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TOMORROW'S ELECTRONIC BARBERSHOP QUARTET

By L. A. Meacham

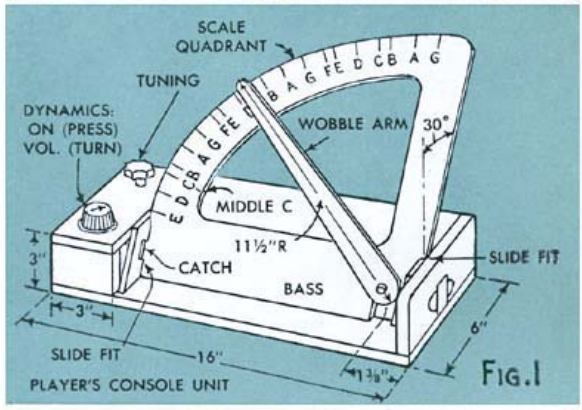
MUSICALLY inclined communications engineers have all, at one time or another, connected a laboratory oscillator to a speaker and twiddled the frequency dial to play themselves a tune. But did anyone ever bother to provide four people with four oscillators, so that they might play electronic barbershop quartets?

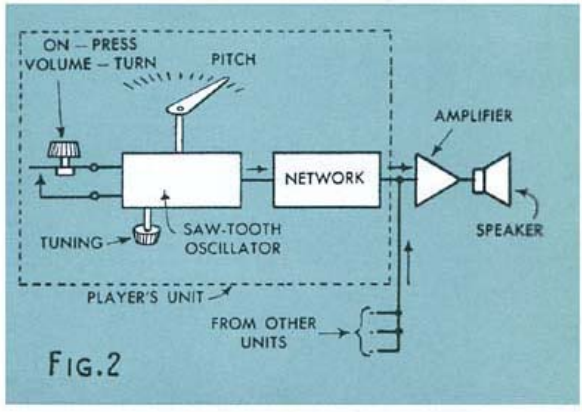
Here is a promising facet of electronics which, up to now, so far as the author has been able to discover, has been left singularly unexplored. The question came up while searching for a novelty to entertain members of a Bell Laboratories glee club at their annual party. The result of preliminary research (conducted in the author's cellar, since it was not an official company project) was a complete electronic "wobble organ" which was received so enthusiastically at the party that improved models were designed in the basement workshop. Playing techniques were improved, and concert experience was obtained before several surprised and delighted audiences.

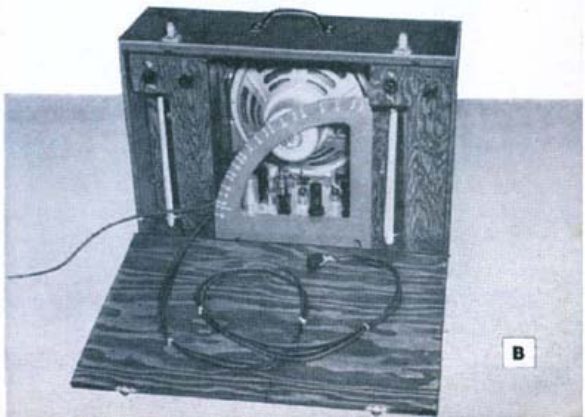
The present state of the art is represented by the units described in this article. The units employ standard inexpensive radio parts which are available from radio-parts houses, and the project offers interesting possibilities for home recreation of the "participation" kind, as well as for the various entertainment fields involving large groups. However, speculation on uses may more properly follow an inspection of the various photos and diagrams.

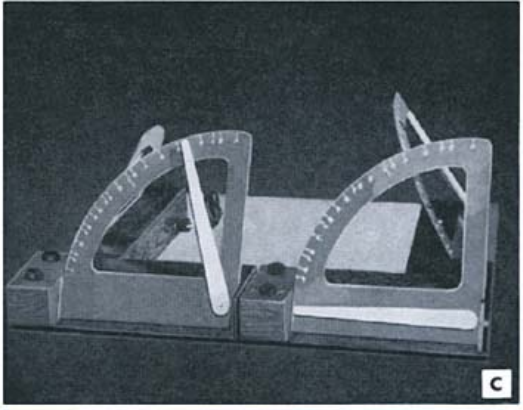
The four players sit around three sides of a card table, as shown in photos A and D. The fourth side is turned toward the audience, and may conveniently be faced by a music rack if desired. In front of each player is a small "playing console." On the floor near the table is a cabinet containing a power supply, an amplifier, and a speaker. Pairs of playing consoles that are adjacent to one another are plugged solidly together mechanically and electrically as shown in photo C and diagram Fig. 3, the whole set of four being connected to the amplifier in the speaker cabinet by a six-conductor cable. Note the positions of the bass, tenor, alto and soprano consoles.

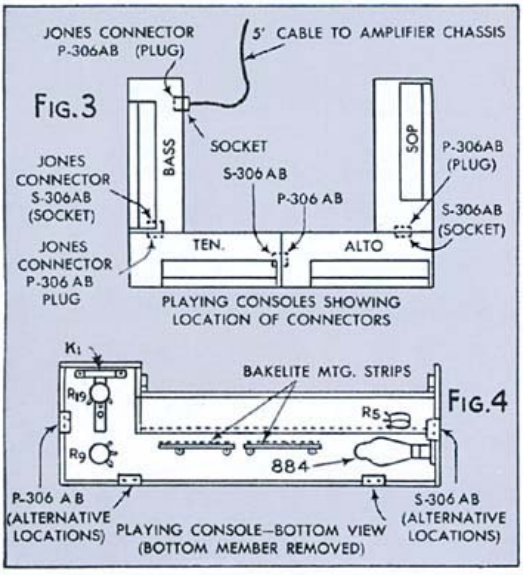
Each playing console, Fig. 1, contains a thyratron saw-tooth oscillator, with suitable control circuits, and a simple wave-form-shaping network which emphasizes or suppresses various harmonics in the





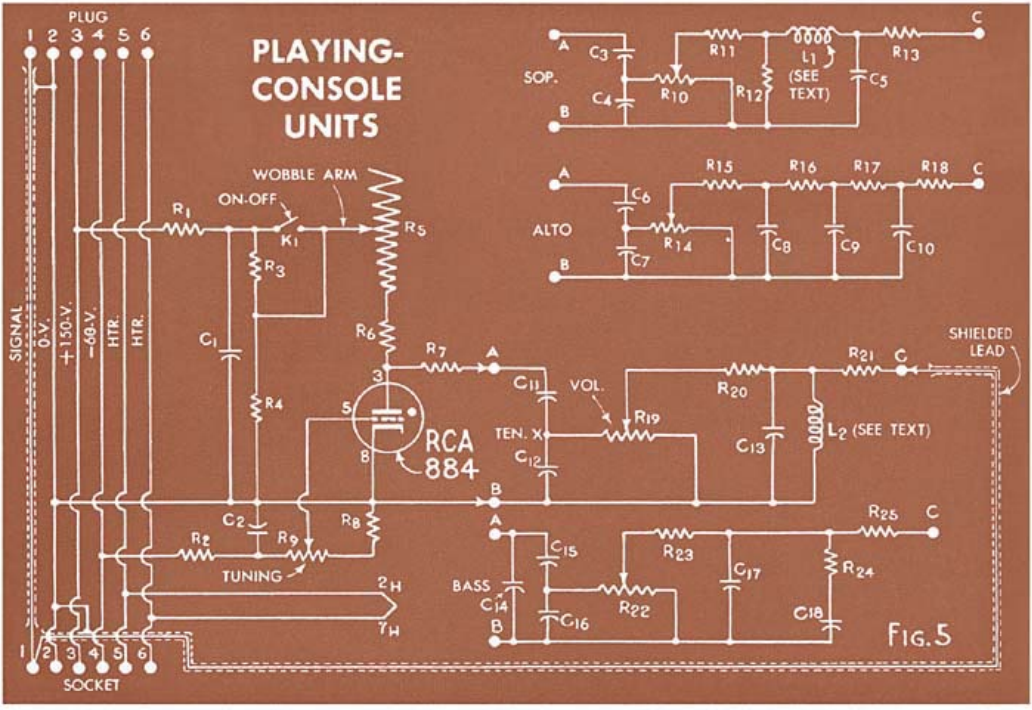




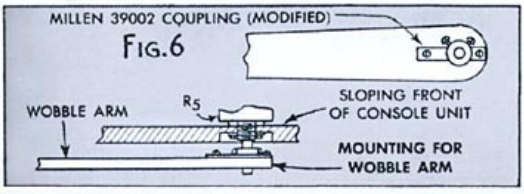


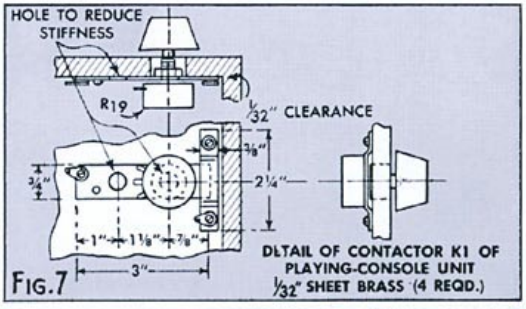
complex saw-tooth wave providing a distinctive tone quality, different for each player. The wobble arm controls the pitch by varying potentiometer R5. Two other potentiometers control volume and tuning, Fig. 2. The main control, of course, is the wobble arm, which is fastened to the potentiometer shaft that extends through the sloping front of the console. This control is designed to vary the pitch over a range of more than 2½ octaves (about six to one in frequency). This range is at least that of the human voice, and in the present model is located differently on the frequency spectrum for each console, covering the vocal ranges of soprano, alto, tenor and bass, respectively. (A "male quartet" model could be obtained merely by changing capacitance values.) Figs. 4, 6 and 7 show construction details for the playing-console units. The schematic circuit diagram for these playing units appears in Fig. 5. The front end of each unit is the same up to connections A and B. The networks for the other tonal ranges connect to the oscillator stage in the same manner, as indicated.

The consoles are made of ⅜-in. plywood, with scale quadrants of ⅛-in. pressed hardboard. Each scale quadrant is made removable to facilitate storage, being mounted in slides at its edges. A simple catch is provided to support the free end of the wobble arm when not in



use. The bottom of each console is removable for access and the principal dimensions are given in Fig. 1. The design of the speaker cabinet is conventional, the only novel feature being the provision for storage space for the playing consoles, two at each side of the speaker as shown in photo B. Thus the entire wobble organ is made portable in a single suitcase-sized unit. This cabinet is made of ⅜-in. plywood except the top and bottom which are ¾-in. plywood. The inside dimensions are 7½ x 17 x 24½ in. The chassis base for the audio amplifier, Fig. 8, is centered in the bottom of the cabinet. This sheet-metal base is 2 x 7 x 11 in. This amplifier is conventional except for special voltage regulation. It includes the power supply and the socket for the 5-ft. cable to the playing consoles. The layout is not critical. However, keep the low-level





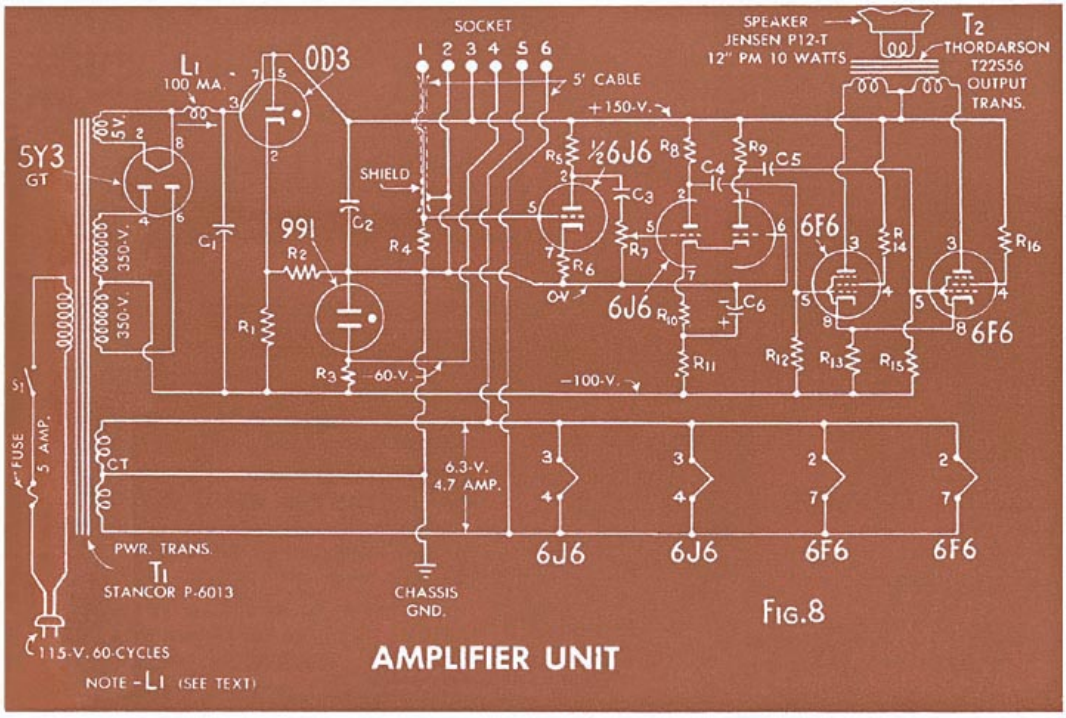


FIG.8

PARTS FOR PLAYING-CONSOLE UNITS

4 SETS REQUIRED

K1 = Special contactor (see sketch Fig. 7)
C1 = 8 mfd. 150-V. Wkg. electrolytic condenser (Cornell-Dubilier BR815)
C2 = .1 mfd. 400-V. tubular-type paper cond.
R1 = 560-ohm, ½-watt carbon resistor
R2 = 150,000-ohm, ½-watt carbon resistor
R3 = 1,300,000-ohm, ½-watt carbon resistor
R4 = 510,000-ohm, ½-watt carbon resistor
R5 = 1-megohm, potentiometer (Ohmite "AB" pot. type CB-1052 log. taper)
R6 = 10,000-ohm, ½-watt carbon resistor
R7 = 300-ohm, ½-watt carbon resistor
R8 = 15,000-ohm, ½-watt carbon resistor
R9 = 25,000-ohm, potentiometer (Ohmite "AB" type CU-2531, linear taper), TUBE = RCA 884
1 = Millen No. 39002 coupling (modified) for wobble-arm mounting
NOTE—All carbon resistors ± 10%

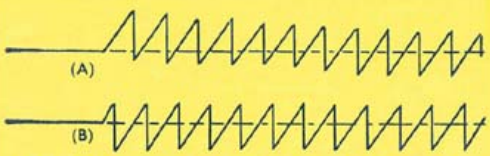
1 SET REQUIRED

L1 = .45 H Graybar Electric No. D-170718 retard coil
L2 = Same as above
C3 = .02 mfd. 400-V. tubular-type paper cond.
C4 = .22 mfd. 400-V. tubular-type paper cond.
C5 = .003 mfd. 600-V. tubular-type paper cond.
C6 = .025 mfd. 400-V. tubular-type paper cond.
C7 = .15 mfd. 200-V. tubular-type paper cond.
C8 = .002 mfd. 600-V tubular-type paper cond.
Note—C9 and C10 are same as above
C11 = .05 mfd. 200-V tubular-type paper cond.
Note—C13, C15, and C17 are same as above
C12 = .5 mfd. 200-V. tubular-type paper cond.
C14 = .03 mfd. 400-V. tubular-type paper cond.
C16 = .5 mfd. 200-V. tubular-type paper cond.
C18 = .25 mfd. 400-V. tubular-type paper cond.
R10 = 250,000-ohm potentiometer (Ohmite "AB" type CU-2541 linear taper) NOTE—R19 and R22 are same as above
R11 = 24,000-ohm, ½-watt carbon resistor
NOTE—R13, R21, R23 and R25 same as above
R12 = 51,000-ohm, ½-watt carbon resistor
NOTE—R15, R16, R17 and R18 same as above
R14 = 1-megohm potentiometer (Ohmite "AB" type CU-1052 linear taper)
R20 = 10,000-ohm, ½-watt carbon resistor
R24 = 5100-ohm, ½-watt carbon resistor
NOTE—All carbon resistors ± 10%
All tubular-type paper cond. Aerovox P88

RESISTORS AND CONDENSERS FOR AMPLIFIER UNIT

R1 = 5000 ohms, 5-watts (Ohmite Brown Devil)
R2 = 100 ohms, ½-watt carbon
R3 = 11,000 ohms, ½-watt carbon
R4 = 20,000 ohms, ½-watt carbon
R5 = 100,000 ohms, ½-watt carbon
R6 = 3300 ohms, ½-watt carbon
R7 = 1-megohm pot. Ohmite "AB" type CA-1052 (LOG)
R8 = 100,000 ohms, ½-watt carbon
R9 = 100,000 ohms, ½-watt carbon
R10 = 39,000 ohms, ½-watt carbon
R11 = 27,000 ohms, ½-watt carbon
R12 = 510,000 ohms, ½-watt carbon
R13 = 360 ohms, 2-watt carbon
R14 = 100 ohms, ½-watt carbon
R15 = 510,000 ohms, ½-watt carbon
R16 = 100 ohms, ½-watt carbon
NOTE—All carbon resistors ± 10%
C1 = 80 mfd., 300-volt, Cornell-Dubilier UP-8030
C2 = 20 mfd., 250-volt, Cornell-Dubilier UP-2025
Note – Above are electrolytic types
C3 = .1 mfd., 400-volt tubular paper type
C4 = .1 mfd., 400-volt tubular paper type
C5 = .1 mfd., 400-volt tubular paper type
C6 = 1 mfd., 200-volt tubular paper type

NOTE – SEE TEXT FOR ALL OTHER PARTS



WAVE FORM AT POINT X (FIG. 5) AT START OF OSCILLATION. (A) WITHOUT BIASING RESISTORS R3 AND R4. (B) WITH BIASING RESISTORS R3 AND R4

FIG. 9

input and high-level output circuits well separated and arrange the taller elements where they will not interfere with the speaker in the cabinet. Voltage-regulating tubes OD3 and 991 provide the necessary regulation to avoid fluctuations of pitch with line voltage, and to insure stable plate and bias potentials. Choke L1 in the amplifier is a Chicago Transformer Corp. RC-8105, 8 hy., 103 ohms, approximately 100 ma. The 5Y3-GT and OD3 tubes require octal sockets; the 991 tube uses a bayonet candelabra double-contact socket; the 6J6 tubes use seven-pin miniature sockets and the 6F6s require octal sockets. The shielded single-conductor wire in all units is Belden type 8411 (about 15 ft. required).

In the playing consoles, Fig. 5, the 884 oscillator tube is a type used in oscilloscope sweep circuits, with the variable timing resistance used for the main pitch control, and the grid bias for tuning. The use of a 1-meg. logarithmic potentiometer (R5) in series with the 10,000-ohm fixed resistor (R6) for each frequency control provides a relationship between shaft angle and musical pitch which is linear over a resistance range of 16,000 to 450,000 ohms, with a slope of about 30 degrees per octave. Accordingly, each half tone occupies 2½ degrees and each whole tone 5 degrees. The wobble arm swings over more than 75 degrees, giving the desired 2½ octaves, and is set on its shaft so that the minimum total resistance actually used is 75,000 ohms. The potentiometer should have a molded carbon element so that mechanical wear will not affect the scale calibration. A voltage divider across the 150-volt supply (resistors R3 and R4 in Fig. 5) holds the plate of the thyratron at about 40 volts above cathode potential while the "on" contact is open. The tube does not conduct in this condition because its firing point for normal tuning is designed to be near 80 volts. The effect of this bias is illustrated in Fig. 9. If

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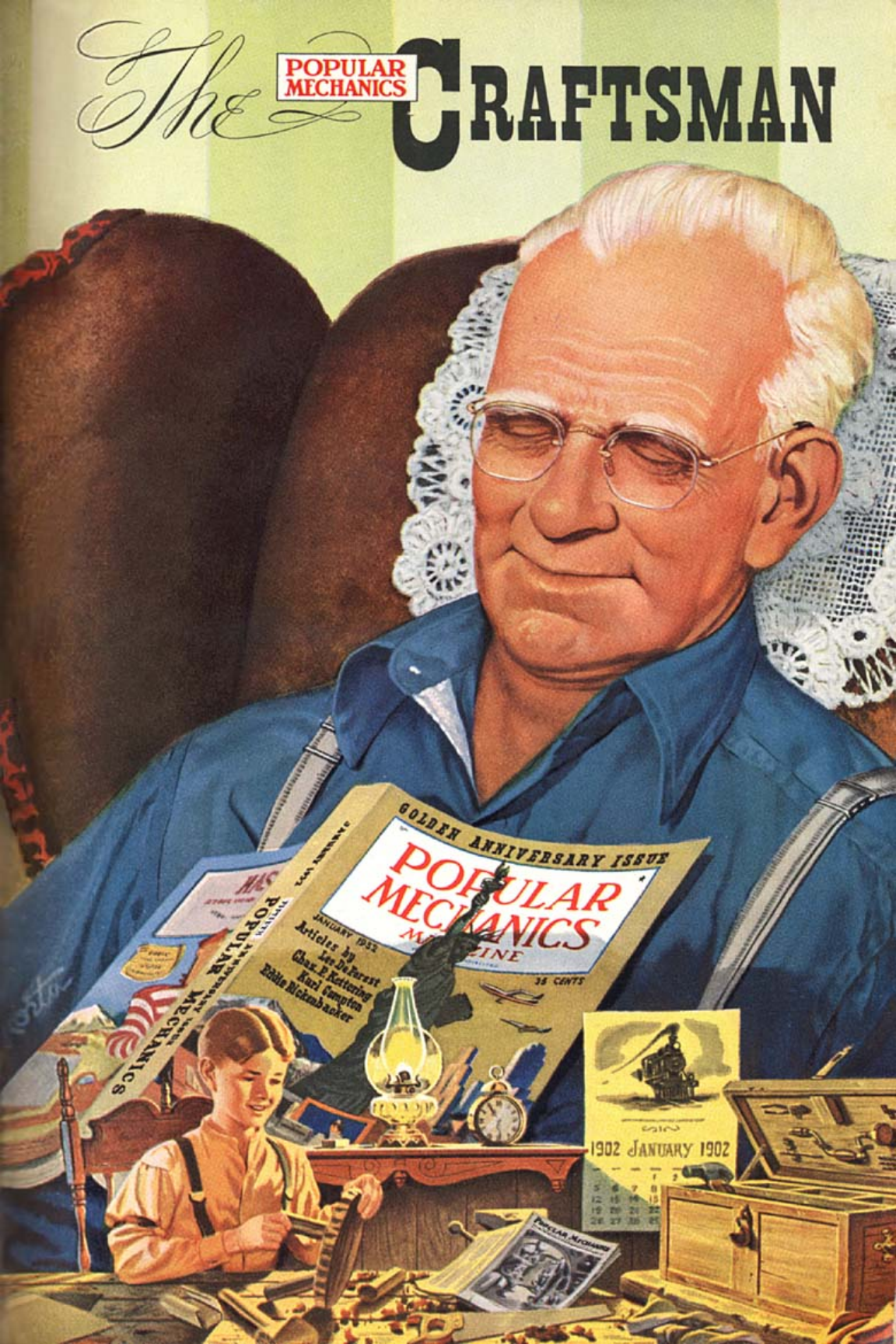
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Tomorrow's Electronic Barbershop Quartet

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not used, there would be a noticeable "thump" at the beginning of each note.

The RCA 884 tube in the console units requires an octal socket. Three Jones connectors, type S-306AB (sockets), and four Jones connector P-306AB (plugs) are required for the playing consoles. Eight six-terminal mounting strips are also needed. One Jones S-306CCT socket is required for the amplifier cable. All other parts are listed above Fig. 9.

Several interesting facts have developed from playing and experimenting on this instrument. First, although steady tones without vibrato are desirable in some kinds of music, a much more "live" effect can be obtained by wobbling the pitch control smoothly through a small range above and below the position of true intonation. This corresponds to the vibrato used in playing a violin or trombone, or occurring naturally in the human voice. This motion, as may be guessed, accounts for the name "wobble organ."

The pitch control, or wobble arm, is operated by the right hand of the player in relation to the musical-scale designations on the sloping "scale quadrant." These designations need be used only as a rough guide, but they are of great value even to an experienced player in making rapid and accurate changes over large musical intervals. Accurate intonation and blending of the four "voices" depend upon the players' musical ear and judgment. Operation of the tone source or oscillator is not continuous; each one can be turned on and off at will by the performer; the instrument is normally silent. Oscillation is started by a slight downward pressure of the player's left hand on the "dynamics" knob shown at the left front of the console, Fig. 1. This pressure closes a contactor (the simple sheet-brass cantilever spring switch, K1) detailed in Fig. 7 thus applying plate voltage to the oscillator. This permits the player to use a *"portamento"* between notes (leaving the tone on) or *"detache"* (momentarily interrupting it), as desired. The volume of the sound delivered by the individual console to the common speaker is also under the control of this knob, which can be turned as well as pressed by the player's left hand. The rotation can be calibrated in musical symbols, *pp, p, mp, f* and *ff*, indicating different degrees of loudness; these are not indicated in Fig. 1. The switch action (K1) is obtained by simply mounting the potentiometer near the free end of the flat cantilever spring, the fixed end of which is screwed to the underside of the console top as indicated in Fig. 7. A downward motion of about 1/32 in. brings the free end into electrical contact with a fixed metal detail that also limits the travel. The tuning adjustment compensates for temperature variations. This tuning knob is readily adjustable by the player's left hand while the corresponding wrist presses down the "dynamics" knob and his right hand aligns the wobble arm with the scale mark (such as "middle C") corresponding to the pitch of the reference source to which he wishes to tune.

(Continued to page 324)

It may be noticed in Fig. 1 that the scale quadrant is calibrated with high notes toward the left and low notes toward the right. This comes about because logarithmic potentiometers having a left-handed taper are not commonly stocked in suitable sizes. Although players quickly become accustomed to this arrangement, it has been found that most of them would prefer to have the scale changed to match the convention of the piano keyboard, and of course this can be done by ordering special left-handed units.

Experience has been obtained both with family groups playing for their own entertainment, and with quartets well rehearsed for public performance. Some solo work has also been done using a single console with piano accompaniment. In every case enjoyment and recreation value have been strikingly evident. Even two professional symphony players who took part in one of the quartets were highly entertained, and incidentally behaved like amateurs in that they played awkwardly at first but improved very rapidly. The music used has varied from simple "rounds" and folk songs to Bach chorales. Although no suggestion is intended that the wobble organ may ever join the ranks of the serious musical instruments, nevertheless it can do things with Bach that are actually rather satisfying. It has a voicelike quality, and yet overcomes certain vocal restrictions. The soprano never has to strain for the high passages, the alto cannot possibly run short of breath, the tenor never cracks and the bass has power at his command for his very lowest note in this electronic barbershop quartet. Volume control R7 in the audio amplifier permits adjusting the instrument for any size room up to a fairly large auditorium.