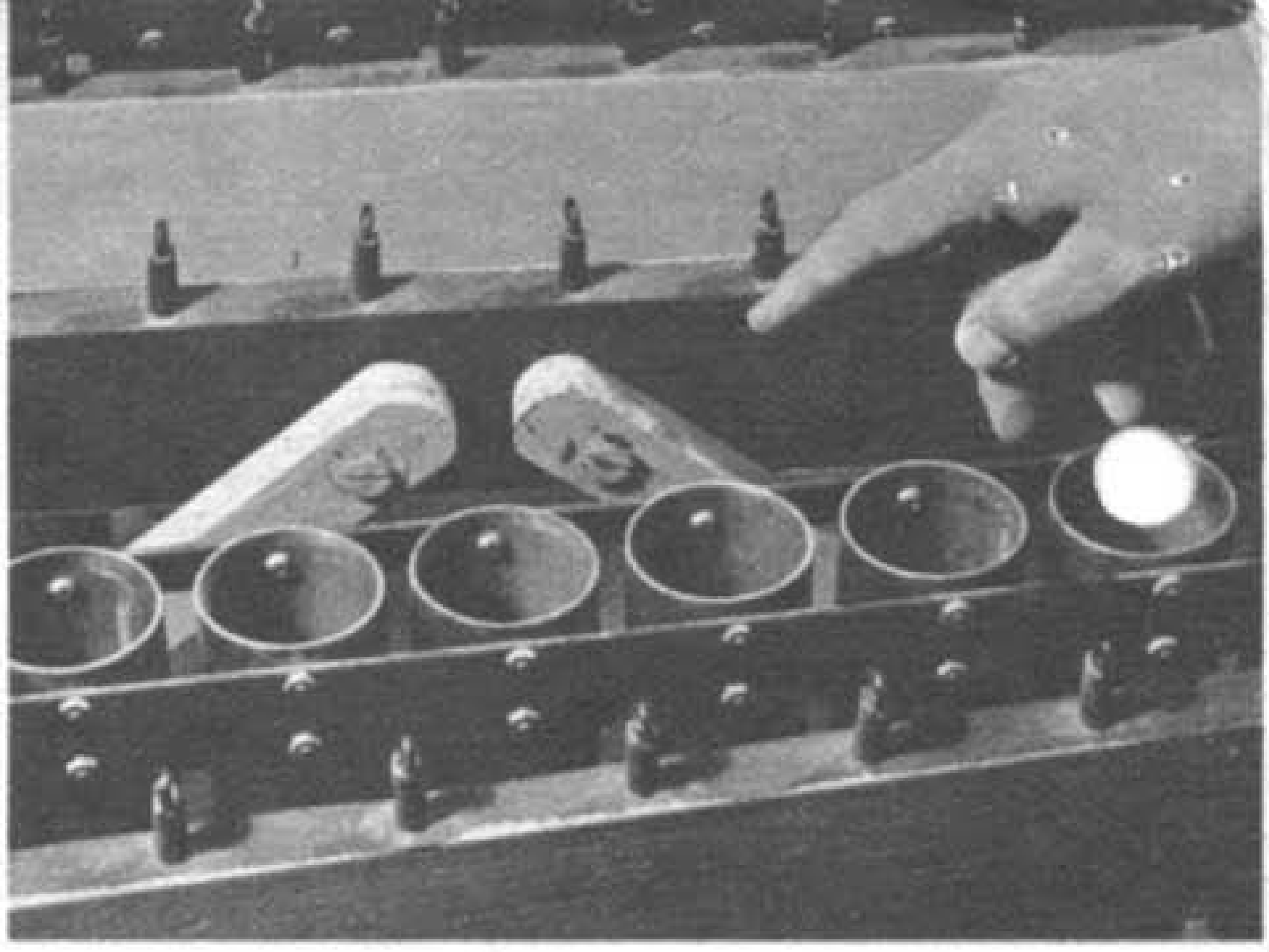


Both sets of keys and resonator tubes can be removed as unit. Note dowels in frame.

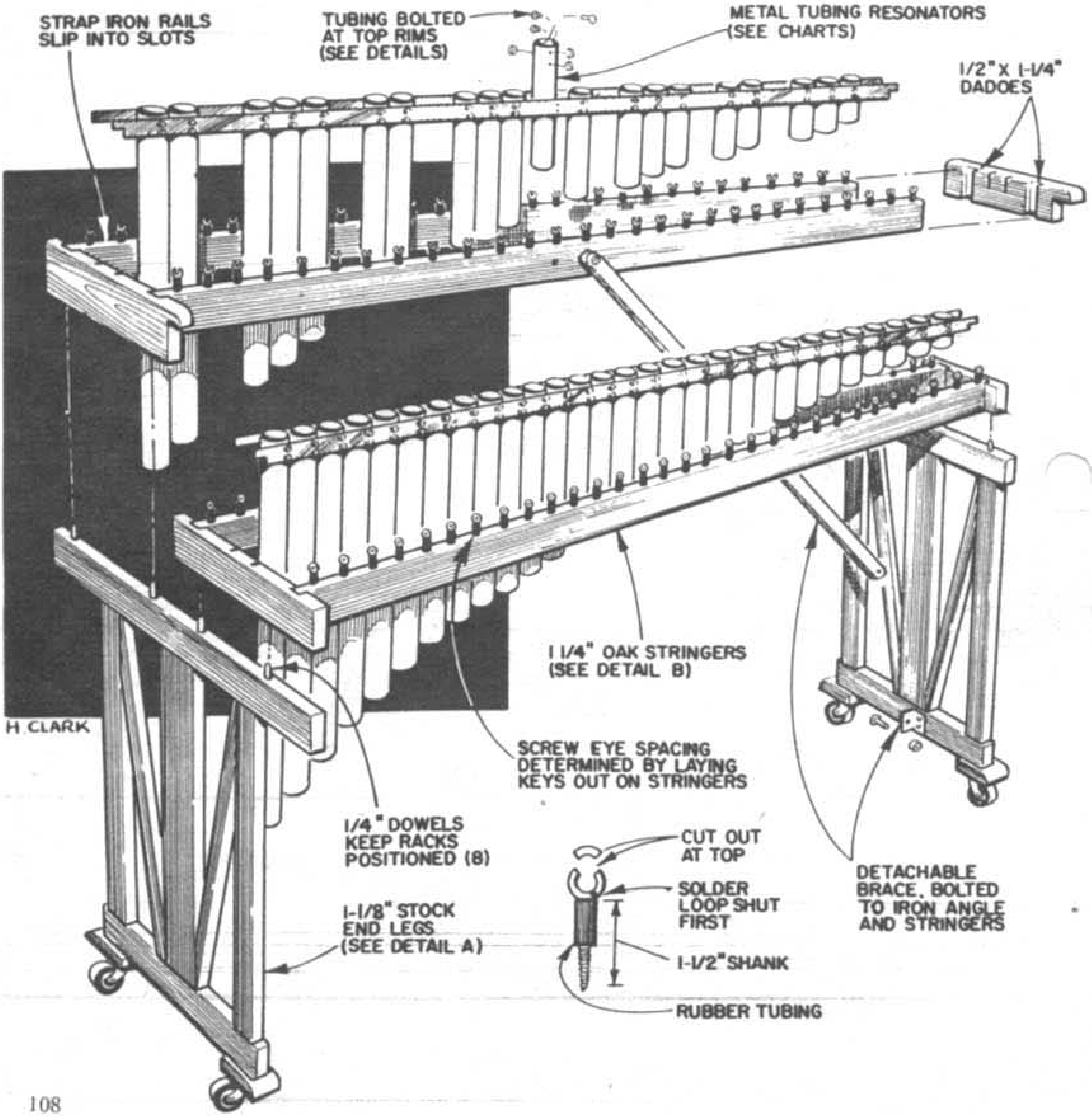
Key is held at node and pitch is compared with that of corresponding key on a piano.



Marimba with all keys removed. Resonator tubes can be aluminum, brass or cardboard.



The two braces are fastened at the center of the stringer with bolts and wing nuts.



rimba, start the C below middle C; for the smaller, start with G below middle C. The instructions given apply to the four octave marimba.

Brazilian rosewood is available in 1½x1½x36-in. and 2x2x36-in. sizes from the Craftsman Wood Service Co., of 2727 S. Mary Street, Chicago 8, Ill. Other large cities have similar supply houses. While the stock furnished by the above company is of excellent quality, its potential musical quality varies rather widely. It is best to obtain a couple of extra pieces, particularly since a few keys may be spoiled in the making. The probable musical value of an unfinished key is determined by letting it hang between thumb and finger, 2 or 3 inches from one end, and tapping it with a mallet. Good wood gives a clear, musical sound. Fruitless labor can be avoided if each

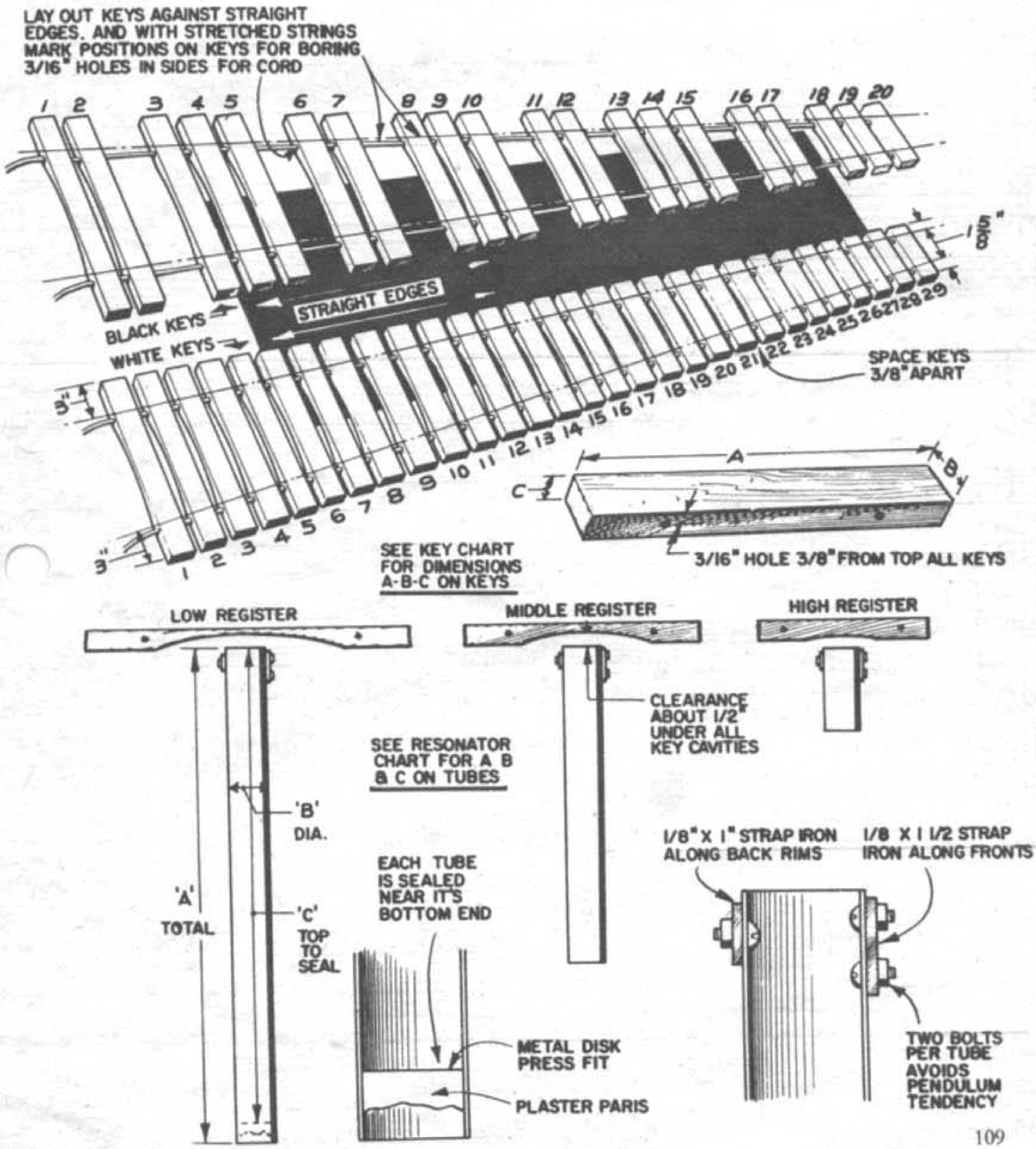


CHART I—WHITE KEYS

OCTAVE	KEY DIMENSIONS				RESONATOR TUBE DIMENSIONS		
	Key No.	Length A	Width B	Thickness C	Total Length A	Air Column Length C	Tube Dia. B
1	1	17¾	2	⅞	26¼	24¾	2¼
	2	17⅜	2	⅞	24	22	2¼
	3	17	2	⅞	21½	19⅝	2¼
	4	16⅝	2	⅞	20	18½	2¼
	5	16¼	2	⅞	18½	16½	2¼
	6	15⅞	2	⅞	17	14½	2¼
	7	15½	2	⅞	15¾	12⅞	2¼
2	8	15⅛	2	⅞	14¾	12⅛	2¼
	9	14¾	2	⅞	13⅝	10¾	2¼
	10	14⅜	2	⅞	12½	9½	2¼
	11	14	2	⅞	11¾	8⅞	2
	12	13⅝	2	⅞	11	7⅞	2
	13	13¼	2	⅞	10¼	6⅞	2
	14	12⅞	2	⅞	9½	6	2
3	15	12½	2	⅞	8⅞	5⅝	2
	16	12⅛	2	⅞	8¼	5	2
	17	11¾	2	⅞	7⅝	4⅜	2
	18	11⅜	2	⅞	7⅛	4⅛	2
	19	11	2	⅞	6⅝	3 11/16	1¾
	20	10¾	2	⅞	6⅛	3 3/16	1¾
	21	10⅜	1⅞	⅞	5¾	2¾	1¾
4	22	10	1⅞	⅞	5½	2 7/16	1¾
	23	9¾	1¾	⅞	5	2 3/16	1¾
	24	9⅜	1¾	13/16	4⅝	1 15/16	1¾
	25	9	1¾	13/16	4¼	1¾	1½
	26	8¾	1⅝	¾	4	1½	1½
	27	8½	1½	¾	3¾	1⅜	1½
	28	8¼	1½	13/16	3½	1⅛	1½
	29	8	1½	13/16	3⅜	1	1½

CHART II—BLACK KEYS

OCTAVE	KEY DIMENSIONS				RESONATOR TUBE DIMENSIONS		
	Key No.	Length A	Width B	Thickness C	Total Length A	Air Column Length C	Tube Dia. B
1	1	17⅝	2	⅞	25½	23⅛	2¼
	2	17¼	2	⅞	24	20⅝	2¼
	3	16½	2	⅞	19⅞	17½	2¼
	4	16⅛	2	⅞	18	15 7/16	2¼
	5	15¾	2	⅞	16½	13⅝	2¼
2	6	15	2	⅞	14	11⅜	2¼
	7	14⅝	2	⅞	13¼	10⅛	2¼
	8	13⅞	2	⅞	11½	8½	2
	9	13½	2	⅞	10¾	7 7/16	2
	10	13⅛	2	⅞	10¼	6½	2
3	11	12⅜	2	⅞	8½	5 7/16	2
	12	12	2	⅞	8	4¾	2
	13	11¼	1⅞	⅞	7	3⅞	1¾
	14	10⅞	1⅞	⅞	6½	3½	1¾
	15	10⅜	1¾	13/16	6⅛	2⅞	1¾
4	16	9⅞	1¾	13/16	5½	2⅜	1¾
	17	9⅝	1⅝	¾	5	2 1/16	1¾
	18	8¾	1½	¾	4½	1 11/16	1½
	19	8⅜	1½	13/16	4	1 7/16	1½
	20	8⅛	1½	13/16	3⅝	1¼	1[illegible]

Note: all dimensions are given in inches.

piece of wood is tested in this manner.

For the sake of clarity, the keys of the marimba are related to those of the piano. In line with this, they are classified as "white keys" and "black keys." Twenty-nine of the white and twenty of the blacks are needed for four octaves in the key of C, each octave consisting of eight white keys and five black keys. These octaves are ruled off in Charts I and II.

In making the keys, begin with the twenty-nine corresponding to the white ones on the piano. Omit, for the time being, the sharps and flats (black keys). Cut out the blocks and plane them to the dimensions given in Table I. Then round all corners and edges, using a block plane and sandpaper. Next, number them in pencil from 1 to 29.

Each of the completed blocks has two $\frac{3}{16}$-in. holes through which the suspending cord is threaded. Note that one line of holes is virtually at right angles to the long axis of the keys; the other is at an angle of [*Continued on page* 150] 157

How To Build A Marimba

[*Continued from page* 110]

about 95 degrees to conform to the diminishing length of the keys. To determine the exact position of the holes, lay all 29 keys in correct order against a straight edge, leaving exactly ⅜-in. between any two of them. Then mark the direction of each pair of holes by means of a stretched string. Next, measure down exactly ⅜-in. from the top face of each key and bore the holes through at these points.

By way of explanation it may be stated that the key holes are in the position of the nodes; that is, those parts of the key which do not vibrate. The key itself may vibrate in one, two or perhaps more segments, like a vibrating string. Thus, by placing the holes through which the supporting cord passes at the nodes, the remainder of the key will vibrate and produce the musical sound without any interference from a more or less stationary support. The dimensions given fulfill the conditions described.

The pitch of a key depends on two factors: its length and its thickness—particularly the thickness of its center section. Since the keys have been finished to correct overall dimensions, they are now tuned to pitch by removing some wood from the undersides, leaving a concavity of relatively large radius. The relative depth of concavity for keys in the low, middle and high register is indicated in the last drawing. Wood is easily removed by chiseling, followed by smoothing with a rasp. For the larger keys, the concavity can be cut on a band saw and finished with a rasp and sandpaper. Check the pitch after each operation by holding the key at its node, between thumb and forefinger and tapping with a mallet. A piano is used for comparison.

It is important not to remove too much wood. In performing the pitch test, it becomes obvious that the pitch is lowered as more wood is removed. Should the pitch inadvertently become a little too low, the key can be salvaged by shortening. A slight change in length has a marked effect on the pitch. The frequency of vibration, and therefore the pitch of a sound produced in a key, varies directly with its thickness, but is inversely proportional to the square of its length. Note that the volume of sound produced by the key itself will be disappointing; the resonator will amplify the sound many times.

Very little, if any, wood need be removed from the centers of keys Nos. 26 to 29, the high pitch keys. It may, in fact, be necessary to shorten them slightly to bring them up to pitch. Since the higher pitched keys are much more easily tuned than the lower keys, it is best to tune the former first. Start with key No. 15, C above middle C, and work toward the upper part of the register. Then tune the lower octaves. A completed octave is readily used in tuning keys of an adjacent octave. It will be found best to adjust the pitch of a key by comparing it with the pitch of a finished key which is one octave lower or higher. Also compare it with adjacent keys.

The 20 black keys are next prepared and fitted into the scale in the manner described above. Table II gives the dimensions in four groups of five keys each.

The tubes used as resonators are cut to the dimensions given in both tables. Length of each resonating chamber is somewhat critical. The tables indicate the overall length and also the length to the closed bottom of the tube (the length of the air column). Tube diameter is not too critical, but one should not depart widely from recommended sizes.

Close the bottom of each tube in the following manner: Cut a round disk of sheet aluminum or other sheet metal to fit snugly into the tube. Place it in position by pushing it against a yardstick or other piece of stock inserted to the proper distance into the tube. Invert the tube and pour about ½ in. of fairly thick plaster of paris into the lower end. This will harden quickly, seal the disk airtight and hold it indefinitely. Be sure the disk is set at right angles to the long axis of the tube.

The resonators are bolted to two pieces of strap iron about 1 in. to 1½ in. wide and from 3/32 in. to ⅛ in. thick. The ends of the strap irons rest in slots in the wooden

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[Continued from page 157]

frame and the entire resonator assembly ca e removed as a unit simply by lifting it . and out. When assembled, the open end of each resonator should be under the center section of the corresponding key and very close to ½ in. below it.

Due to the fact that the tubes are made progressively shorter in conformity with the needs of the higher pitched keys, a marimba may appear physically unbalanced. In some (but by no means all) commercial instruments this unbalance is overcome by lengthening the tubes for the high-pitched black keys and filling the keyless spaces with blanks. The home builder of a marimba may wish to follow this procedure, it being understood that the actual length of the resonating air column is not affected.

While the resonator lengths are given in the tables, some builders of an instrument may wish to know how these precise lengths are determined. The process, a simple and interesting one, is as follows: Support a piece of glass or metal tubing of about 1½-in. diameter vertically. Close its lower end with a stopper. A small piece of glass or metal tubing passes through a hole in the stopper. Connected to this is a piece of flexible rubber tubing which, in turn, connects with a leveling bulb. When w : is introduced, the water level in the large tube, and therefore the length of the resonating air column, can be controlled by raising or lowering the leveling bulb. Place the prepared key, supported at its nodes, over the tube and, while striking it gently with a mallet, raise and lower the water level. A position will be found where the resonance is very marked. This is the correct length.

Frame construction allows considerable latitude, depending on available materials and the fancy and ingenuity of the builder. Height of the keyboard is usually 33 to 34 in. However, it can be varied to meet the requirements of the player. Hardwood is recommended for the stringers since such wood will hold the cord (key) supporting screws more rigidly. Length of the stringers will vary with the total width of the keys. Narrower or wider keys (depending on stock available) will shrink or expand these distances.

The cord which supports the keys is run through screw eyes set into the stringers. These screw eyes should be about 1½ in. long in shank and have a head of about ⅜-in. diameter. Place a short length of rubber tubing of about ⅛-in. inside diameter around each screw shank. This prevents metal contact with the keys. If the marimba must be transported, the screw eyes should be modified by cutting out the top of each eye. Of course the open end is soldered first. The entire set of keys can then be removed or replaced as a unit.

Aluminum tubing can be obtained through local dealers. Central Sheet and Wire Co., 3000 W. 51st St., Chicago 80, Ill., can supply aluminum tubing in all needed sizes, but only in 12 ft. lengths. Wall thickness of 18 Stubs gauge, .049-in., is satisfactory. Their number on this tubing is 61 S-T6. •