

Heathkit of the Month #122:
by Bob Eckweiler, AF6C



Miscellaneous:

Heathkit GD-232

Thomas by Heathkit

Transistor Electronic Organ

Dedication:

This HotM is dedicated to the memory of Bob Heil - K9EID, Ham, Audio Engineer and accomplished Organist, who taught so many, so much, about sound.

Introduction:

Heathkit of the Month #106 ¹ discussed the GD-1110 BALLY™ by Heathkit FIREBALL® Pinball Game. It was a product that was available on the market completely assembled. Heathkit licensed the pinball game and turned it into a kit. With the GD-232, Heathkit took a Thomas™ home organ and sold it in kit form. How the actual licensing worked is unknown, but it appears Bally and Thomas also received payment from spare parts and assemblies that Heathkit later sold for these kits. It is the only reason, that comes to mind, why Heathkit used special part numbers, different from Heathkit's normal part numbering system. All but a few parts for the GD-232 start with 247-² and likewise most all the parts for the GD-1110 start with 218-³. Evidently, parts that are in the original product have a special number,

Here is a link to the index of Heathkit of the Month (HotM) articles:

http://www.w6ze.org/Heathkit/Heathkit_Index.html

1. Notes begin on page 11



Figure 1: Thomas by Heathkit GD-232 Organ

and parts that are used only in the Heathkit version continue to carry the Heathkit part number. As an example Heath used IC sockets in GD-1110, but evidently the ICs in the original version are soldered in. Thus Heath used its regular part number (434-xxx) for the various DIP IC sockets they used.

The GD-232 Electronic Organ:

Heathkit introduced the GD-232 Thomas Organ in the Christmas 1962 catalog (80/31). It was originally priced at \$329.95, with the optional bench seat an additional \$24.95. By the time the Summer 1963 catalog was released, the GD-232 was receiving glowing reports from builders. By then its price had increased to \$349.95 (less bench). Available accessories, besides the GDA-232-1 Bench seat, were the GDA-232-2 Self-Teacher Recorded Lessons - \$19.95; The Organ Demonstration Record- "50¢ to cover handling & postage"; and, after the GD-232R was released, the optional GDA-232-4 Variable Repeat Percussion Module (to add the

new GD-232R feature to the GD-232) - \$9.95. (discussed later).

The GD-232, and even the later GD-232R and GD-232A, have the word Transistor in their title, yet each of them are really hybrid, the GD-232 using five vacuum tubes in addition to sixty-five NPN silicon transistors⁴. The 12 tone generator boards and their associated Eccles-Jordan bistable frequency dividers are transistorized as is the Low 'C' divider board. The power supply, vibrato circuit and amplifier that drives the 12" permanent speaker use tubes. **Table I** lists them. Of interest are the amplifier output tubes. Originally the 6BQ5 tube was shown in the specifications, but later the GD-232 and GD-232R are shown using the 6GK6 tube. However, the pinout on the schematic is still for the 6BQ5 tube (See **Table II**).

The GD-232 sold for one year. In the Christmas 1963 catalog (80/41) Heath announced the new GD-232R. The difference between the GD-232 and GD-232R is the addition of a "Variable Repeat Percussion" circuit that produces banjo, marimba, mandolin and balalaika effects.

With the announcement of the new GD-232R, Heathkit offered an upgrade kit for owners of the earlier GD-232 to add "Variable Repeat Percussion". The GDA-232-4 upgrade sold for \$9.95. And, since the new model is capable of new sounds, Heath also offered a new demonstration record, the GDA-232-5 for 50¢ "to cover handling & postage."

All the ads for the GD-232 series feature a 5-year warranty. However, the warranty covers only the dozen plug-in tone generator boards:

The transistorized plug-in tone generator boards, the heart of the organ, are warranted for five years. You buy with confidence when you buy a Heathkit version of the Thomas

GD-232 Organ Tube Lineup

| | | |
|--------|-----------|-----------------------|
| V701 | 6CA4 | Full Wave Rectifier |
| V702A | ½ 12AT7 | Phase Splitter |
| V702B | ½ 12AT7 | Vibrato Oscillator |
| V703A | ½ 12AX7 | First Preamplifier |
| V703B | ½ 12AX7 | Second Preamplifier |
| V704 | 6BQ5/EL84 | ½ Push Pull Amplifier |
| - or - | 6GK6 | |
| V705 | 6BQ5/EL84 | ½ Push Pull Amplifier |
| - or - | 6GK6 | |

TABLE I

Organ. Replacement upon prepaid return of undamaged board to the Heath Company.

When you ordered the GD-232R you received the standard GD-232 Organ kit, and along with it at no extra cost, the GDA-232-4 - Repeat Percussion kit. The first paragraph of the twelve page manual that came with the GDA-232-4 states:

The THOMAS-HEATHKIT Model GDA-232-4 Repeat Percussion kit is an accessory designed for the Model GD-232 Transistor electronic Organ. This Repeat Percussion kit is designed

GD-232 Organ Amplifier Tube Pinout

| PIN# | 6BQ5 | 6GK6 |
|-------------|-------------------|---------------------------------------|
| 1 | I.C. ^A | Cathode |
| 2 | Grid 1 | Grid 1 |
| 3 | Cathode & Grid 3 | Grid 3 ^B & Internal Shield |
| 4 | Filament | Filament |
| 5 | Filament | Filament |
| 6 | I.C. ^A | No Connection |
| 7 | Plate | Plate |
| 8 | I.C. ^A | Grid 2 |
| 9 | Grid 2 | Grid 3 ^B & Internal Shield |

Notes: A Internal Connection (Do not use).
B Pins 3 and 9 internally connected.

TABLE II



America's Lowest Cost, Quality Built, Two-keyboard Organ . . . The Thomas Transistor Organ by Heathkit . . . Praised by All Who Have Seen and Built It!

Seldom has an instrument received such enthusiastic praise and acceptance as the sensational Thomas Transistor Organ by Heathkit! Here are some of the comments we have received from our customers . . . "Tonal quality exceeds our expectations" . . . "Assembly manual is a masterpiece" . . . "Far easier to build than I expected" . . . "Functions perfectly" . . . "A beautiful instrument" . . . "I never thought I would enjoy building a kit as much as this" . . . "Tuning is really simple and accurate!" Savings realized through do-it-yourself assembly makes it possible for you to own a truly outstanding organ at hundreds of dollars less than other comparable organs available today! Assembly is easy . . . everything is furnished, everything is explained. Parts are all genuine Thomas factory-fabricated and the factory assembled cabinet is finished, ready for installation of the various component modules as you complete them. Average assembly time, according to our customers, is 50 to 60 hours . . . many indicated that this was their first experience in kit building.

Incorporating an outstanding array of engineering advances, the Heathkit organ features transistorized plug-in tone generators, voicing circuits and low-frequency dividers for clear, undistorted sound, long life and virtual elimination of service problems. Unique self-cleaning keyboard contacts assure positive contact at all times . . . eliminate key clicks . . . never need adjustment! Other features include 10 true organ voices: Trombone, Reed, Flute, Oboe, Cornet, Violin, Saxophone, Horn, Viola, and Diapason for endless combinations of sound, variable Vibrato to add richness and warmth to music, and Expression Pedal to control volume from soft to full majesty, and 13-note bass pedals usually found only on organs costing hundreds more! Order your Heathkit organ now . . . you'll discover a whole new world of entertainment!

Kit GD-232, Organ, 160 lbs., no money down, \$23 mo. **\$349.95**
GDA-232-1, Matching walnut bench, 16 lbs., no money down, \$5 mo. **\$24.95**
 Export model available for 115-230 VAC, 50-60 cps; write for details.

SELF-TEACHER RECORDED LESSONS—48 STEPS TO FUN!

48 lesson course on four 12" LP records, with music book. Provides a firm basis of music knowledge, not just playing by number or color. 5 lbs.
GDA-232-2, RECORDED LESSONS, List \$50. only **\$19.95**

to be installed in a completely assembled, tuned, and properly operating Organ. After it has been installed, the Organ model number will become GD-232R.

REAL ORGAN FEATURES—Ten true organ voices, variable bass pedal volume, manual balance control, variable vibrato, expression pedal, 13-note heel & toe bass pedals, overhanging 37-note keyboards (range C through C), beautiful hand-rubbed walnut cabinet, compact size (34½" H x 39¼" W x 21¼" D.)

DEMONSTRATION RECORD
 Hear for yourself, the many beautiful voices and range of expression offered by the Heathkit organ. Enclose 50c for handling and postage. GDA-232-3, 7" 33¼ rpm record.

20-WATT PEAK POWER AMPLIFIER
 . . . Specially designed to deliver full frequency response and excellent tone quality.

3

Figure 2A: GD-232 Listing from the Summer 1963 catalog includes a few reviews by satisfied customers. (First of two columns)

Figure 2B: Second column shows the tube amplifier which is located on the floor of the organ cabinet, as well as the available vinyl demo record.

In the February 1964 issue of *Popular Electronics* Heath had an ad for the GD-232A which incorporated the GD-232 and GDA-232-4 into a single kit with a single updated manual, functionally identical to, and replacing, the GD-232R.

The last revision, the GD-232B, appeared in early 1965. In the March catalog it was selling for \$349.95. On the same page was a notice:

Attention Heathkit Organ Owners . . . Last chance to add Variable Repeat Percussion to your Heathkit Organ with this easy-to-install Kit. GDA-232-4, 5 lbs..... Only \$9.95

With the B version, the organ finally became fully transistorized. In place of the five tubes are two additional rectifier diodes and seven additional transistors. Also, the audio power out increased substantially from 10 watts music power output (20 watts peak power) to 37-½ watts music power output (75 watts peak power).

The organ cabinet has a “genuine walnut finish, with solid hardwood at all points which require extra strength and rigidity”.

Features of the GD-232:

The GD-232 features two keyboards, each with 37 keys. The upper keyboard is called the “Swell Manual” and the lower keyboard is called the “Great Manual”. Both keyboards cover three octaves plus an additional ♯C note⁵ (from ♯C2 through ♯C5, where ♯C3 is middle ♯C). It also features 13 foot pedals that cover one octave from ♯C1 through ♯C2. Actual frequencies are given in **Table III**, along with their associated keyboard or pedal.

On either side of each keyboard is a cheek-block. The left-hand cheek-block of both manuals contain a series of controls in a row. **Table IV** lists the controls. The tab switches

| NOTE FREQUENCIES | | | | |
|-------------------------|------------------|---------------------|---------------------|------------------------|
| Musical Note ♯ | Freq. Hz. | Swell Manual | Great Manual | Diapason Pedals |
| ♯C1 | 65.406 | - | - | X |
| ♯C#1 | 69.296 | - | - | X |
| ♯D1 | 73.416 | - | - | X |
| ♯D#1 | 77.782 | - | - | X |
| ♯E1 | 82.407 | - | - | X |
| ♯F1 | 87.307 | - | - | X |
| ♯F#1 | 92.499 | - | - | X |
| ♯G1 | 97.999 | - | - | X |
| ♯A1 | 110.00 | - | - | X |
| ♯A#1 | 116.54 | - | - | X |
| ♯B1 | 123.47 | - | - | X |
| ♯C2 | 130.81 | X | X | X |
| ♯C#2 | 138.59 | X | X | - |
| ♯D2 | 146.83 | X | X | - |
| ♯D#2 | 155.86 | X | X | - |
| ♯E2 | 164.81 | X | X | - |
| ♯F2 | 174.61 | X | X | - |
| ♯F#2 | 184.99 | X | X | - |
| ♯G2 | 195.99 | X | X | - |
| ♯G#2 | 207.65 | X | X | - |
| ♯A2 | 220.00 | X | X | - |
| ♯A#2 | 233.08 | X | X | - |
| ♯B2 | 246.94 | X | X | - |
| ♯C3 | 261.62 | X | X | - |
| ♯C#3 | 277.18 | X | X | - |
| ♯D3 | 293.66 | X | X | - |
| ♯D#3 | 311.12 | X | X | - |
| ♯E3 | 329.62 | X | X | - |
| ♯F3 | 349.22 | X | X | - |
| ♯F#3 | 369.99 | X | X | - |
| ♯G3 | 391.99 | X | X | - |
| ♯G#3 | 415.30 | X | X | - |
| ♯A3 | 440.00 | X | X | - |
| ♯A#3 | 466.16 | X | X | - |
| ♯B3 | 493.88 | X | X | - |
| ♯C4 | 523.25 | X | X | - |
| ♯C#4 | 554.36 | X | X | - |
| ♯D4 | 587.32 | X | X | - |
| ♯D#4 | 622.25 | X | X | - |
| ♯E4 | 659.25 | X | X | - |
| ♯F4 | 693.45 | X | X | - |
| ♯F#4 | 739.98 | X | X | - |
| ♯G4 | 783.99 | X | X | - |
| ♯G#4 | 830.01 | X | X | - |
| ♯A4 | 880.00 | X | X | - |
| ♯A#4 | 932.32 | X | X | - |
| ♯B4 | 987.76 | X | X | - |
| ♯C5 | 1046.50 | X | X | - |

TABLE III

**Controls on the left Swell Manual
Cheek-Block**

Left to right:

Off - On switch: SPST. Full CCW position of pedal volume control

PEDAL VOLUME Control: 10 KΩ pot.

Pilot Lamp - Jeweled, #53 bulb⁶.

MANUAL BALANCE Control: 50 KΩ pot.

Bank of six tab switches:

Voice: **TROMBONE**

Voice: **REED**

Voice: **FLUTE**

Voice: **OBOE**

Voice: **CORNET**

Voice: **VIOLIN**

**Controls on the left Great Manual
Cheek-Block**

Left to right:

Bank of six tab switches:

Voice: **SAXOPHONE**

Voice: **HORN**

Voice: **VIOLA**

Voice: **DIASAPON**

Vibrato: **VIBRATO FULL** / medium

Vibrato: **VIBRATO ON** / off

Pedal Control at right of Diapason Pedals

Expression Pedal

TABLE IV

select the desired voice or voices, and control the Vibrato. The **PEDAL VOLUME** control controls the volume of the bass pedals. The **MANUAL BALANCE** pot controls the relative volume between the two keyboards. The **EXPRESSION PEDAL** controls the overall volume of the organ.

GD-232 Organ Assembly:

Assembly time reported by builders was on the order of 50 to 60 hours. Or a “20 Evening kit”. To aid assembly Heath supplied some special tools with the kit:

490-71 Coil alignment tool.

490-2 Phillips screwdriver.

490-57 Nut driver set: with 3/16” 1/4” 5/16” & 11/32” sockets

490-56 Keyboard alignment tool.

453-66 ¼” shaft. (Switch assembly aid).

Assembly is done in this order:

Pedals: Diapason, and expression pedals.

Amplifier, power supply and vibrato chassis.

Circuit Boards:

Distribution Circuit Board.

Low ‘C’ Divider Circuit Board.

Tone Generator Circuit Boards (11 ea.)

(The 12th tone board comes factory wired and aligned and is used for calibrating the other eleven).

Keyboards: Great Manual then Swell Manual.

Voice Switches: cheek-block controls.

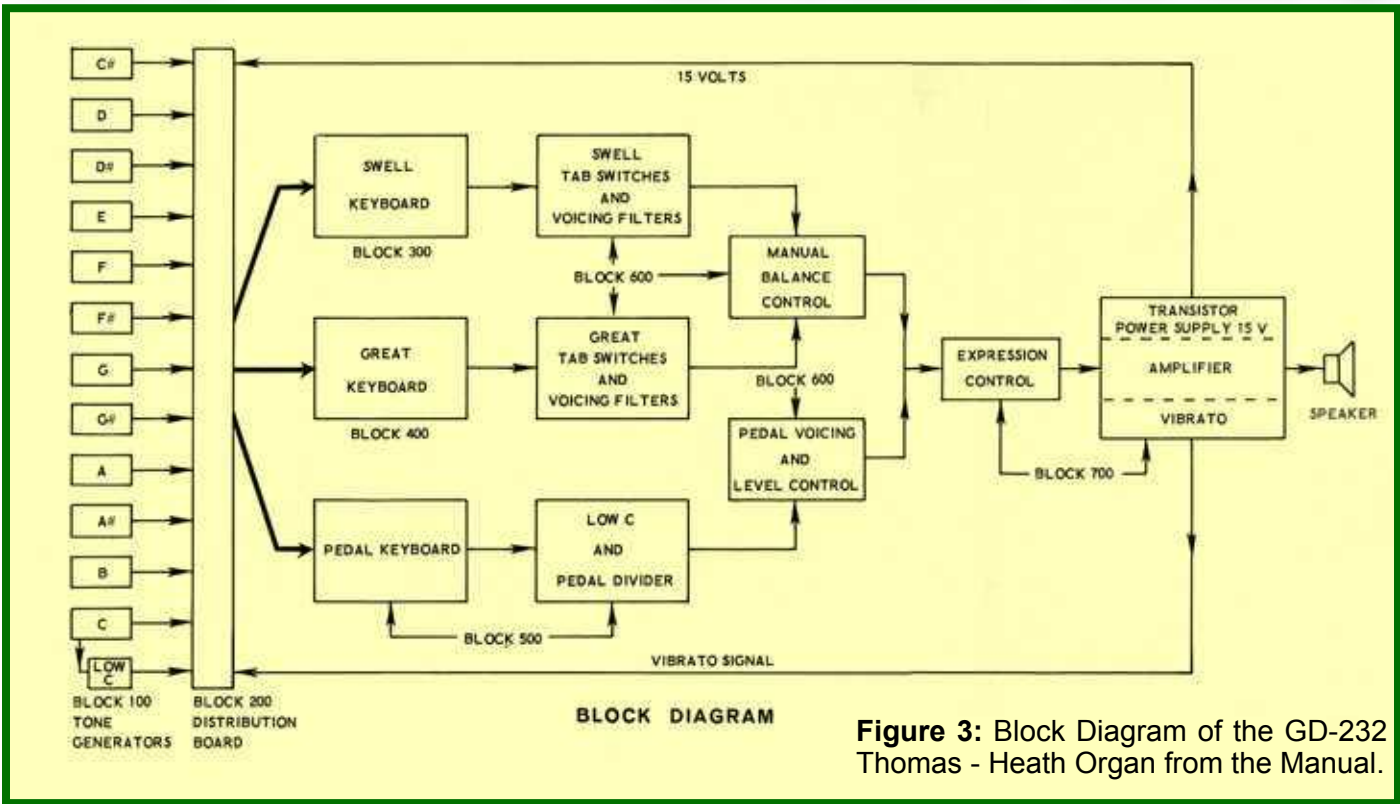
Initial Test and Adjustment.

Final Assembly.

Interestingly, though the organ has 100 switches, only one comes assembled! That is the SPST power switch on the pedal volume control. All the others are assembled as part of the kit. Alignment of the keyboards might have been a torturous job except for the alignment tool and numerous templates that are supplied with the kit, and support from many illustrations and pages of instructions. While not mentioned in the manual, it would be a good idea to have a second person available as the organ must be positioned differently for some steps, and the completed organ weighs 117 lbs. (Shipping weight is 78 lbs for the electronic package and 83 lbs for the Cabinet. (100 lbs. when ordered with the optional bench.)

GD-232 Organ Circuit Overview:

The circuitry of the GD-323 is too involved for a full explanation. So this will be kept brief. **Figure 3** shows the block diagram of the original GD-232. The specification sheet with a schematic is available online for the GD-232⁷, the GD-232R⁸, and the GD-232B⁹. No specification sheet nor schematic has been found for the GD-232A.



Tone Oscillator Circuit Boards:

The organ contains 12 tone oscillator boards, for tones from ♯C#4 to ♯C5 (Bold in **Table IV**). The ♯C5 tone board is factory assembled and aligned. Don't touch its adjustment as it will be used to calibrate the remaining eleven tone oscillator boards. All the other tones are sub-harmonics of these 12 tones. The tone oscillator boards are all identical except for the value of three capacitors, C101, C102 and C103. **Table V** gives their values. The tone board schematic is shown in **Figure 4**. Each board has three sections, an oscillator and two identical Eccles-Jordan bistable divide-by-two frequency dividers. TR101 is wired as a simple Harley oscillator, its frequency determined by the inductor and the three capacitors mentioned above. Though not shown on the schematic, the inductor is adjustable with a ferrite slug. The output of the oscillator is fed to the board's connector as well as to the first frequency divider. Each frequency divider uses two transistors. They are wired

so when one is on the other is off. The transistors flip states with each fast negative going trigger from the previous stage, as shown on the waveform photos below the schematic. The output of the first frequency divider is half the oscillator frequency and is fed to the

Capacitor Values For Tone Boards

| <u>Musical Tone</u> | <u>Freq. Hz</u> | <u>C101 μFD</u> | <u>C102 μFD</u> | <u>C103 μFD</u> |
|---------------------|-----------------|-----------------|-----------------|-----------------|
| ♯C#4 | 554.36 | 0.180 | 0.082 | 0.180 |
| ♯D4 | 587.32 | 0.180 | 0.082 | 0.180 |
| ♯D#4 | 622.25 | 0.180 | 0.082 | 0.180 |
| ♯E4 | 659.25 | 0.120 | 0.053 | 0.120 |
| ♯F4 | 693.45 | 0.120 | 0.053 | 0.120 |
| ♯F#4 | 739.98 | 0.120 | 0.053 | 0.120 |
| ♯G4 | 783.99 | 0.091 | 0.043 | 0.091 |
| ♯G#4 | 830.01 | 0.091 | 0.043 | 0.091 |
| ♯A4 | 880.00 | 0.091 | 0.043 | 0.091 |
| ♯A#4 | 932.32 | 0.068 | 0.033 | 0.068 |
| ♯B4 | 987.76 | 0.068 | 0.033 | 0.068 |
| ♯C5 | 1046.50 | 0.068 | 0.033 | 0.068 |

TABLE V

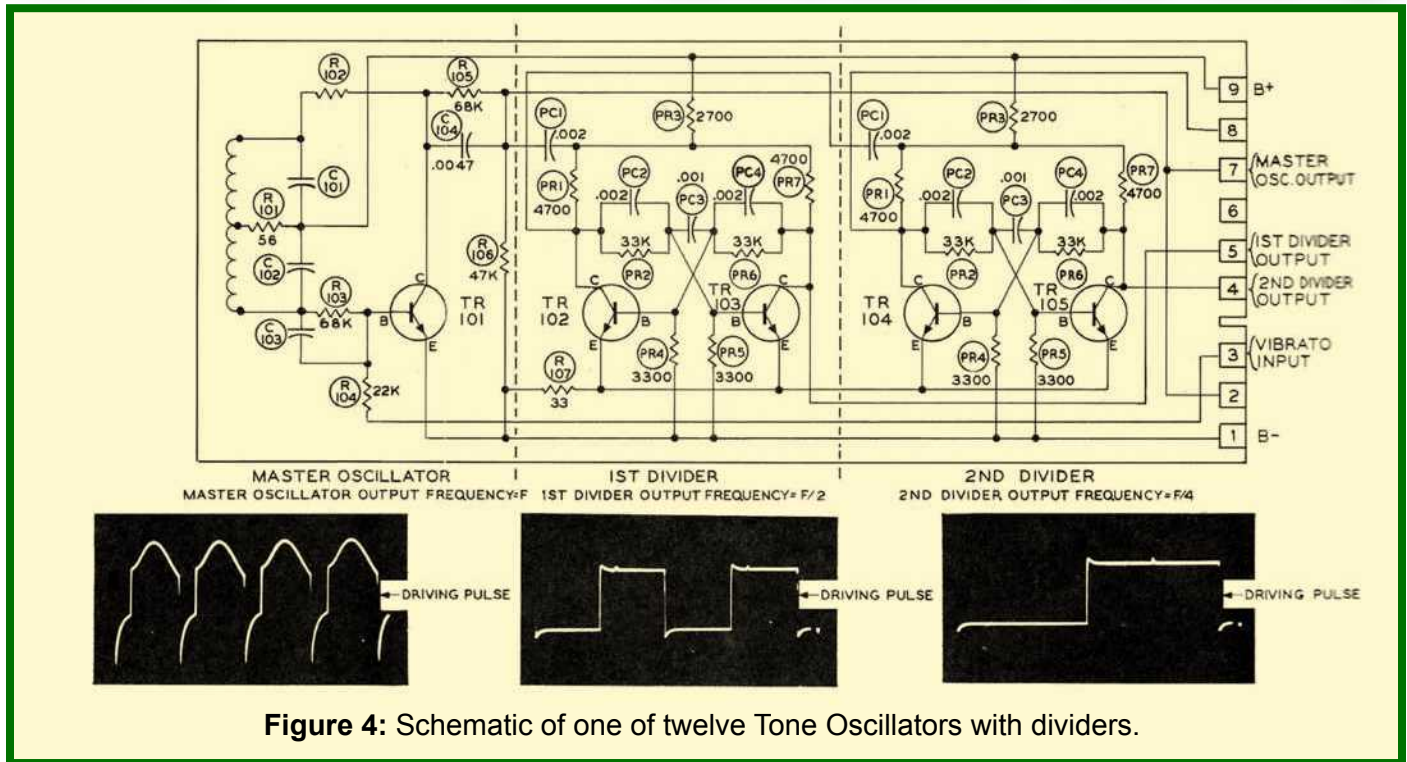


Figure 4: Schematic of one of twelve Tone Oscillators with dividers.

board's connector as well as to the second frequency divider. The second frequency divider is identical to the first, and its output, a fourth of the oscillator's frequency, is also fed to the board's connector. Thus, for example, the ♩C tone board produces three octaves; ♩C5 , ♩C4 and ♩C3 . Tones ♩C2 through ♩C1 are developed later in the low ♩C divider board.

Except for R107, which should be shown in the oscillator section, all the components, except the transistors, for the two dividers are located in a packaged electronic circuit (P.E.C.) See Figure 5.

Distribution Board and Keyboards:

The distribution board is a long board with mating connectors where the 12 tone boards plug in. It distributes B+ and B- power and the vibrato signals to the tone boards. It also accepts the oscillator (Osc) and frequency divided signals (F/2) and (F/4) from each of the tone boards.

While the Osc signal is rich in both odd and even harmonics, the outputs from the frequency dividers, being a square wave, only contains odd harmonics. On the distribution board the Osc signal is combined in a resistive 'Y' network with F/2, that results in F/2 becoming rich in both odd and even harmonics. In a similar network F/2 and F/4 are combined, resulting in F/4 also becoming rich in both harmonics. These resistive networks are

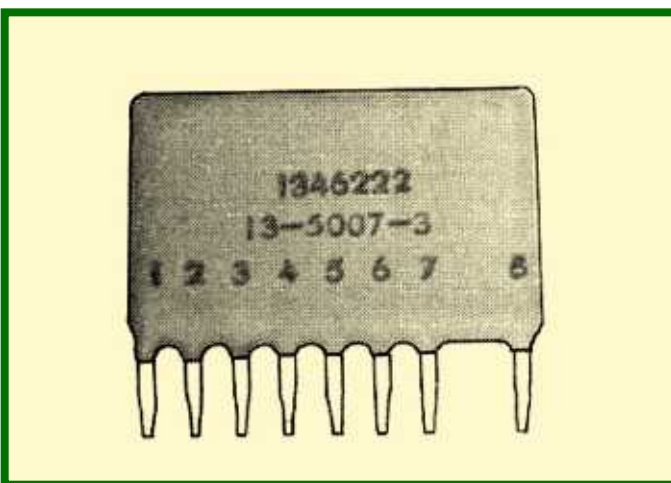


Figure 5: This Packaged Electronic Circuit (P.E.C.) Thomas Part # 13-5007-3 contains 7 resistors and 4 capacitors. (Heath Part #: 247-12).

contained in 12 P.E.C.s mounted on the distribution board, each containing 9 resistors.

All the tones required for both keyboards are available from the tone cards except for $\text{J}C2$. The distribution board sends $\text{J}C3$ to the Low C and Pedal Divider circuit board where it is divided by two, its harmonics enriched and is sent back as $\text{J}C2$ to the distribution board.

Both the swell and great manual keyboards connect to the distribution board through wiring harnesses. Each manual operates independently and when one or more keys are pressed on the manual the resulting tone(s) are combined (not mixed) and sent to that manual's voicing filters.

The pedal keyboard is also connected to the distribution board by a third wiring harness. It operates a bit differently. First, excluding $\text{J}C2$, none of the other tones, $\text{J}B1$ through $\text{J}C1$ are available on the distribution board, so the pedals actually select the second harmonic tones $\text{J}B2$ through $\text{J}C2$. Also the pedals are wired in series so only one tone is output at a time. If more than one pedal is pushed, only the lower tone is output.

Low C and Pedal Divider Board:

As mentioned in the previous section, one function of this board is to create tone $\text{J}C2$ from $\text{J}C3$ and enrich it in harmonics. The second function is to divide the output from the pedal keyboard by two, giving the desired $\text{J}B1$ through $\text{J}C1$ tones. The tone from the pedal keyboard is first amplified to insure proper divider triggering. The dividers are the same as used on the tone boards, including utilizing the same type P.E.C.s, with one exception; the pedal divider adds two capacitors to the divider circuit in parallel with the capacitors within the P.E.C. This is done to enhance the low frequency capability of the divider.

Voicing Filter Circuit Board:

The voicing circuits take the tones rich in harmonics and modify the harmonic content to produce the desired organ voice. This is done with groups of filters. The great manual and swell manual keyboards have separate groups of voice filters.

The pedal keyboard has a fixed voice set by a two-pole low-pass filter, which is located on the Pedal Divider Board. After the filter the signal is sent to the PEDAL VOLUME control.

One voice of the swell keyboard, the FLUTE voice is basically harmonic free. In order to remove harmonics, the output from the keyboard is split into three groups each an octave or so wide. It does this by using three separate bus bars over the 37 keyboard range. The groups are each filtered and then combined for the FLUTE voice. The three groups are also combined through a resistor network to provide a single signal which is then fed to the remaining swell voice filters. Rocker switches on the left swell manual cheek-block select which voicing filter or filters will be used.

The great keyboard does not have the FLUTE problem so all three octaves use the same keyboard bus bar. the signal is sent to the input of each voicing circuit. Each output can be selected by the tab switches on the left great manual cheek-block.

The outputs from the swell and great voicing filters are fed to opposite ends of the MANUAL BALANCE control. The center of that control is combined with the output from the PEDAL VOLUME control and the combined signal is sent to the amplifier.

Amplifier Chassis:

The amplifier has four sections, a +305 VDC power supply for the amplifier, a +15 / -13 VDC power supply for the transistor circuit-

ry and amplifier bias, the amplifier itself and a vibrato oscillator. A 12-pin Molex socket (S701) connects the amplifier chassis to the rest of the organ. **Table VI** lists the connections for this socket. A second, 5-pin, socket S702 named **TONE CABINET SOCKET** on the schematic is located on the amplifier chassis. No reference to this socket could be found in the manual. It is evidently for an unknown accessory. The S702 socket connections are also shown in **Table VI**.

The amplifier power supply uses a transformer with three secondary windings. A 6.3 volt winding provides filament current for the five vacuum tubes and pilot light. The HV winding produces 500 VAC center-tapped (CT). Output, after the 6CA7 rectifier and a filter capacitor, is about 305 VDC. The third winding is 43 volts CT and produces +15 VDC, available at pin 2 of S701 for the transistorized circuitry. It also produces -13 VDC for grid bias for the amplifier output tubes. The AC line-cord for the organ goes directly to the Amplifier chassis.

The amplifier section is made up of two stages of pre-amplification using a 12AX7 dual triode, followed by a phase splitter using one-half of a 12AT7. The phases are sent to a push-pull amplifier using two 6BQ5 or 6GK6 tubes. To improve linearity, negative feedback is applied from the secondary of the output transformer to the cathode of the second preamplifier section. Output is also sent to the speaker via pin 9 of S701. Pin 2 of S701 is the ground return for the speaker.

The remaining section of the 12AT7 is the vibrato oscillator. It is a phase shift oscillator that produces a signal at about 6 cps. This signal is output on pin 4 of S107. When the VIBRATO ON tab switch is depressed, the vibrato signal is fed to each of the tone oscilla-

Amplifier Socket S701 Pin-Out

| <u>PIN #</u> | <u>Purpose</u> |
|--------------|--|
| 1 | Start-up Pulse to tone boards |
| 2 | +15 VDC Power |
| 3 | 6.3 VAC to pilot light terminal 1 |
| 4 | Vibrato Oscillator Signal to tone boards |
| 5 | To terminal 1 of Power Switch |
| 6 | Chassis Ground |
| 7 | Audio to optional Tone cabinet |
| 8 | 6.3 VAC to pilot light terminal 2 |
| 9 | 8 Ω Audio Out to Speaker |
| 10 | To terminal 2 of Power Switch |
| 11 | Speaker Return (Chassis Ground) |
| 12 | Unused |

Note: Pin 7 and 9 are jumpers in mating P701

Amplifier Socket S702 Pin-Out

| <u>PIN #</u> | <u>Purpose</u> |
|--------------|--|
| 1 | 8 Ω Audio Out and Pin 9 of S701 |
| 2 | 115 VAC power (hot) |
| 3 | Chassis Ground |
| 4 | 115 VAC power (neutral) |
| 5 | 8 Ω Audio Out to Speaker and pin 7 of S701 |

TABLE VI

tors changing the bias, and causing the frequency to change slightly at 6 cps with the vibrato signal. When the VIBRATO FULL tab switch is depressed, the full vibrato voltage is applied to the tone boards; otherwise the vibrato signal is attenuated by passing through a 6.8 KΩ resistor (R641).

As part of the vibrato circuit, a pulse is sent out when the organ is powered on. This pulse appears on pin 1 of S701 and is fed via the vibrato bus to each of the tone oscillators to insure all oscillators startup.

GD-232 Organ Tuning:

Tuning is done in two steps. First a rough tuning sets the tones close, followed by a fine tuning. Both tuning procedures use the principle of the “beat note”. this is a note that is created when two tones are nearly the same

frequency. If they are off by three cps from each other, three beat notes will be heard per second.

Rough Tuning:

The $\text{J}C$ tone board came factory built and tuned, and is used to tune the other oscillators. To do the rough calibration you need to set the **MANUAL BALANCE** fully CW; turn the organ on using the **PEDAL VOLUME** control; set only the **FLUTE** tab switch and set the **EXPRESSION PEDAL** at about $\frac{1}{3}$ of its travel.

Use the lower octave keys of the swell manual for the following steps.

Press the $\text{J}C3$ key then release it and press the $\text{J}B2$ key. If it sounds lower in pitch than the $\text{J}C3$ key turn the adjustment on the $\text{J}B$ tone generator board coil CCW; if it is higher in pitch turn it CW.

Continue alternating keys and adjusting the $\text{J}B$ coil until they sound nearly same. Now press down both the $\text{J}C3$ and $\text{J}B2$ keys. You should hear a beat note. Adjust the $\text{J}B2$ coil for zero beat. Then turn the $\text{J}B2$ coil adjustment $1\text{-}\frac{3}{4}$ turns CW.

Repeat this procedure using the $\text{J}B2$ and $\text{J}A\#2$ keys, except adjust the $\text{J}A\#$ coil and, after zero-beat is achieved, turn the $\text{J}A\#$ coil $2\frac{1}{4}$ turns.

Continue this procedure using the Rough Tuning Chart - **Table VII**,

This completes the rough tuning. In some cases this will tune the organ close enough that only a trained ear can detect any mis-tuning.

Fine Tuning:

For fine tuning use the **TROMBONE** voice instead of the **FLUTE** voice; continue using the swell manual. Referring to **Table VIII** hold down the two keys listed in the first column. If the rough tuning was done correctly, you

| ZERO BEAT | THEN ADJUST GENERATOR COIL CLOCKWISE |
|--------------------------------------|--------------------------------------|
| 1. $\text{J}B2$ with $\text{J}C3$ | B 1-3/4 turns |
| 2. $\text{J}A\#2$ with $\text{J}B2$ | A# 2-1/4 turns |
| 3. $\text{J}A2$ with $\text{J}A\#2$ | A 1-3/4 turns |
| 4. $\text{J}G\#2$ with $\text{J}A2$ | G# 2 turns |
| 5. $\text{J}G2$ with $\text{J}G\#2$ | G 2-1/4 turns |
| 6. $\text{J}F\#2$ with $\text{J}G2$ | F# 1-3/4 turns |
| 7. $\text{J}F2$ with $\text{J}F\#2$ | F 2 turns |
| 8. $\text{J}E2$ with $\text{J}F2$ | E 2-1/4 turns |
| 9. $\text{J}D\#2$ with $\text{J}E2$ | D# 1-3/4 turns |
| 10. $\text{J}D2$ with $\text{J}D\#2$ | D 2 turns |
| 11. $\text{J}C\#2$ with $\text{J}D2$ | C# 2-1/4 turns |

ROUGH TUNING CHART - TABLE VII

| PLAY NOTES | Coil Turn CW | Beats in 10 Sec. | Beats in 30 Sec. |
|---------------------------------------|--------------|------------------|------------------|
| 1. $\text{J}C3$ and $\text{J}G3$ | G | 9 | 26 |
| 2. $\text{J}G2$ and $\text{J}D3$ | D | 7 | 20 |
| 3. $\text{J}D3$ and $\text{J}A3$ | A | 10 | 29 |
| 4. $\text{J}A2$ and $\text{J}E3$ | E | 7 | 23 |
| 5. $\text{J}E3$ and $\text{J}B3$ | B | 11 | 33 |
| 6. $\text{J}B2$ and $\text{J}F\#3$ | F# | 8 | 25 |
| 7. $\text{J}F\#2$ and $\text{J}C\#3$ | C# | 6 | 18 |
| 8. $\text{J}C\#3$ and $\text{J}G\#3$ | G# | 10 | 28 |
| 9. $\text{J}G\#2$ and $\text{J}D\#3$ | D# | 7 | 21 |
| 10. $\text{J}D\#3$ and $\text{J}A\#3$ | A# | 11 | 31 |
| 11. $\text{J}A\#2$ and $\text{J}F3$ | F | 8 | 24 |
| 12. $\text{J}F2$ and $\text{J}C3$ | Check Only | $6\pm 3^*$ | $18\pm 3^*$ |

* See Text

FINE TUNING CHART - TABLE VIII

should hear a beat note. Slowly adjust the coil referenced in the second column until the beat count each ten seconds equals the number in the third column. If desired, you can further refine the tuning by further adjusting the designated coil until the beat count each thirty seconds equals the number in the fourth column. Continue this process for each of the 11 tone coils. When completed, check the tuning by holding down the ♯F2 and ♯C3 and counting the beat notes. If you only made the adjustment using column 3 and, you count between 3 and 9 beats, tuning is acceptable, if you opted to use the fourth column and you are within ± 3 of 18 beats you are well tuned and if the beats are right on you are in perfect tune. Should the count be outside the ± 3 beats you should run through the final tuning process from the beginning one more time.

Final Assembly:

With the organ tuned, all that is needed is to secure the swell manual frame to the assembly tray with two $\frac{1}{4}$ " x 4" bolts, install top cover to the cabinet that was removed during assembly, slide the music rack into its two mounting holes and install the back panel, after dressing the line-cord through the proper hole. If you're a skilled musician enjoy your playing. If you're just learning, keep the volume down or your family and neighbors may complain!

Comments:

I have to confess that its been over 60 years since I last played a piano. I was not really good even then. I learned a lot writing this article, exploring organs on the Internet and reading the GD-232 manual almost from cover to cover.

I'd like to thank Chuck Penson - WA7ZZE for his help researching his extensive library of catalogs to fill in dates and model numbers. Without his input I would not have learned

about the GD-232R. Chuck also provided me with the spec sheets which I scanned (see notes 7, 8 & 9 below), as well as the GD-232 assembly manual.

73, from AF6C



Notes:

- https://www.w6ze.org/Heathkit/Heathkit_106%20GD1110.pdf.
- From the numerical index in Heathkit's Parts MasterFile:
218 --- BALLY PARTS PINBALL
247 --- SET OF PARTS - THOMAS ORGAN
- See Note 2 above.
- Three different transistors are used in the GD-232. Part #s; 247-254 (1); 247-256 (12); and 247-257 (52). There is no identification given to these transistors except orange, violet and blue dots respectively.
- Notes are designated with a leading ♯ so they won't be confused with a component designator. After the ♯ is the note (A to G#) followed by (when necessary) a number that signifies the octave. ♯C3 is middle ♯C
- If the GD-232-4 Repeat Percussion kit is installed, the pilot light is replaced with the **REPEAT RATE** control.
- The specification sheet with full schematic for the GD-232 is available online at:
[https://www.w6ze.org/Heathkit/HeathSpecSheets/MUS/GD-232%20\[596-652\]%206-14-63.pdf](https://www.w6ze.org/Heathkit/HeathSpecSheets/MUS/GD-232%20[596-652]%206-14-63.pdf)
- The specification sheet with full schematic for the GD-232R is available online at:
[https://www.w6ze.org/Heathkit/HeathSpecSheets/MUS/GD-232R%20\[696-652\]%2010-4-63.pdf](https://www.w6ze.org/Heathkit/HeathSpecSheets/MUS/GD-232R%20[696-652]%2010-4-63.pdf)
- The specification sheet with full schematic for the GD-232B is available online at:
[https://www.w6ze.org/Heathkit/HeathSpecSheets/MUS/GD-232B%20\[596-722\]%204-9-65.pdf](https://www.w6ze.org/Heathkit/HeathSpecSheets/MUS/GD-232B%20[596-722]%204-9-65.pdf)

Heath Logo: An April Fools' tribute to my favorite candy bar.

Remember if you are getting rid of any old Heathkit Manuals or Catalogs, please pass them along to me for my research.

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Thanks - AF6C