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Description: Service Manual

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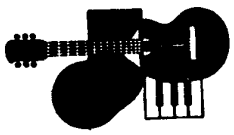
CRUMAR

SERVICE MANUAL
T1 - T2

MUSIC TECHNOLOGY, INCORPORATED



This service manual is valid for both the T1 and T2 for though the two instruments are different, for musical performance the electric wiring is the same.
In effect almost all the T1 plates are also used on the T2 and therefore this service manual is based on the description of these plates.
There are also plates which are used only on the T1 or only on the T2 and these have been dealt with separately.
We may think of the T1 and the T2 as being formed of two assemblies of plates, the first assembly we shall describe makes the FLUTE and PERCUSSION possible and the second the BASS.

FLUTE AND PERCUSSION

With this system (or assembly of plates) we obtain the sound of the FLUTE and PERCUSSION. In particular in the T1 model, the system provides the performance of the keyboard, in the T2 model the same system used in T1 plus the SUSTAIN, provide the performance of the upper manual and a reduced system the lower manual (the system for the T2 lower manual is reduced since this keyboard nas no percussion). This system utilizes an electronic contact board; the basic theoretical electric diagram of this board is shown in Fig. 1.

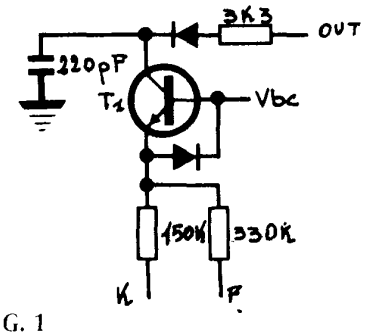


FIG. 1

Two signals are applied through two resistances on the emitter of transistor T1.
The first is a 0 ÷+ 15V amplitude Frequency (F) and the other a key (K) which on rest leaves 150K open (in actual fact at a certain positive voltage) and when working hangs the 150K to a voltage of around − 6.5V.

The OUT point is polarized with a positive voltage of +7.5V. If we now connect Vbc (T1 base control voltage) to the potential of OV (GND) we find that as soon as key K is brought to working position (i.e. about − 6.5V) on the collector of transistor T1, the frequency of point F is seen. In effect, in the conditions which we have just described, T1 has passed to conducting under the action of a key and has therefore carried out the function of electronic switch for a key and for a note.

All that is necessary now to obtain the nine musical feet is to expand this concept vertically nine times using key K as a control and making sure nine different and appropriate frequencies arrive at point F (see Figure 2).

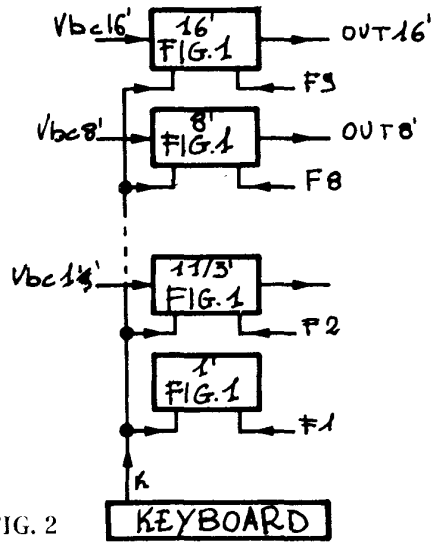


FIG. 2

The electronic contact board used in models T1 and T2 employs this basic concept exactly, the only variation being that point Vbc is not connected permanently to potential OV (GND), but is connected to a variable potential between − 4V and OV so that the amplitude control (volume) of the output signal is directly on the transistor base (see Figure 3).

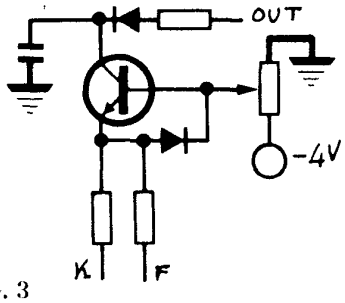


FIG. 3

If we now think of key K being always pressed down (— 6.5V) we can see that on the collector of T1 the amplitude of the signal is always proportionate to Vbc. In particular we will have nil amplitude with VBC at — 4V and maximum amplitude with Vbc at OV. Developing Fig. 2 horizontally (61 times), we have FLUTE and PERCUSSION on nine musical feet (16' - 51/3' - 8' - 4' - 22/3' - 2' - 13/5' - 11/3' - 1') for 61 keys where the volume control of each musical foot is obtained with a voltage varying from — 4V to 0 and where the same filter serves the FLUTE and also the PERCUSSION (i.e. the Vbc is exploited to provide both the FLUTE as well as the PERCUSSION; we will discuss this basic concept in more detail further on).
Particular attention was given (in the practical version we shall be examining) to the reply speed of this system. It is well known that every electronic contact board has problems with transistors designed for connecting and for releasing; these problems are expressed by disturbing clicks when a key is pressed or released. To eliminate this click, the connecting and release fronts must be slowed down, but in this case the problem of a windy sound arises, typical of loose connections, which, though it is definitely less disturbing than the click is still absolutely unacceptable in keyboards such as the T1 and T2. In this electronic contact board system the problem was solved by a signal (PERCUSSION GATE) which blocks the audio path for about 10 m/sec and after the 10 m/sec have elapsed restores the audio path when all the phenomena associated with connecting transistors have ended. The result is a spontaneous sound free of any connecting clicks.

The polarization of the collector of the basic electronic switch module (FIG 1) is effected directly at the filter input stage as can be seen in FIG. 4. The divider 3K3//3K3 supplies the + pin of the operational amplifier a voltage of + 7.5V which trough Rr and Rs is applied to the T1 collector.

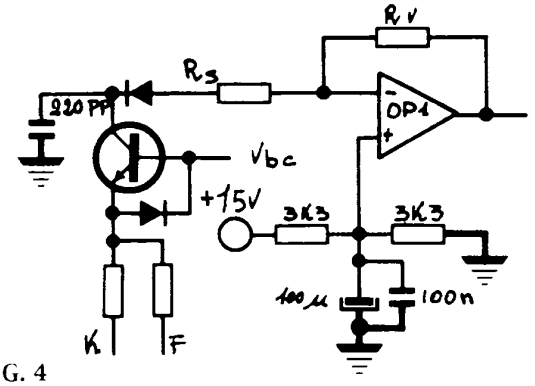
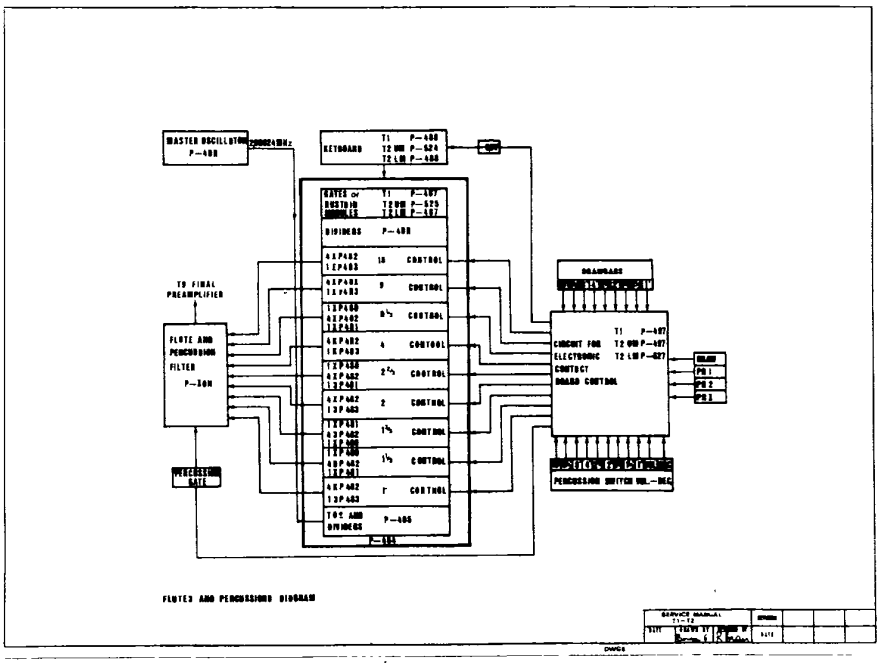


FIG. 4

When K is brought to — 6.5V (key lowered) F is transferred to the output of OP1 which is symmetric with respect to + 7.5V which is the voltage guaranteeing the maximum amplitude of the signal since OP1 is fed between + 15V and GND. The value of Rs and Rr determines the amplification factor of OP1.
Now let us examine the system in practice. We will begin with the block diagram and then go on to examine each plate contained therein.
In the block diagram when the same plate is common for T1 and T2 a single line is shown, but when different plates are involved, the lines for plates T1, T2 UM (Upper manual) and T2 LM (Lower manual) are specified.



MASTER OSCILLATOR DWG 6 - DWG 6 B

The function of this plate is to supply the frequency at 2.00024 MHz to pilot the MOSTEK 50240 octave generator which is situated in plate P 485. The oscillating element is composed of the two sections of 74LS221 connected as shown in the wiring diagram.

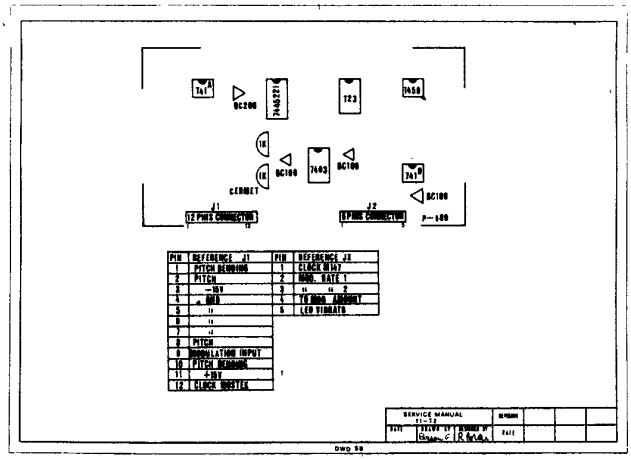
The most important factor that determines the frequency of oscillation, in addition obviously to the RC groups of pins 15 - 14 - 7 - 6, is the voltage of point A which must be about 4V. The value of this voltage is kept stable, through the reaction of the operational amplifier 741, by the 5.6V Zener diode.

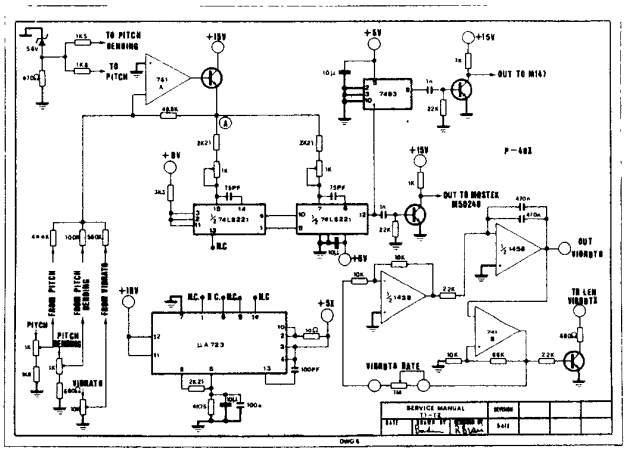
The 2.00024 MHz rating is obtained by setting the CH potentiometer at che center of its course, the PITCH BENDING potentiometer at the center of its course, and the RANGE modulation potentiometer at zero, at the same time operating the two 1K trimmers located at pins 15 and 7 of 74LS221. The setting must be obtained by operating the two trimmers and making sure they are stopped at the end of the setting in the same position so that the duty cycle of 2.00024 MHz is 50%.

The PITCH, PITCH BENDING and MODULATION do not affect the RC time constants but influence the voltage of point A in direct proportion. 723 serves to feed (+5V) TTL.

7493 serves to divide by a factor of 4 the 2.00024 MHz in order to guide M 147 (BASS SECTION) with 500.06 KHz.

The rest of the circuity in this plate (1 x 1458; 1 x 741) serves to obtain the low frequency oscillator for frequency and amplitude modulations.





ELECTRONIC CONTACT BOARD
OCTAVE GENERATOR AND DIVIDERS
KEYBOARD INTERFACING - DWG 7 - DWG 7 B

DWG 7 contains the following plates:

a) **P488 - Mechanical contact board -**
This printed circuit holds the contact springs and is under the keyboard.

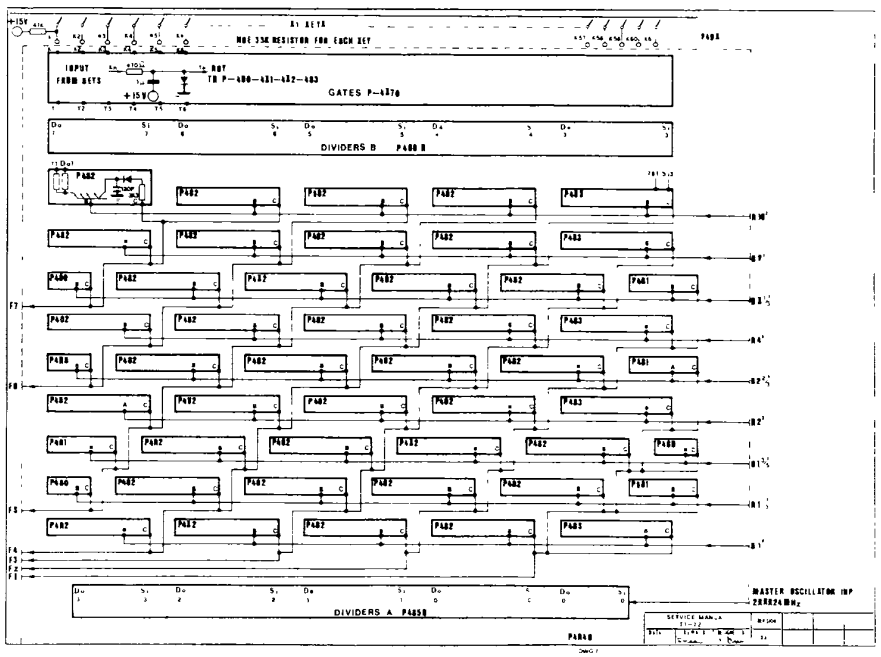
b) **P484 - Connector holder and interconnections**
Through the card to card connectors, this printed circuit supports the plate described below and effects interconnections between the various plates.

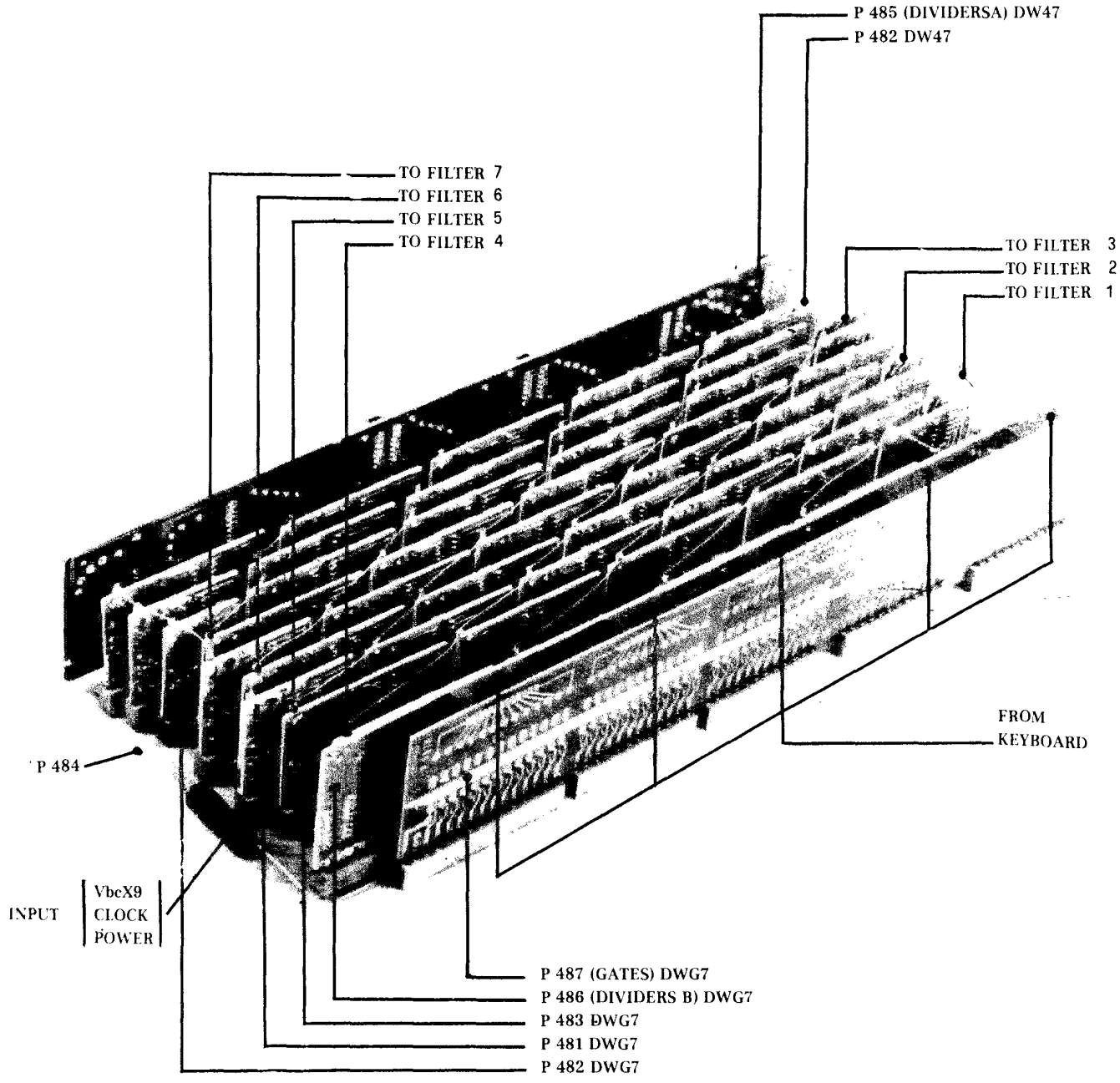
c) **P487 - Gates**
This printed circuit contains the small interface modules of the keyboard. — 6.5V of each key, before reaching the analog switches making up the electronic contact board, pass through this plate.

d) **P485 - Dividers and octave generator**
MOSTEK 50240 is on this printed circuit and, through the HBF 4727's, the first three divisions of the output frequencies of 50240 are completed here.

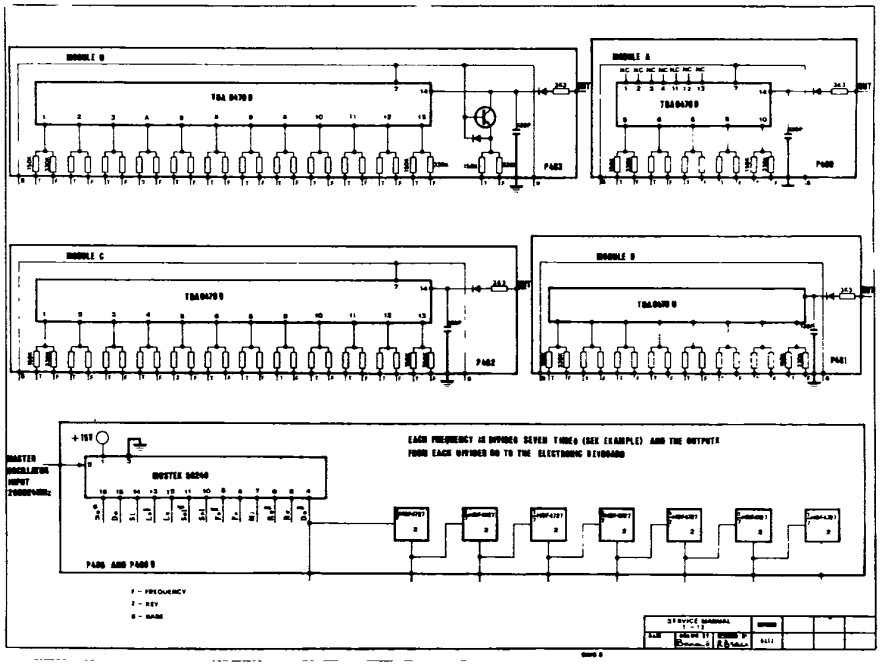
e) **P486 - Dividers**
This printed circuit, through P484, receives the third divisions and completes the subsequent divisions of the out put frequencies of 50240 up to the seventh.

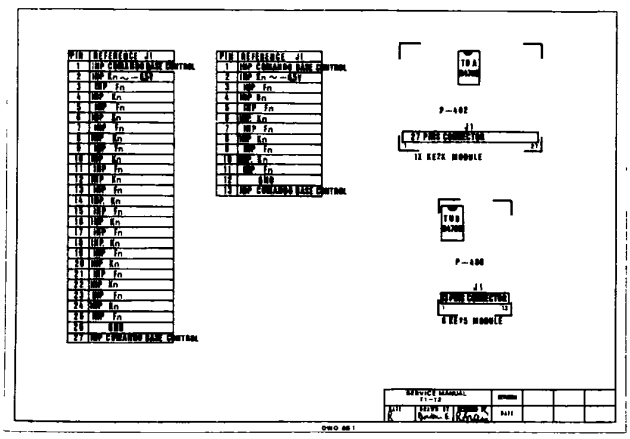
f) **P480 - P481 - P482 - P483**
These printed circuits, by using the 12-channel transistor TDA 0470 D, complete the 549 analog switches necessary for making up the electronic contact board of each T1 and T2 manual. The small module design was used to facilitate the connections necessary for filtrating the output signals per octave.
The number 549 dérives from 61 x 9 = 549 where 61 is the number of keys and 9 the number of musical feet.

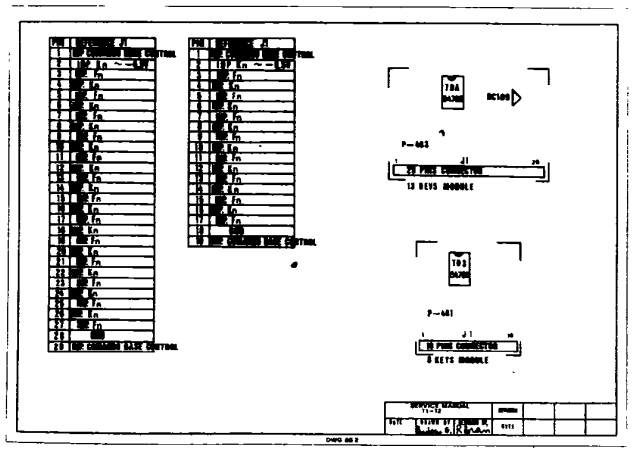



P 485 (DIVIDERSA) DW47
P 482 DW47
TO FILTER 7
TO FILTER 6
TO FILTER 5
TO FILTER 4
TO FILTER 3
TO FILTER 2
TO FILTER 1
FROM KEYBOARD
P 484
INPUT
VbcX9
CLOCK
POWER
P 487 (GATES) DWG7
P 486 (DIVIDERS B) DWG7
P 483 ÐWG7
P 481 DWG7
P 482 DWG7

PLATES CONNECTED ON P 484
DWG 8 - DWG 8 B 1 - 2 - 3 - 4 - 5

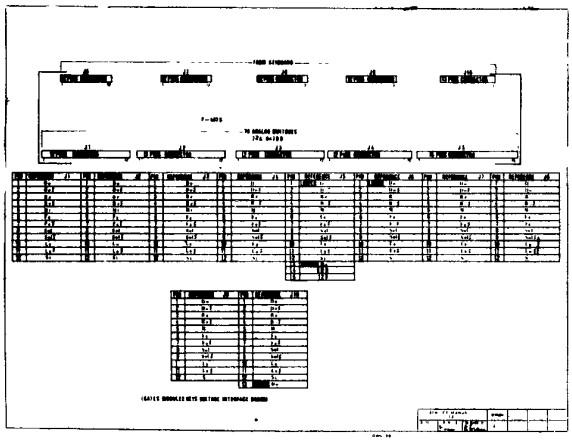






c) P480 - P481 - P482 - P483 - Small modules of the analog switches

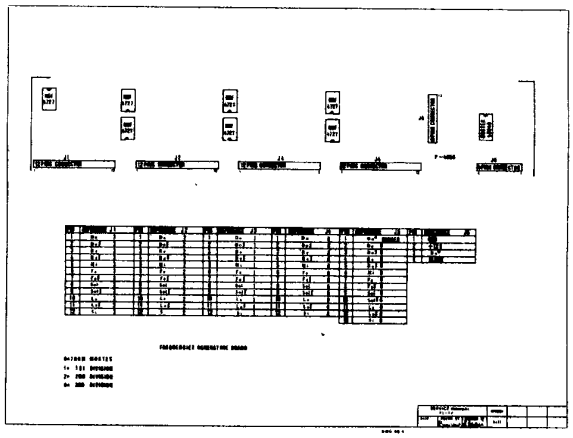
By combining these four small modules in an appropriate manner, the 9 musical feet are set up for filtrating the output frequencies per octave.
The layout is shown in DWG 5, DWG 7 and DWG 7B.
Connection between the various small modules leading to the filters is shown in DWG 7.

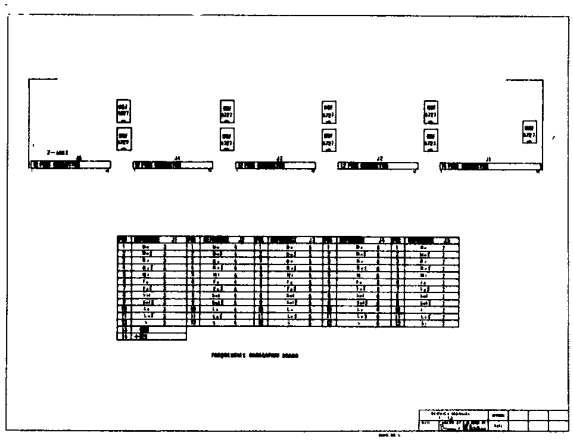


a) P487 - Gates (see DWG 7)

On point Tn, at rest, there is a voltage of about +0.6V because of the +15V - 47K - 470ohm diode path towards earth; this voltage, independently of Vbc (see Fig. 1), keeps all the analogic switches open.

When a key (for example K 1) is pressed at point T1 the voltage of the bar (which is about — 6.5V) is transferred and the analog switches concerning K 1 (which are 9) are closed and the nine relative frequencies pass to output with amplitude proportional to the Vbc. The F 1 - micro capacitor and the 470ohm resistance serve to avoid hearing disturbing connecting and releasing clicks.

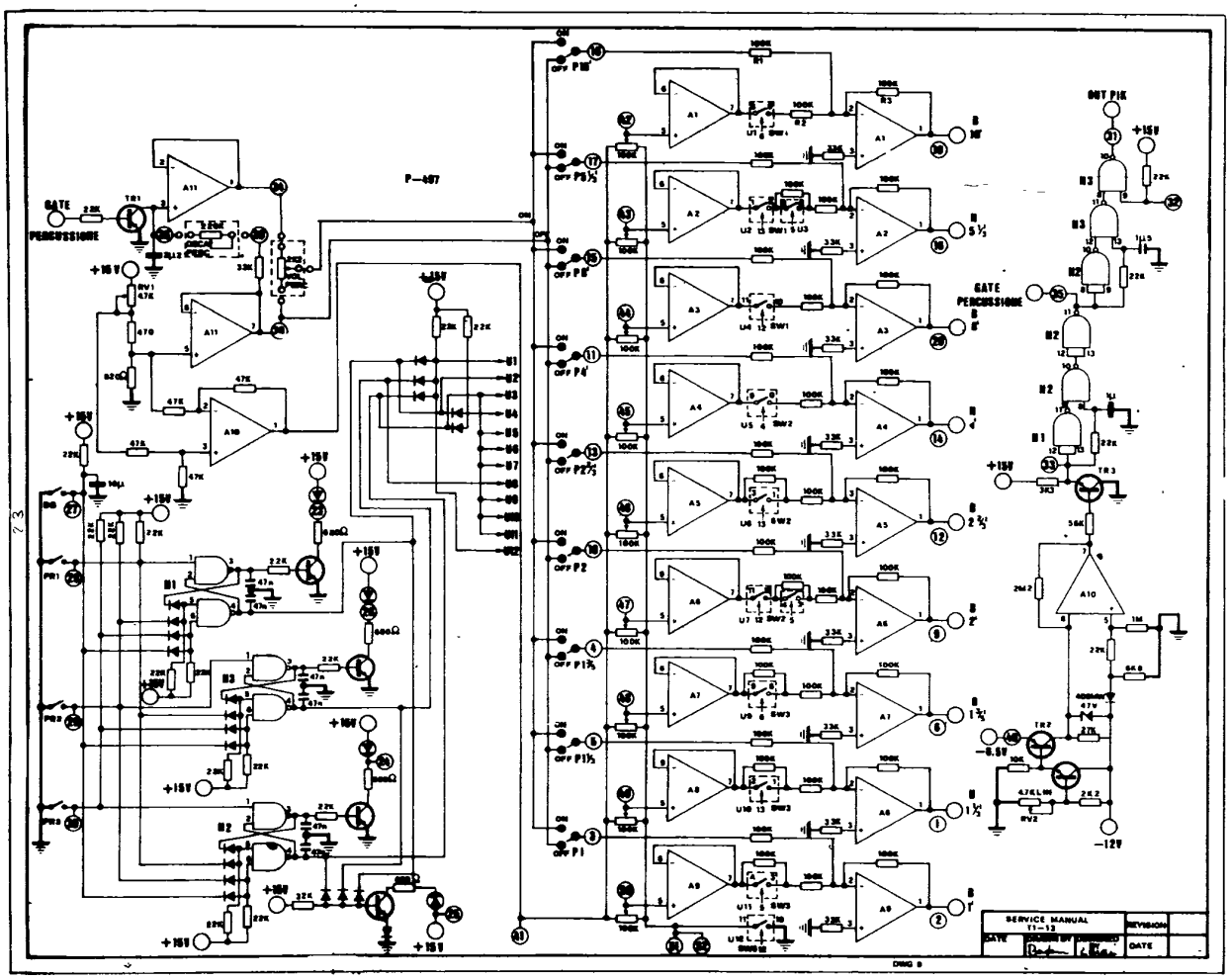


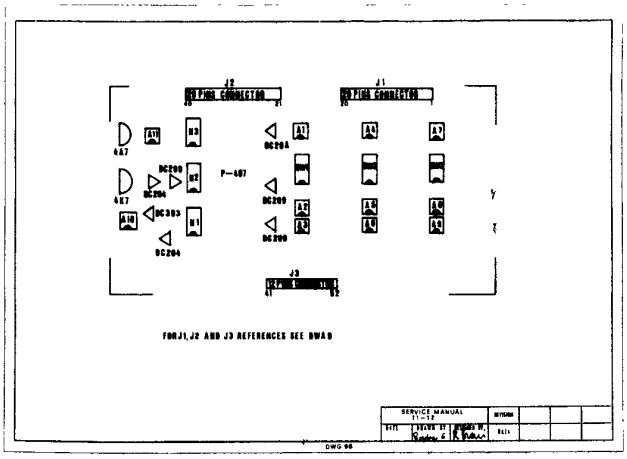


b) P485 - P486 - Dividers and octave generators

These two plates have as input the 2.00024 MHz and as output all the 96 frequencies necessary for completing a 61-key manual set up in 9 different musical feet.

ELECTRONIC CONTACT BOARD CONTROL CIRCUIT - DWG 9 AND DWG 9 B





The functions associated with the electronic contact board which this plate carries out are the following (see DWG 5):

a) To supply, for each musical foot, a voltage control for the TDA0470 D (Vbc) bases. This control (for example the control wire for the 16' which is called B16') provides volume information for the FLUTE voice as well as volume and decay information for the PERCUSSION voice.
b) To supply preset combinations.
c) To supply the negative voltage for the bar (about − 6.5V).
d) To supply the impulse of a pressed key in order to control the percussion envelope and to inhibit the audio path for about 10 m/sec.
e) To supply the impulse for the PIK effects.

We previously mentioned the fact that the base control voltage (see DWG 3) varies from − 4V to 0V. In particular we can add that when the Vbc is at − 4V even if a Kn key is pressed no output signal passes through the corresponding TDA 0470 D path.
One begins to see the output signal as soon as the − 4V Vbc begins to rise towards zero (GND). The closer the Vbc is to zero, the greater the output signal. With this in mind we can go on to observe the resistive divider connected by pin 5 of A11. The RV1 4K7 trimmer must be set to that there is a voltage of about 2.5V at pint 5 of A11. The current which passes on the 820ohm is therefore about 30 mA which means that the voltage drop on 470ohm is about 1.5V.
We observe that since

$$V_{820ohm} + V_{470ohm} = 2.5 + 1.5 = 4V$$

the resistive divider of the RV1 trimmer serves to supply the already mentioned 4V which is the positive Vbc (instead of the negative which we need) and that this voltage is divided into two parts.
With voltage V470ohm (1.5V) we control the flute volume through the drawbars, with voltage V820 ohm (2.5V) we control the percussion volume using the selector keys.
To follow the path of these two voltages, let us assume we are working with the 16' with the preset selector in drawbars.
At pin 1 of A10 we have a voltage equal to +1.5V and this voltage is connected to a lateral of the 16' drawbars; the other lateral through the gate (11 - 10 - 12) of SW3 is connected to GND. The 16' drawbars center (point 42) can therefore give a performance which goes from +1 5V to zero. The voltage which is then found at pin 5 of A1 (+1.5V to 0) we find again at pin 7 of A1, at pin 8 of SW1 and at pin 9 of SW1.
At pin 7 of A11 we have a voltage of +2.5V and this voltage, through the DECAY PERC potentiometer, holds the 2 micro 2 capacitor of pin 3 of A11 at +2.5V. We also find this +2.5V at pin 1 of P 16'. At P 16' foot rest we again find +2.5V through the connection with pin 7 of A11. Therefore, independently of how we find P 16' at point 18, we find +2.5V.
For the (1 - 2 - 3) section of A1, the following relationship applies:

$$V_{pin\ 1} = V_{bc\ 16'} = -R3\left(\frac{VR2}{R2} + \frac{VR1}{R1}\right)$$

REL 1

$$V_{bc\ 16'} = -100K\left(\frac{1,5}{100K} + \frac{2,5}{100K}\right) = -4V$$

In other words in rest conditions the 16' Vbc is at − 4V and therefore the analogic switch is blocked.
By observing FIG 10

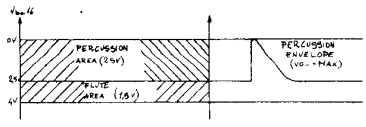


FIG. 10

we can see how from — 4V to — 2.5V there is an area reserved for the drawbars (the volume adjustment limit of which is therefore 1.5V) while from — 2.5V to 0V there is an area reserved for percussion (the adjustment limit of which controlled by the VOL PERC potentiometer is therefore 2.5V).

The percussion envelope starts each time the 2 micro 2 capacitor of pin 3 of A11 is discharged to 0 by transistor TR1 which is closed each time the PERCUSSION GATE is present in the base. To see how the PERCUSSION GATE is generated, let us observe the RV2 4K7 trimmer. This trimmer must be operated so that at point 40 there is a voltage of about — 6.5V which is the supply voltage of the common bar. As soon as a K key is pressed on TR2, a current passes which changes the condition of A10 pin 7 which, from a position of rest at +15V goes to — 15V; under these conditions the TR3 collector goes from +15V to zero and as soon as a key is pressed pins 12 - 13 of N1 feel a negative front (from +15V to 0) which when differentiated at N2 pin 11 makes a positive voltage impulse appear which is the PERCUSSION GATE lasting about 10 m/sec.

Now let us consider the test norms for the plate under examination (P497)

a) Set the RV1 trimmer so that the voltage at point (B) is +4V (or at A11 pin 5 +2.5V).
b) Having set the voltage, make sure that at pin 7 and pin 1 of A11 the voltage is +2.5V and that at pin 1 of A10 it is +1.5V.
c) Insert PRESET 1 and keep all the drawbars at zero. Make sure that pins 1 of A1 - A2 - A3 - A4 - A5 - A6 - A7 - A8 - A9 are all at — 4V +100 mV. This reading is extremely important since the perfect functioning of the drawbars depends on it. Consequently, you must make sure that besides being around — 4V there are no differences greater than 20 — 30 mV between these voltages.

   Now, still with preset 1 connected, we can observe, again at pins 1 of A1 ..... A9, the exact operation of the drawbars which when brought from 0 to 8 must increase — 4V at every trip until — 2.5V is reached when the drawbar is at 8.

   In each one of the A1 ..... A9 pins 1 we can see that the relative percussion increases the voltage towards the zero of 2.5V to return to the starting value at a time period established by the percussion decay.
d) Connect presets 2 - 3 - 4, respecting the following table which gives the position of the gate of the analog switches for each preset:

	PR1	PR2	PR3	PR4
V1	H	L	L	L
V2	H	L	H	H
V3	H	H	H	L
V4	H	L	H	L
V5	H	H	H	L
V6	H	H	H	L
V7	H	H	H	L
V8	H	H	L	H
V9	H	H	H	L
V10	H	H	H	L
V11	H	H	H	L
V12	H	L	L	L

N. B.: H = analog switches closed (R =0)
L = analog switches open (R =00)

e) Adjust the trimmer so that the initial voltage on the TR1 collector is — 6.5V. This voltage under the action of n pressed keys (for example 10 keys) must not go above — 6V.
It is always preferable to set the — 6.5V a second time at the end of the test, i.e. when the entire organ is functioning, to see if it is possible to go a little below — 6.5V since the lower this voltage is the more the instrument gives a signal. The limit is about 100 mV above the negative voltage, at which we note that the instrument plays, even with all the drawbars at zero. The operation of the PRESETS is based on the characteristics of 4016. For this analog switch we can say that when its GATE is at +15V the resistance between the input and output terminals is practically zero ohm, while if the gate is at 0V, the same resistance becomes infinite. The 'truth' table shows that as soon as one of the PRESETS is selected (PR2, PR3, PR4), gate U12 of a SW3 section is brought to 0V (GND).

This inhibits the drawbars since the +1.5V, no longer having reference towards GND, is no longer under control and is present, regardless of the position of the various drawbars, at pins 5 of A1 - A2 - A3 - A4 - A5 - A6 - A7 - A8 - A9. 1.5V is therefore also present at pins 7 of these operational amplifiers and, keeping in mind the section of 4016, REL 1 becomes

$$Vpin1 = -R3\left(\frac{Vpin7\ (1,5V)}{Ron/off\ 4016 + R2} + \frac{VR1}{R1}\right)$$

REL 2

of which:

a) $Vpin2 = -100K\left(\frac{1,5V}{0 + 100K} + \frac{2,5}{100K}\right) = -4V$

i.e., when the gate is at +15V (H) **there is no sound** of that foot on the preset.

$$b)\ Vpin1 = -100K\left(\frac{1,5V}{00 + 100K} + \frac{2,5}{100K}\right)$$

or

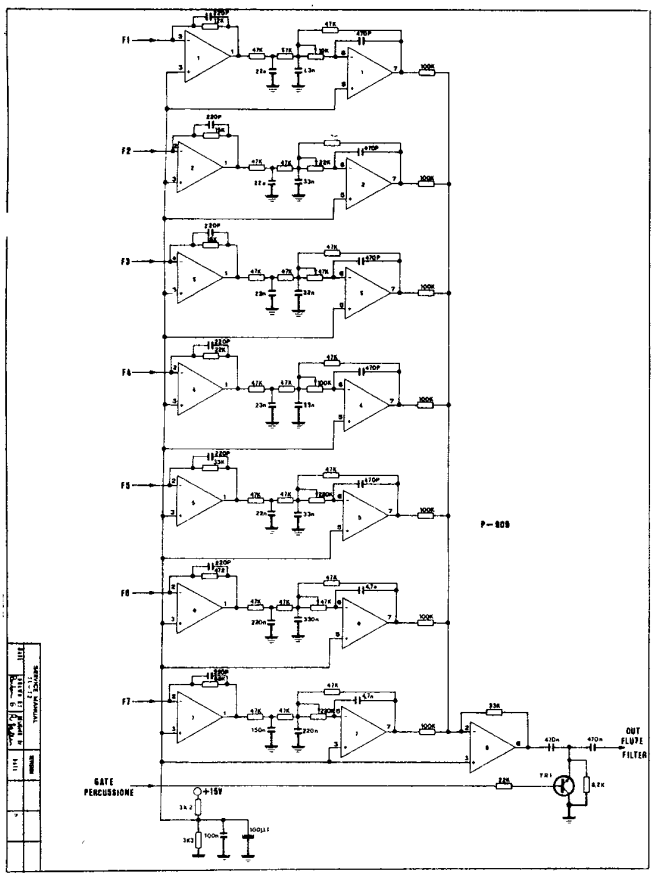
$$Vpin1 = -100K\left(0 + \frac{2,5V}{100K}\right) = -2,5V$$

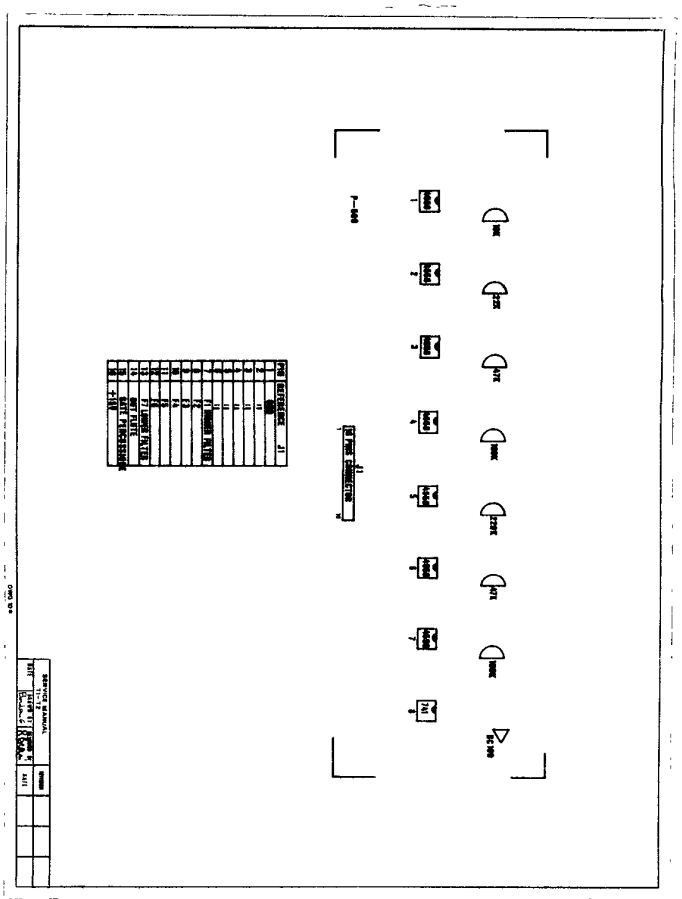
i.e. when the gate is at 0V (L) **there is the sound** of that foot in the present.

Therefore to assure the formation of the various combinations simply direct the gates of the various 4016's as shown in the preset 'truth' table.

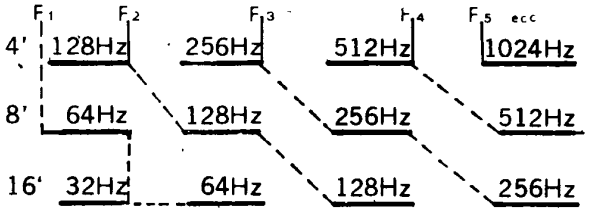
We observe at points 27, 28, 29, 30 how the addition of each preset excludes the preceding one and that the various combinations are obtained by diodes connected to AND.
The presence of a resistance in parallel with some sections of 4016 serves to adjust the amount of musical feet present in a certain preset.
Adjustment a) in the case of the LOWER MANUAL of T2 (T2LM) is made on the 4K7 trimmer of pin 3 of A10 so that there will be a +4V voltage at pin 1 of A10. (See DWG 13).
Adjustment e) for the UPPER MANUAL of T2 (T2UM) is always made on the RV2 trimmer so that there will be an initial voltage of about −8V on the collector of TR2.
This increase in the negative voltage of the bar is due to the fact that the Sustain is present on the T2UM.

FLUTE AND PERCUSSION FILTERS DWG 11 AND DWG 11 B





This plate holds the filters which serve to obtain the tone colors characteristic of CRUMAR organs. The first section of each filter serves as polarization for the TDA 0470 D (see Fig. 3) and as amplifier for the output signal towards the filter.
The filters (seven altogether) are set up by octaves as mentioned previously. This means that the octaves of different musical feet which have the same frequencies are directed towards the same filter as can be seen in the following diagram:



The flute filters are set on the G of each octave after the instrument has been put in frequency (MASTER OSCILLATOR at 2.00024 MHz) by proceeding as following:

a) Connect the drawbars and set the 16' at 8.
b) Play the second G (beginning from the left) and set the relative filter by operating the adjustment trimmer till the maximum amplitude of the output signal is obtained. We recommend using an oscilloscope.
c) Repeat the operation described in paragraph b) on the third, fourth, and fifth $G^{\sharp}$, with the 16' always set at 8.
d) Set the 16' on zero and the 8' on 8.
e) Repeat the operation described in paragraph b) on the fifth $G^{\sharp}$
f) Set the 8' on zero and the 4' on 8.
g) Repeat the operation described in paragraph b) on the fifth $G^{\sharp}$
h) Set the 4' on zero and the 2' on 8.
i) Repeat the operation described in paragraph b) on the fifth $G^{\sharp}$ to set the last of the seven filters.

At the end of the filters and immediately after preamplifier A, we can see how the PERCUSSION GATE, through T1, cancels the slow attack transient, in order to permit the sound to reach the audio paths only when running speed is reached (see **DWG**.10 and **FIG**. 11)

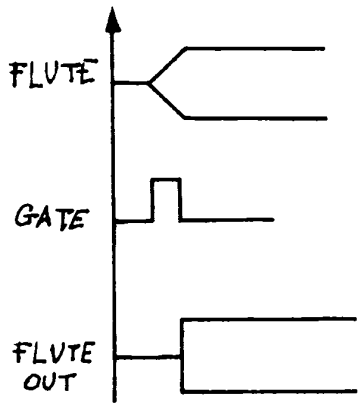


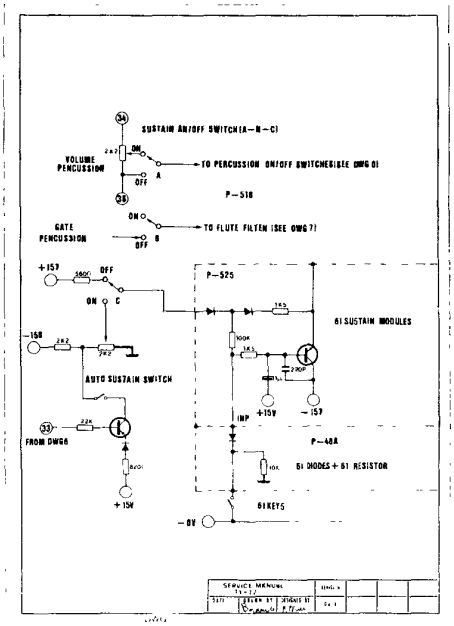
FIG. 11

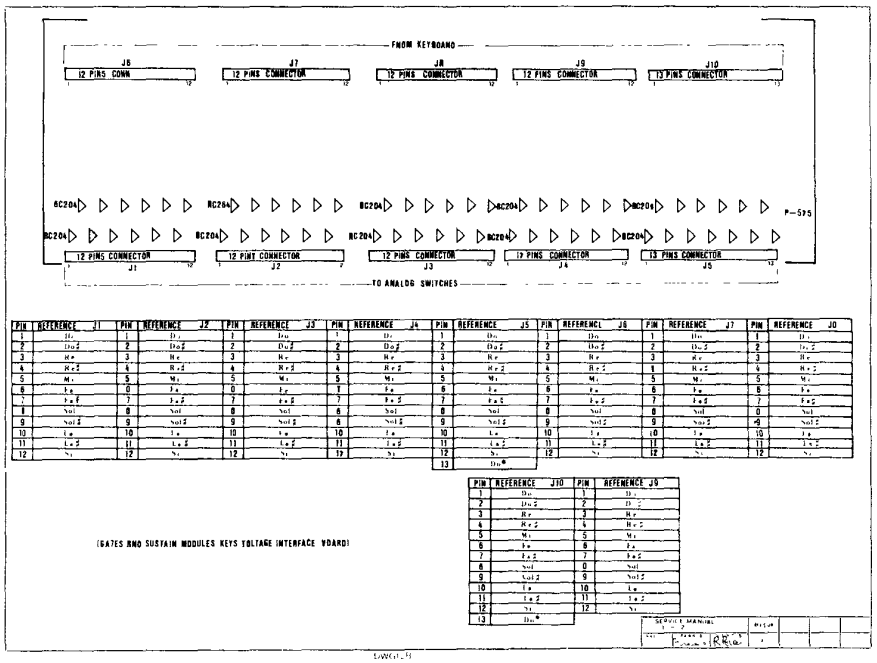
The system we have just described is to be adapted to the various keyboards (T1 - T2UM - T2LM) trying to respond to the different needs with a minimum of variations.

T1
On the T1 the electronic contact board for obtaining the FLUTES and PERCUSSION is exactly the same as the one described.

T2 UM
There is a variation of the T1 system on the T2 UM since sustain is included in this manual. The only plate that varies is P 487 (GATES) which is replaced by P 525. This plate contains the interface gates as always, but in addition also the small sustain modules (61). We can see from the wiring diagram that as soon as the sustain is connected, PERCUSSION is disconnected. See DWG 12 and DWG 12B. The rest is exactly the same as the T1 system.

T2 LM
There is a variation of the T1 system on the T2 LM since this manual does not include PERCUSSION. The only plate that changes is the P 497 which is replaced by P 527, which is a simplied version of the previous one.
See DWG 13 and DWG 13B.

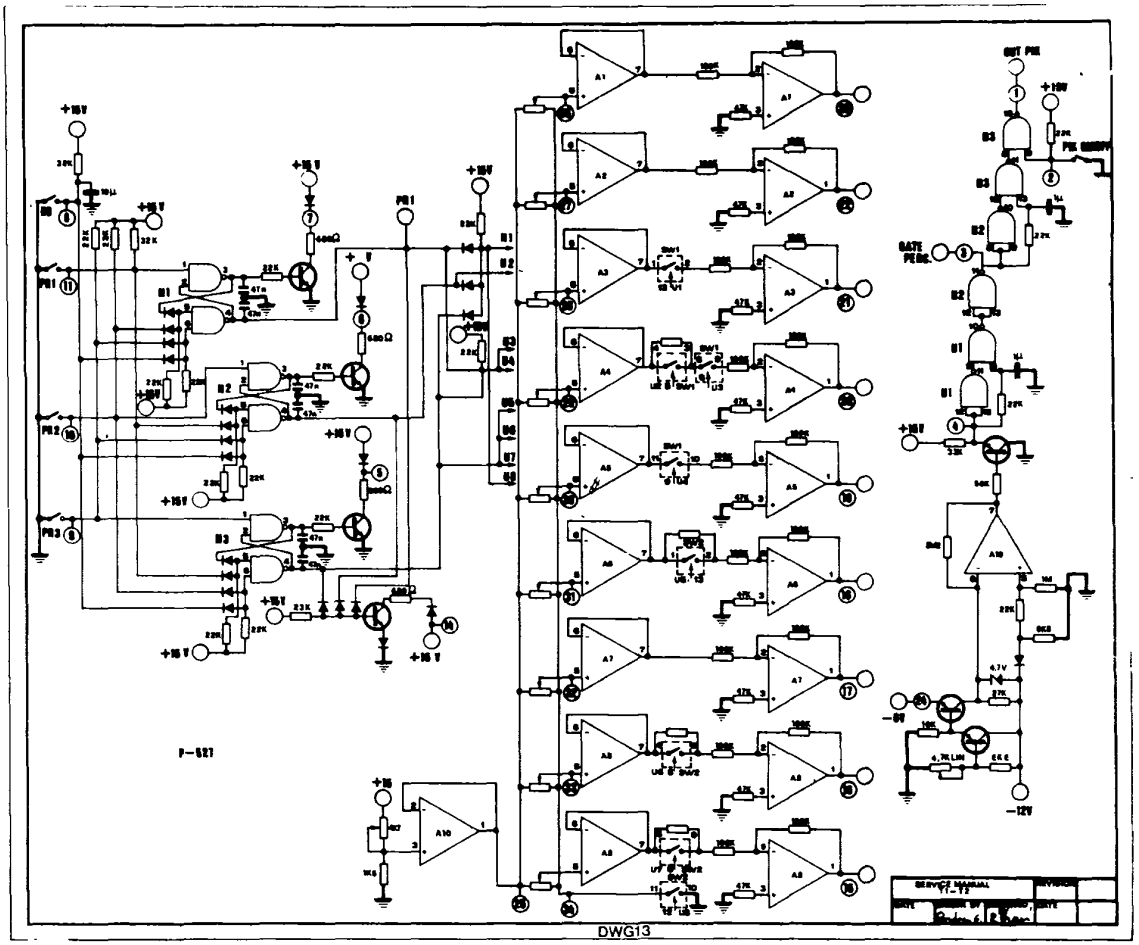




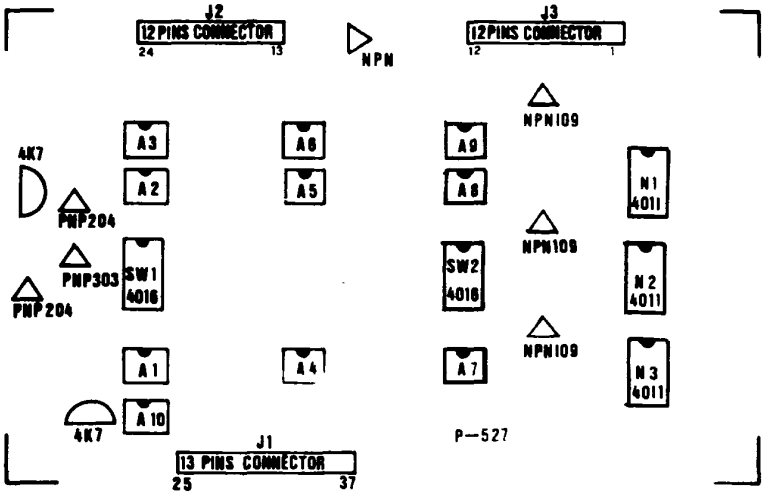
PIN	REFERENCE J1	PIN	REFERENCE J2	PIN	REFERENCE J3	PIN	REFERENCE J4	PIN	REFERENCE J5	PIN	REFERENCE J6	PIN	REFERENCE J7	PIN	REFERENCE J0
1		1		1		1		1		1		1		1	
2		2		2		2		2		2		2		2	
3		3		3		3		3		3		3		3	
4		4		4		4		4		4		4		4	
5		5		5		5		5		5		5		5	
6		0		1		6		6		6		6		6	
7		7		7		7		7		7		7		7	
8		8		8		8		8		8		8		8	
9		9		9		9		9		9		9		9	
10		10		10		10		10		10		10		10	
11		11		11		11		11		11		11		11	
12		12		12		12		12		12		12		12	
								13							

PIN	REFERENCE J10	PIN	REFERENCE J9
1		1	
2		2	
3		3	
4		4	
5		5	
6		6	
7		7	
8		8	
9		9	
10		10	
11		11	
12		12	
13			

(GATES AND SUSTAIN MODULES KEYS VOLTAGE INTERFACE BOARD)



DWG13



FOR J1, J2 AND J3 REFERENCES SEE DWG 12

35 = +15 V

36 = -15 V

SERVICE MANUAL
T1-T2

REVISION

DATE | DRAWN BY | DESIGNED BY | DATE

DWG13B

BASS SECTION

With this system (or assembly of plates) we obtain the sound of the BASS in the first two octaves of T1 and on the first two octaves of the LM of T2 or on the pedal board of T2.
In this section it should be noted from the beginning that there is no difference in the circuitry between T1 and T2 since the BASS performs identically in both. The only difference is that one plate on T2 performs the function of "manual control" or "pedal board control".
The block diagram for the bass section is shown in Fig. 5.

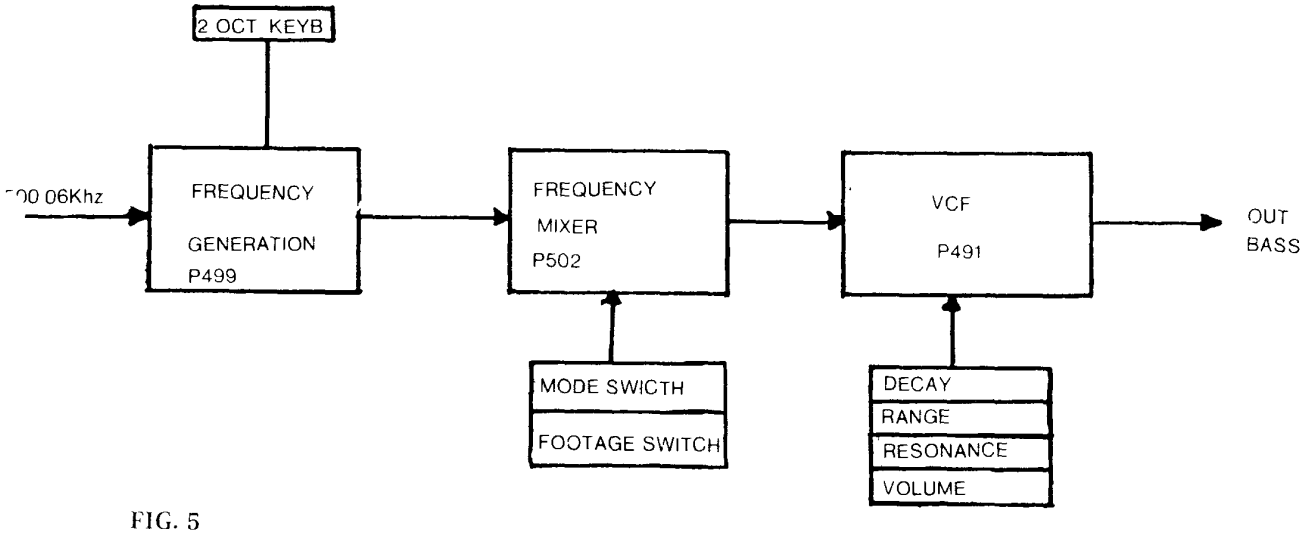
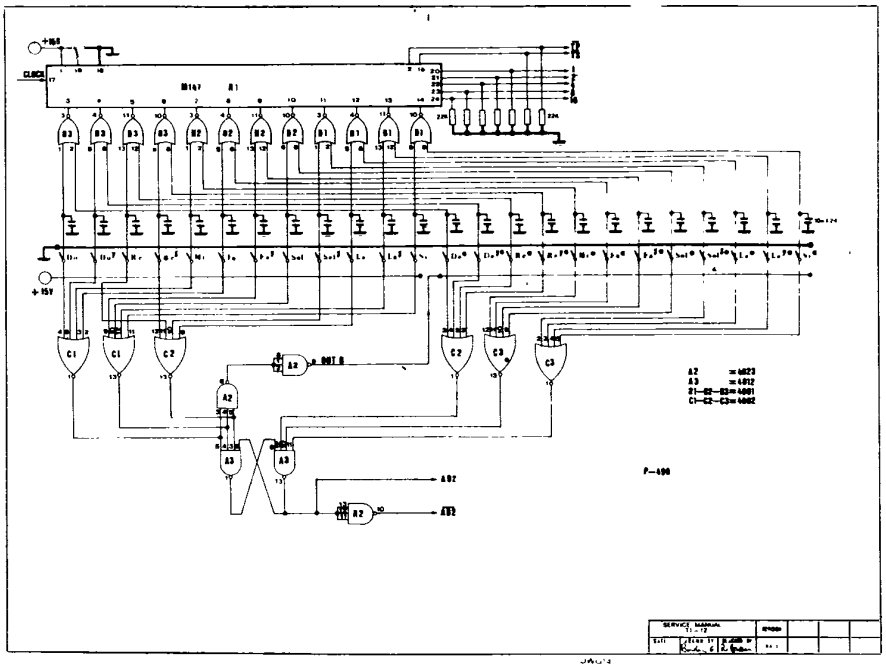


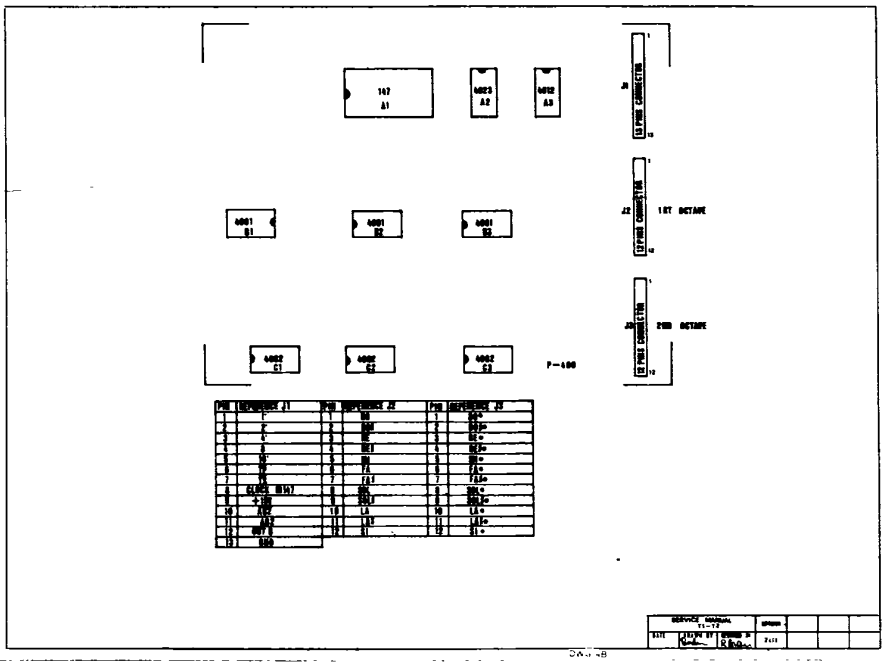
FIG. 5

FREQUENCY GENERATION
DWG 13 — DWG 13B

) generate the bass frequencies, the SGS M 147 integrated circuit was used. This circuit, guided by an appropriate input frequency (clock) gives at the output, for 5 different musical feet, 13 audio frequencies corresponding with other inputs. The "priority" function is also carried out on the inputs meaning that M 147 only accepts one key at a time and, if more than one key is pressed at the same time, only accepts the first to the left.
The circuity as shown in DWG 14 is necessary since the inputs must be increased from 13 to 24. In rest conditions, all the input pins of M 147 are at logic 1 (+15V). Suppose we press the first C; pin 1 of B3, from logic 0 (GND) goes to 1, then pin 3 goes from 1 to 0 and activates input 3 of M 147, and at the output pins 20 - 21 - 22 - 23 - 24 of M 147 5 frequencies will appear corresponding with the C pressed. Note that when a key of the first octave is pressed, the second octave is disconnected since in the previous conditions pin 4 of C1 is brought to 1, then pin 1 of C1 goes to 0, pin 6 of A2 becomes 1 and pin 9 of A2 (OUT B) becomes 0 and therefore every key of the second octave finds only 0 when at rest and 0 when operating and is therefore inactive. This inhibition works for any key of the first octave. The second octave therefore can only be played if no key of the first is used. In effect, in this case pins 1 - 13 of C1 and pin 13 of C2 are at 1, pin 6 of A2 is at 0 and pin 9 of A2 is at 1 and this makes the keys of the second octave active since in the exchange we go from 0 (rest) to 1 (work).
If the first and second octaves are played contemporaneously, the first always has precedence. We can see in DWG 13 how the notes of the same name of the two octaves produce frequencies which are the same. To relate to each note the appropriate frequency in the scale of valores of the octave, signals AB2 and $\overline{AB2}$ furnished by A3 are used. $\overline{AB2}$ is 1 when the first octave is played and 0 with the second. M 147 also supplies two very important signals which are the $\overline{TP}$ (percussion trigger) and $\overline{TS}$ (sustain trigger).
The first is an impulse which appears every time a proprietor key is pressed, the second is a logic level which is maintained until there is at least one key pressed.

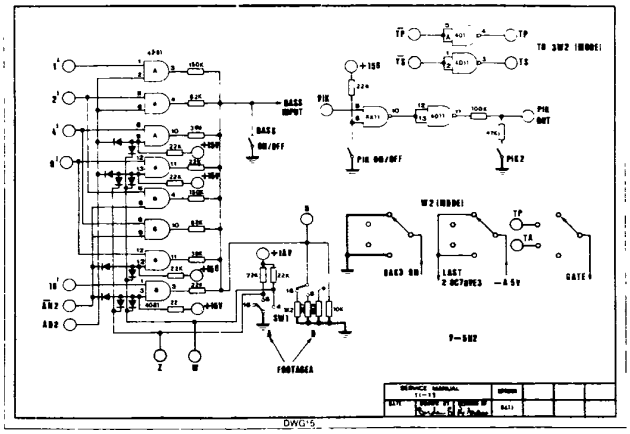


DWG 12

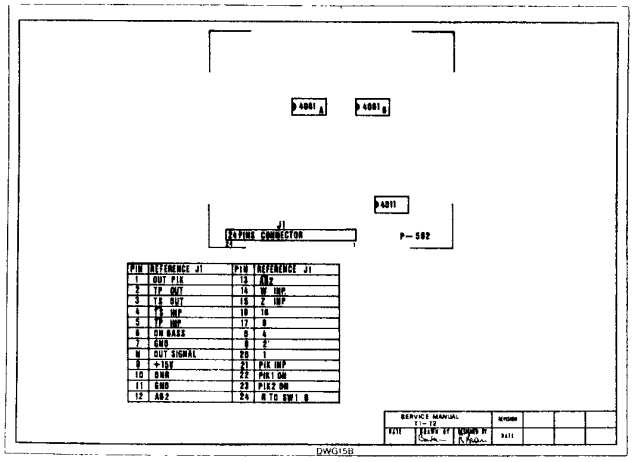


PIN	REFERENCE J1	PIN	REFERENCE J2	PIN	REFERENCE J3
1		1		1	
2		2		2	
3		3		3	
4		4		4	
5		5		5	
6		6		6	
7		7		7	
8	CLOCK (1MHz)	8		8	
9	+15V	9		9	
10		10		10	
11		11		11	
12		12		12	
13					

DWG 13

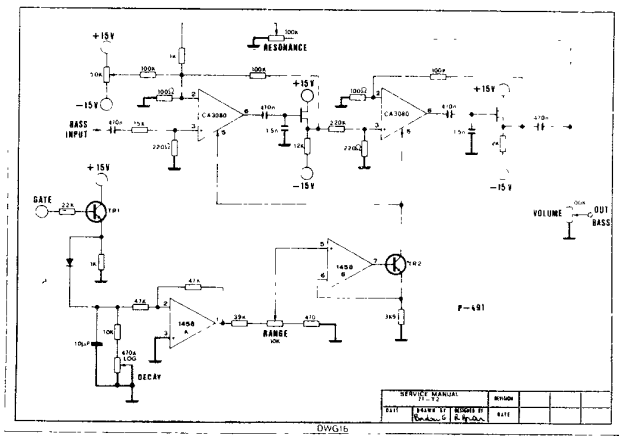


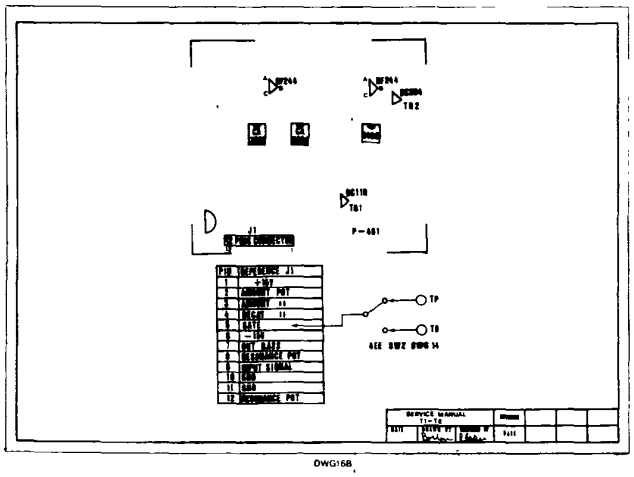
DWG 15



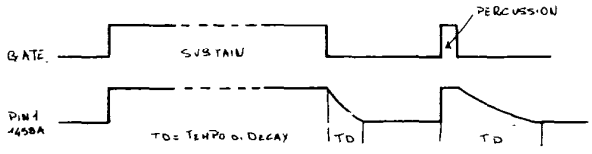
The outputs of P 499 go to P 502 (FREQUENCY MIXER DWG 15 — DWG 15B).
The function of this plate is to assign the exact frequency to each octave and to each musical foot. Everything is effected through AND type logics. At the BASS INPUT there will be a sawtooth consisting of 16 steps for the 16', 8 steps for the 8' and 4 steps for the 4'. By observing the wiring diagram we can see that in order to obtain the various musical feet, SW1 inhibits (going from 16' towards 4') the lowest frequencies. The section with B of SW1 keeps the sawtooth amplitude of the various musical feet constant.

VCF (BASS FILTER) DWG 16 — DWG 16B





This plate serves to obtain the bass sound coming from a sawtooth. The VCF is an active filter in which the cut-off frequency can be controlled through a negative voltage.
The GATE (see DWG 15) charges the F 10 micro capacitor through TR1 creating an envelope generator which, reversed by 1458 A, controlled in amplitude by the RANGE potentiometer and buffered by 1458 B, controls through TR2, the current which flows to the pins of CA 3080.



The DECAY time is established by de DECAY potentiometer.

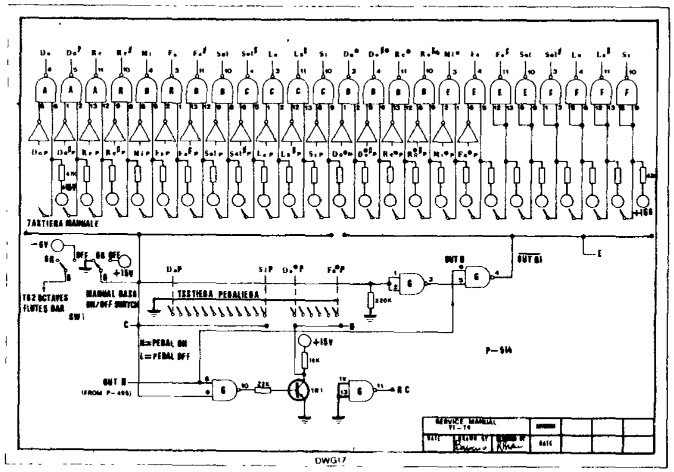
All this applies to the bass manual (T1 and LM T2). In the T2 the bass can also be played by the pedal board and in this case the plates we have already discussed remain exactly the same, with the addition, however, of one plate (P 514) which serves to mix the controls coming from either the pedal board of the manual.

KEYBOARD/PEDAL MIXER
DWG 17 — DWG 17 B

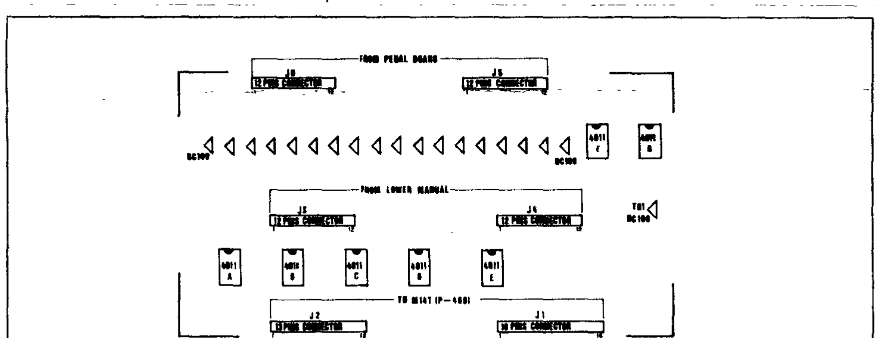
With section B of SW1 ON, point C is at 0, also point D is at 0 (in effect with 0 at pin 9 of G, pin 10 is always at 1, TR1 is satured and therefore D is at 0) and therefore the pedal board is always inhibited since each one of its 18 keys is on rest which when operating show a zero.
The manual on the other hand can function: point C is at 0 and the first octave is activated, pin 3 of G is at 1 so pin 4 of G can follow the OUT B function (in negated form) and activate or not activate also the second octave.
With section **B** of SW1 in the OFF position, point C is at 1 and the first octave of the pedal board is activated. Through pin 8 of G, OUT B (which is now pin 9 and at 1) can activate or not activate also the second octave.
(The logic of OUT B is exactly the same as that described previously in DWG 14).
In this case the manual cannot function since with C at 1, pin 3 of G goes to 0 and blocks pin 4 of G at 1, therefore none of the keys of the manual can function. This can be summarized in the followir truth table:

SW1	C	D	PEDAL	C	E	MANUAL
ON	0	0	INHIBIT	0	$\overline{\text{OUT}}$ B	WORK
OFF	1	$\overline{\text{OUT}}$ B	WORK	1	1	INHIBIT

With this table in mind, let us see what happens when we press for example C of the first octave of the manual.
SW1 is in the ON position so the manual can work. Pin 5 of A is always at 1, pin 6 of A goes from 1 to 0 under the action of C and therefore pin 4 of A (which at rest is at 0) goes to 1 and (see DWG 13) C plays.
The same procedure applies to all the other keys. Section A of SW1 serves to activate or inhibit the sound of the FLUTE and the PERCUSSION on the first two octaves of the LM.



DWG17



PIN	REFERENCE J1	PIN	REFERENCE J2
1	Do*	1	Do
2	Do#*	2	Do#
3	Re*	3	Re
4	Re#*	4	Re#
5	Mi*	5	Mi
6	Fa*	6	Fa
7	Fa#*	7	Fa#
8	Sol*	8	Sol
9	Sol#*	9	Sol#
10	La*	10	La
11	La#*	11	La#
12	Si*	12	Si
13	OUT III (E)	13	GND
14	OUT II		
15	C		
16	B		

TO M147 (P-488)

PIN	REFERENCE J3	PIN	REFERENCE J4
1	Do	1	Do
2	Do#	2	Do#
3	Re	3	Re
4	Re#	4	Re#
5	Mi	5	Mi
6	Fa	6	Fa
7	Fa#	7	Fa#
8	Sol	8	Sol
9	Sol#	9	Sol#
10	La	10	La
11	La#	11	La#
12	Si	12	Si

FROM LOWER MANUAL

PIN	REFERENCE J5	PIN	REFERENCE J6
1	La P	1	GND
2	La#P	2	"
3	Si P	3	"
4	Do*P	4	Do P
5	Do#*P	5	Do#P
6	Re*P	6	Re P
7	Re#*P	7	Re#P
8	Mi*P	8	Mi P
9	Fa*P	9	Fa P
10	+15V	10	Fa#P
11	"	11	Sol P
12	"	12	Sol#P

FROM PEDAL BOARD

SERVICE MANUAL T1-T2

DWG17B

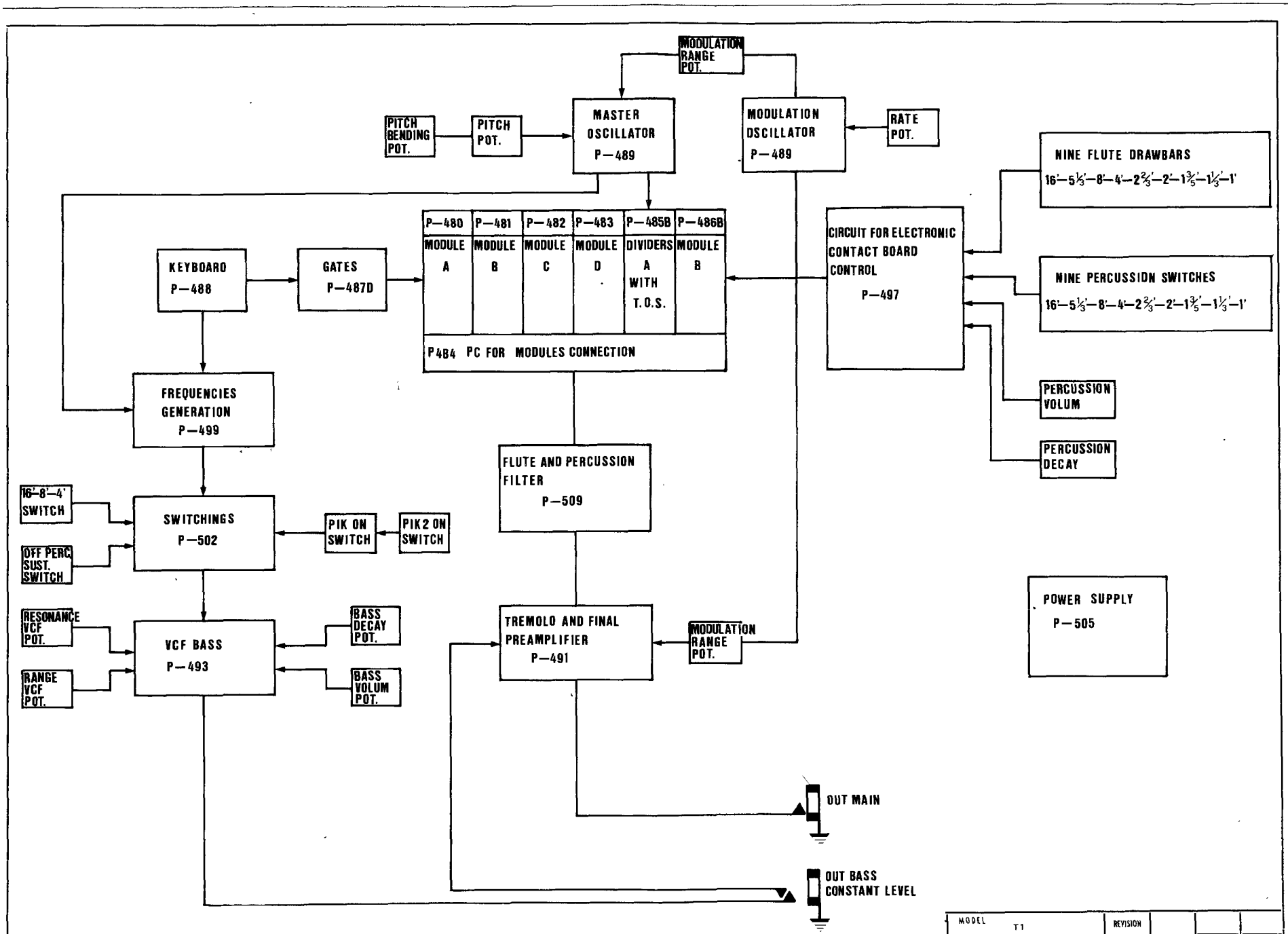
SCHEMATIC DIAGRAM

CRUMAR®

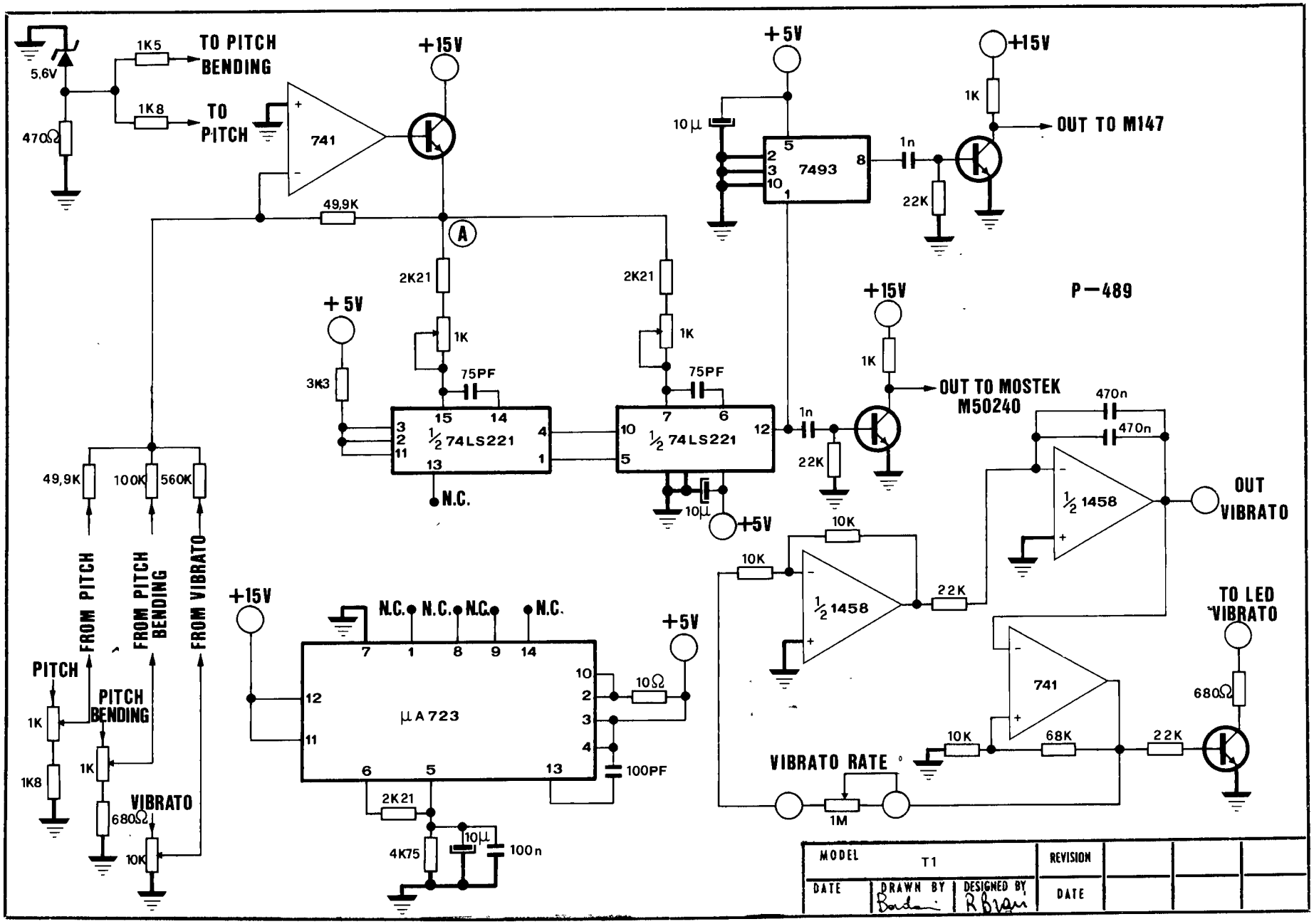
Musical Instruments

mod.

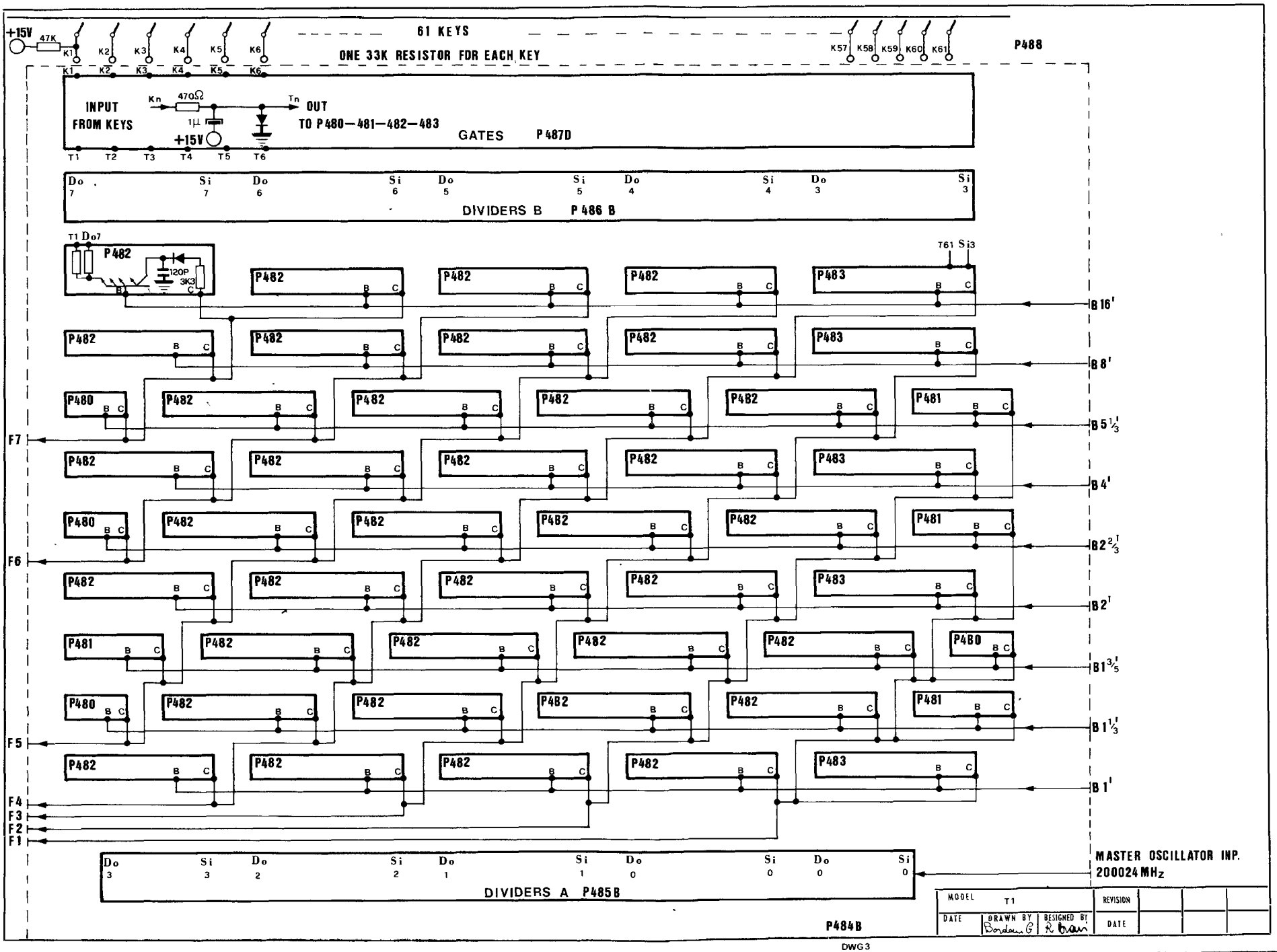
T-1

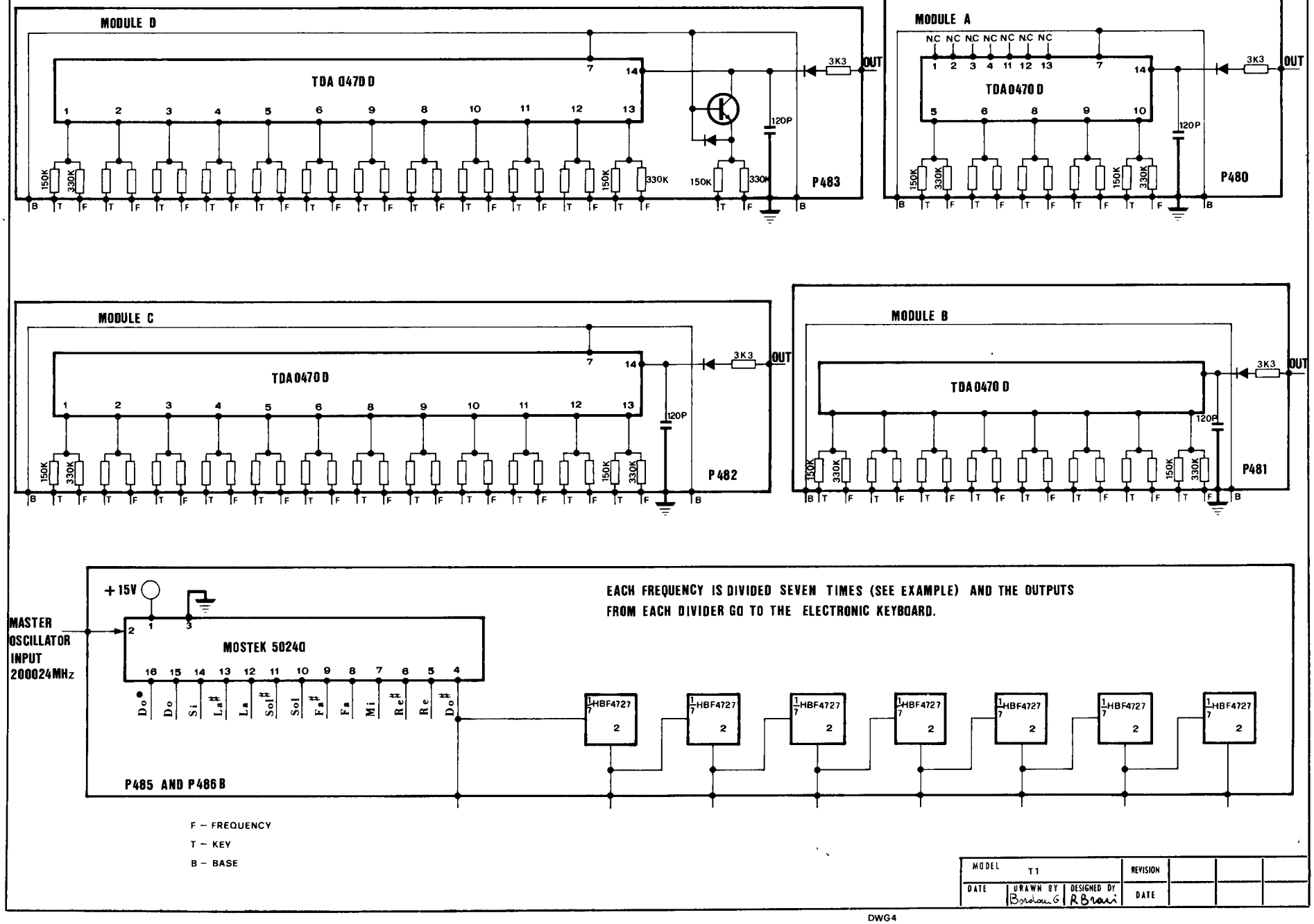

MODULATION RANGE POT.
PITCH BENDING POT.
PITCH POT.
MASTER OSCILLATOR P—489
MODULATION OSCILLATOR P—489
RATE POT.
NINE FLUTE DRAWBARS
16'—5⅓'—8'—4'—2⅔'—2'—1⅗'—1⅓'—1'
P—480 MODULE A
P—481 MODULE B
P—482 MODULE C
P—483 MODULE D
P—485B DIVIDERS A WITH T.O.S.
P—486B MODULE B
P484 PC FOR MODULES CONNECTION
KEYBOARD P—488
GATES P—487D
CIRCUIT FOR ELECTRONIC CONTACT BOARD CONTROL P—497
NINE PERCUSSION SWITCHES
16'—5⅓'—8'—4'—2⅔'—2'—1⅗'—1⅓'—1'
PERCUSSION VOLUM
PERCUSSION DECAY
FREQUENCIES GENERATION P—499
FLUTE AND PERCUSSION FILTER P—509
16'—8'—4' SWITCH
OFF PERC SUST. SWITCH
SWITCHINGS P—502
PIK ON SWITCH
PIK2 ON SWITCH
RESONANCE VCF POT.
RANGE VCF POT.
VCF BASS P—493
BASS DECAY POT.
BASS VOLUM POT.
TREMOLO AND FINAL PREAMPLIFIER P—491
MODULATION RANGE POT.
POWER SUPPLY P—505
OUT MAIN
OUT BASS CONSTANT LEVEL
MODEL T1
REVISION
DATE
DRAWN BY Bordoni G
DESIGNED BY R Bigari
DATE

DWG 1

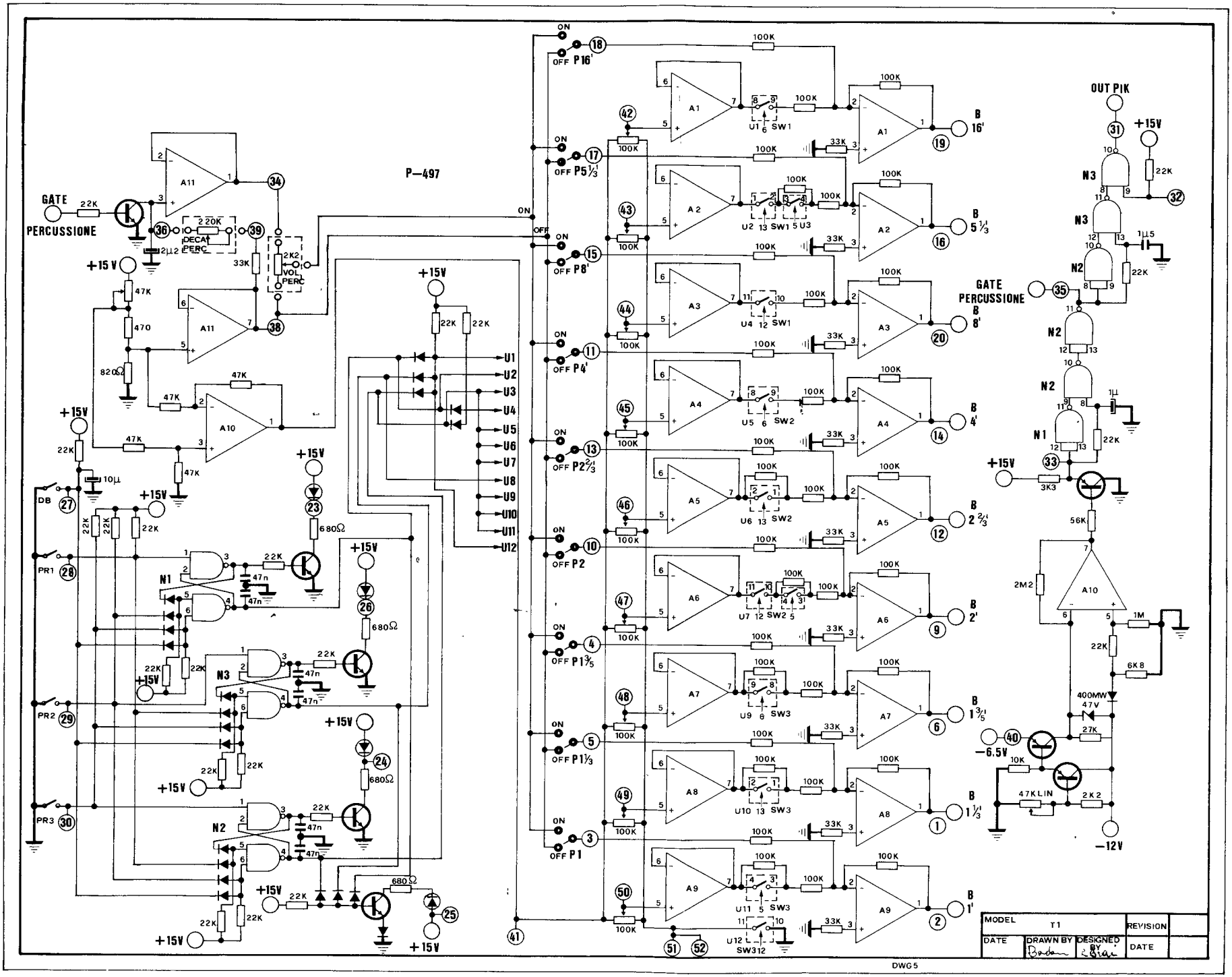

5,6V
1K5
TO PITCH BENDING
1K8
TO PITCH
470Ω
741
+15V
49,9K
A
2K21
1K
75PF
3K3
+5V
15 14
3 2 11 13
½ 74LS221
4 1
N.C.
2K21
1K
75PF
7 6
10 5
½ 74LS221
12
10µ
+5V
+5V
10µ
5 2 3 10 1
7493
8
1n
22K
+15V
1K
OUT TO M147
+15V
1K
OUT TO MOSTEK M50240
1n
22K
P—489
470n
470n
½ 1458
OUT VIBRATO
10K
10K
½ 1458
22K
TO LED VIBRATO
741
680Ω
10K
68K
22K
VIBRATO RATE
1M
49,9K
100K
560K
FROM PITCH
FROM PITCH BENDING
FROM VIBRATO
PITCH
PITCH BENDING
VIBRATO
1K
1K8
1K
680Ω
10K
+15V
N.C. N.C. N.C. N.C.
7 1 8 9 14
12
11
µA723
10
2
3
4
6 5 13
+5V
10Ω
100PF
2K21
4K75
10µ
100n
MODEL T1
REVISION
DATE
DRAWN BY
DESIGNED BY
R Bran
DATE

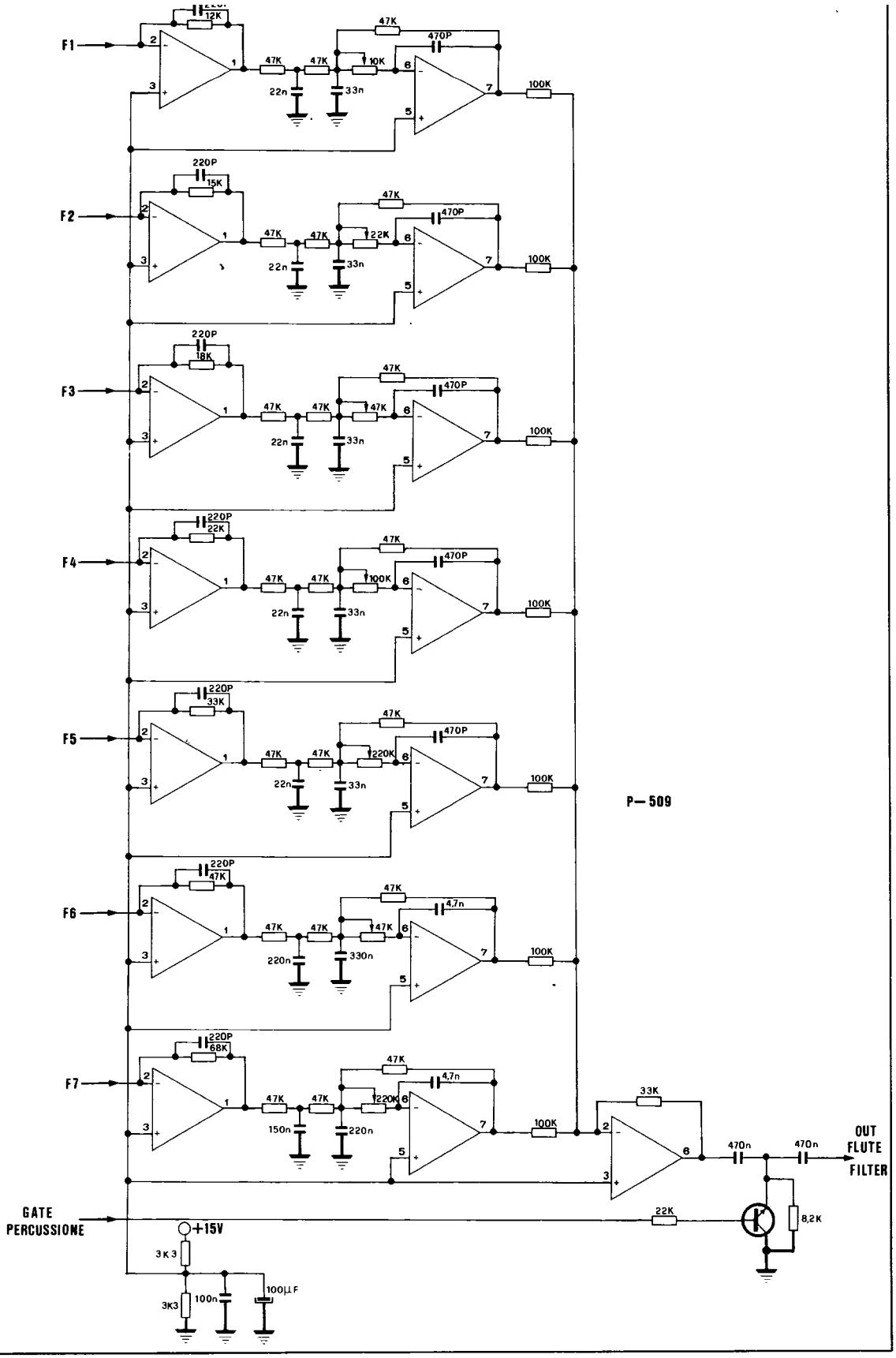
DWG2


+15V
47K
61 KEYS
ONE 33K RESISTOR FOR EACH KEY
K1 K2 K3 K4 K5 K6
K57 K58 K59 K60 K61
P488
INPUT FROM KEYS
Kn
470Ω
1µ
+15V
Tn
OUT
TO P480—481—482—483 GATES P487D
T1 T2 T3 T4 T5 T6
Do 7 Si 7 Do 6 Si 6 Do 5 Si 5 Do 4 Si 4 Do 3 Si 3
DIVIDERS B P486 B
T1 Do7
P482
120P
3K3
T61 Si3
P483
P480
P481
B16'
B8'
B5 1/3'
B4'
B2 2/3'
B2'
B1 3/5'
B1 1/3'
B1'
F7
F6
F5
F4
F3
F2
F1
Do 3 Si 3 Do 2 Si 2 Do 1 Si 1 Do 0 Si 0 Do 0 Si 0
DIVIDERS A P485B
MASTER OSCILLATOR INP.
200024 MHz
P484B
DWG3
MODEL T1
REVISION
DATE
DRAWN BY Gordon G
DESIGNED BY R Bram
DATE


MODULE D
TDA 0470 D
P483
MODULE A
TDA0470 D
P480
MODULE C
TDA0470 D
P482
MODULE B
TDA0470 D
P481
3K3
OUT
120P
150K
330K
+15V
MASTER OSCILLATOR INPUT 200024MHz
MOSTEK 50240
P485 AND P486 B
EACH FREQUENCY IS DIVIDED SEVEN TIMES (SEE EXAMPLE) AND THE OUTPUTS FROM EACH DIVIDER GO TO THE ELECTRONIC KEYBOARD.
1/7 HBF4727
F – FREQUENCY
T – KEY
B – BASE
MODEL T1
REVISION
DATE
DRAWN BY
DESIGNED BY
R Brani

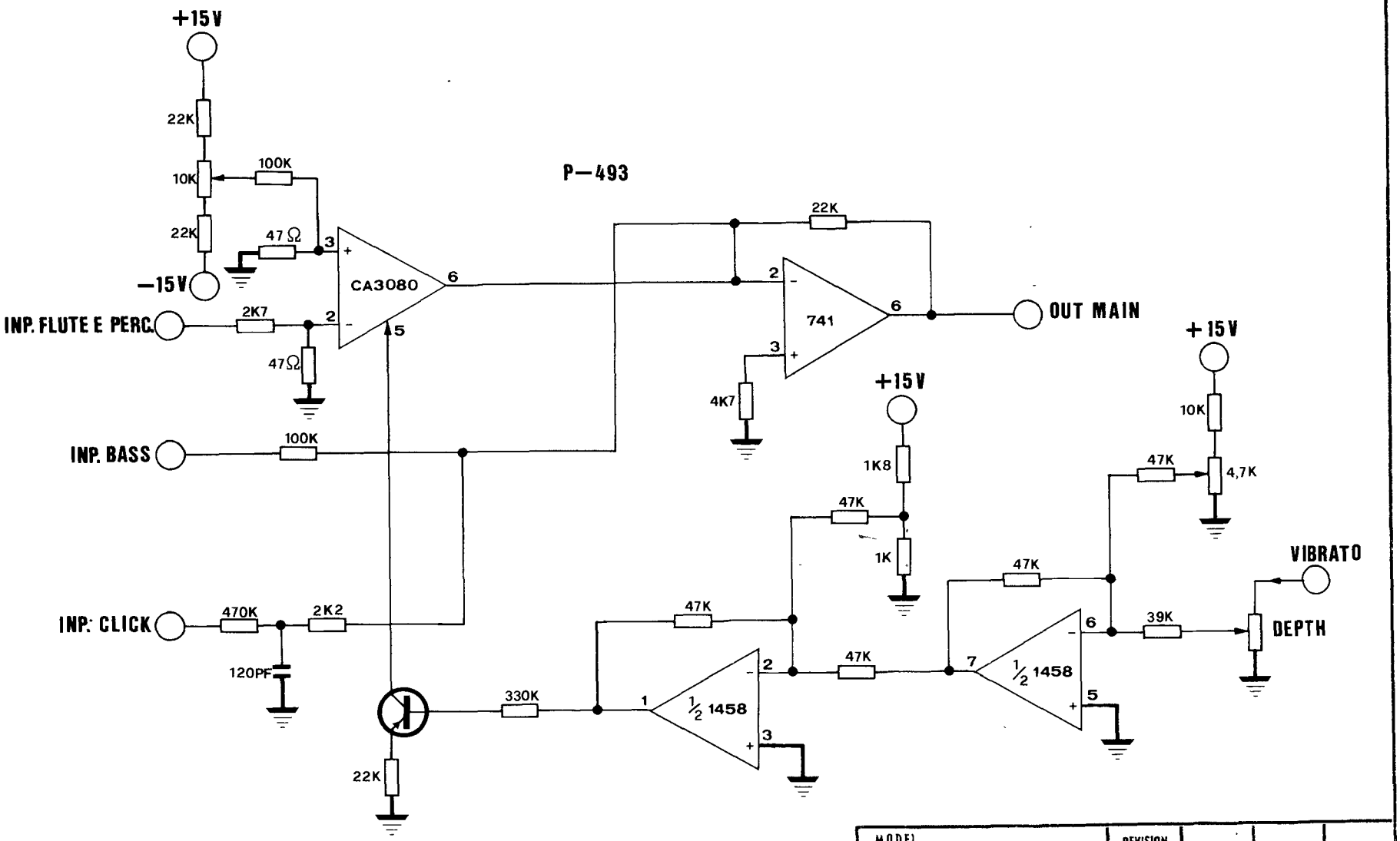
DWG4


P—497
GATE PERCUSSIONE
+15V
DECAY PERC
VOL PERC
OUT PIK
GATE PERCUSSIONE
-6.5V
-12V
P16'
P5 1/3'
P8'
P4'
P2 2/3'
P2
P1 3/5
P1 1/3
P1
B 16'
B 5 1/3'
B 8'
B 4'
B 2 2/3'
B 2'
B 1 3/5'
B 1 1/3'
B 1'
SW1
SW2
SW3
SW312
DB
PR1
PR2
PR3
MODEL T1
REVISION
DATE
DRAWN BY
DESIGNED BY
DWG 5

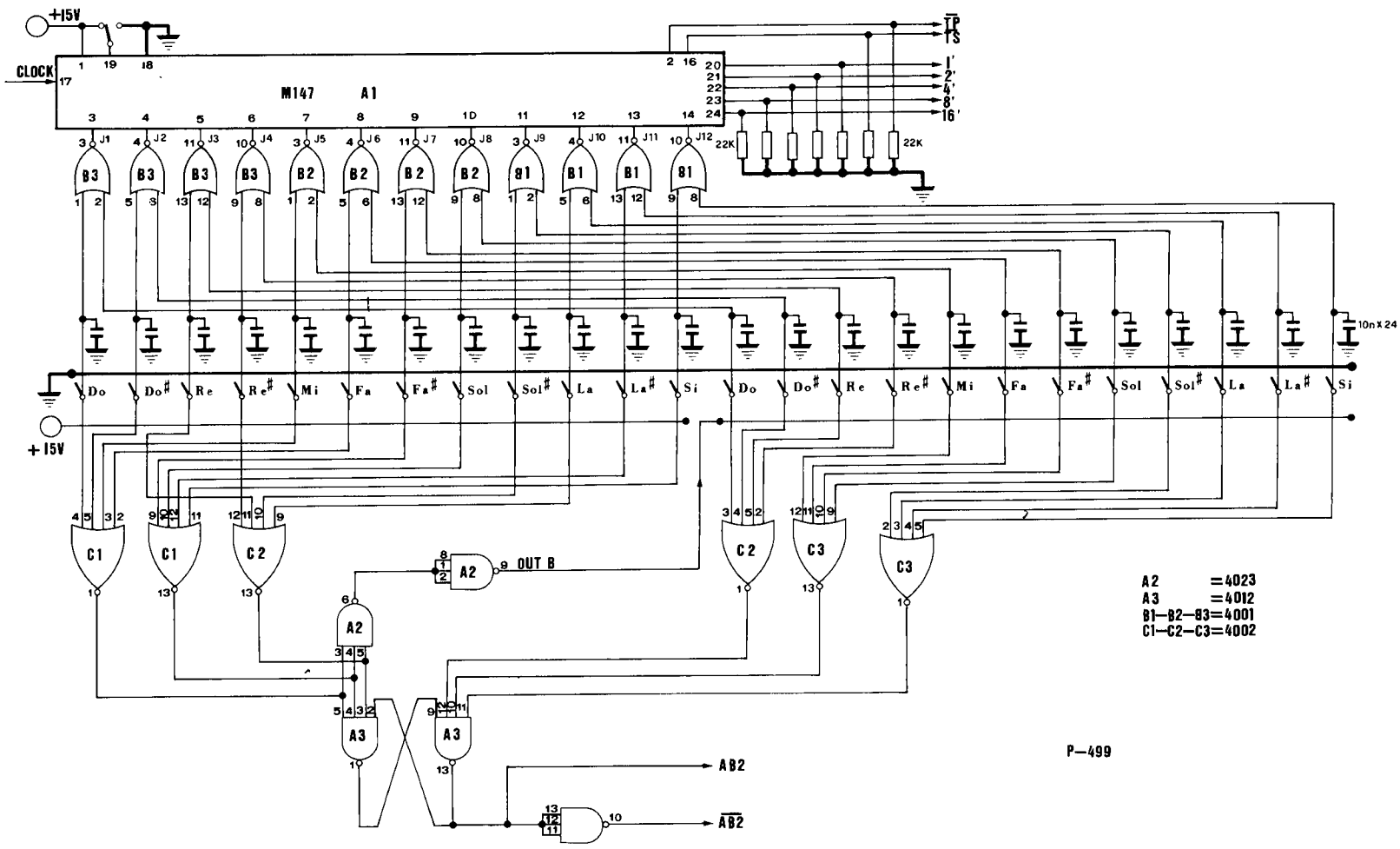


DWG6

MODEL	DRAWN BY	DESIGNED BY	DATE	REVISION
T1	Rodger G	RJ Rodger		

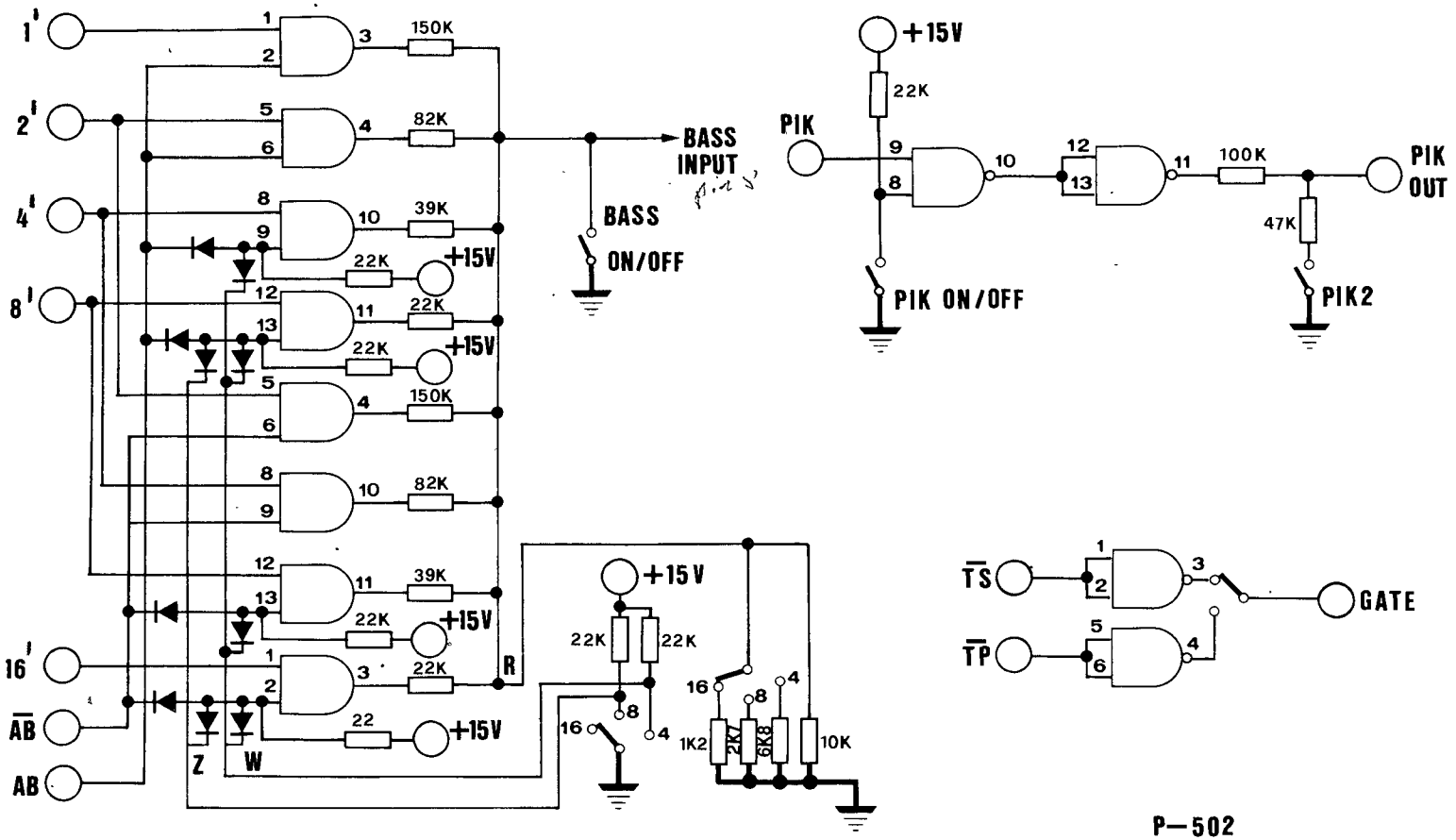

P—493
+15V
22K
10K
100K
22K
47Ω
−15V
CA3080
INP. FLUTE E PERC.
2K7
47Ω
INP. BASS
100K
INP: CLICK
470K
2K2
120PF
330K
22K
47K
1/2 1458
22K
741
OUT MAIN
4K7
+15V
1K8
47K
1K
+15V
10K
47K
4,7K
47K
39K
VIBRATO
DEPTH
1/2 1458
MODEL T1
REVISION
DATE
DRAWN BY Bala
DESIGNED BY R Barani
DATE

DWG7



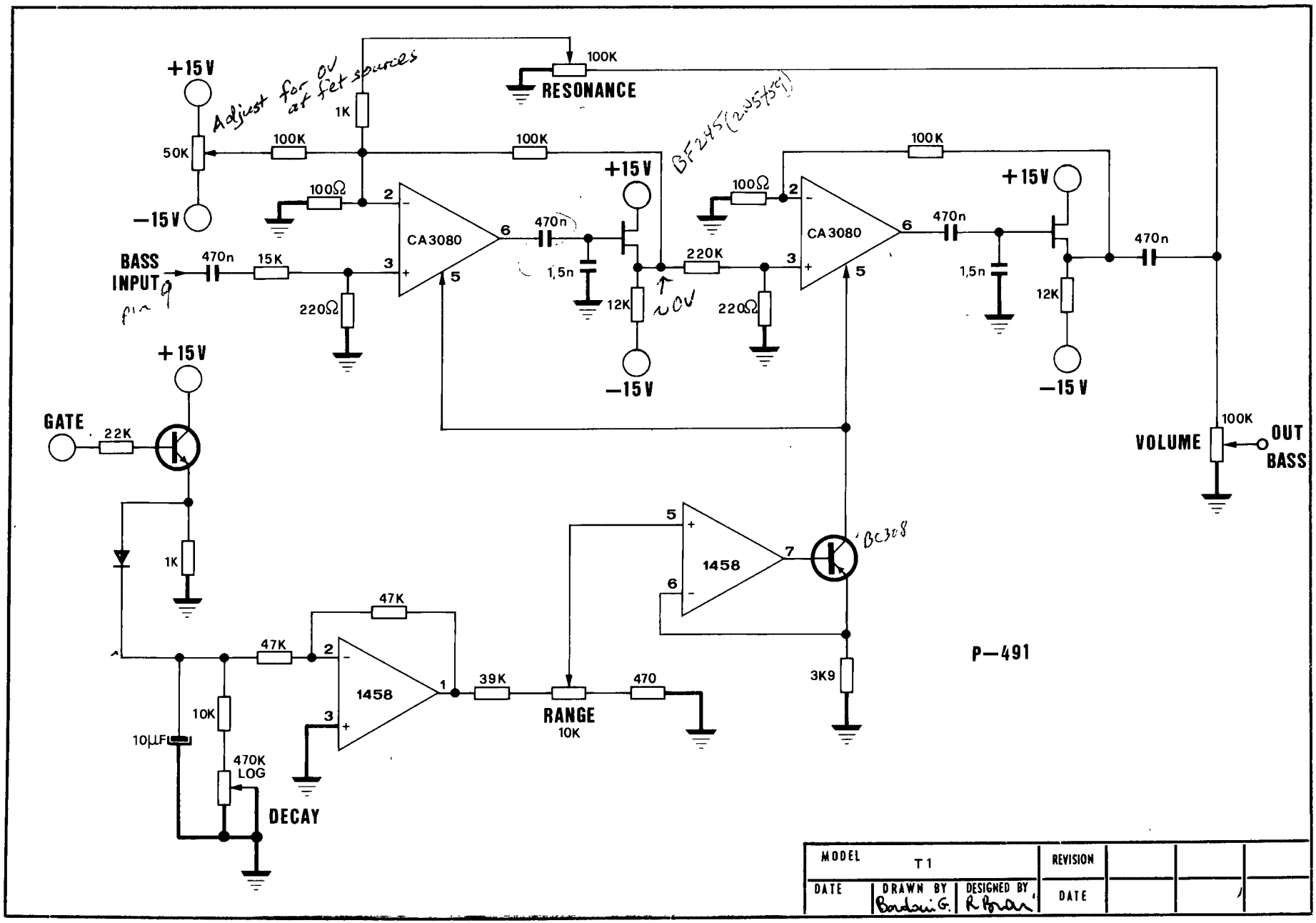
MODEL T1			REVISION			
DATE	DRAWN BY Borda G	DESIGNED BY R Ryan	BASE			

DWG 8

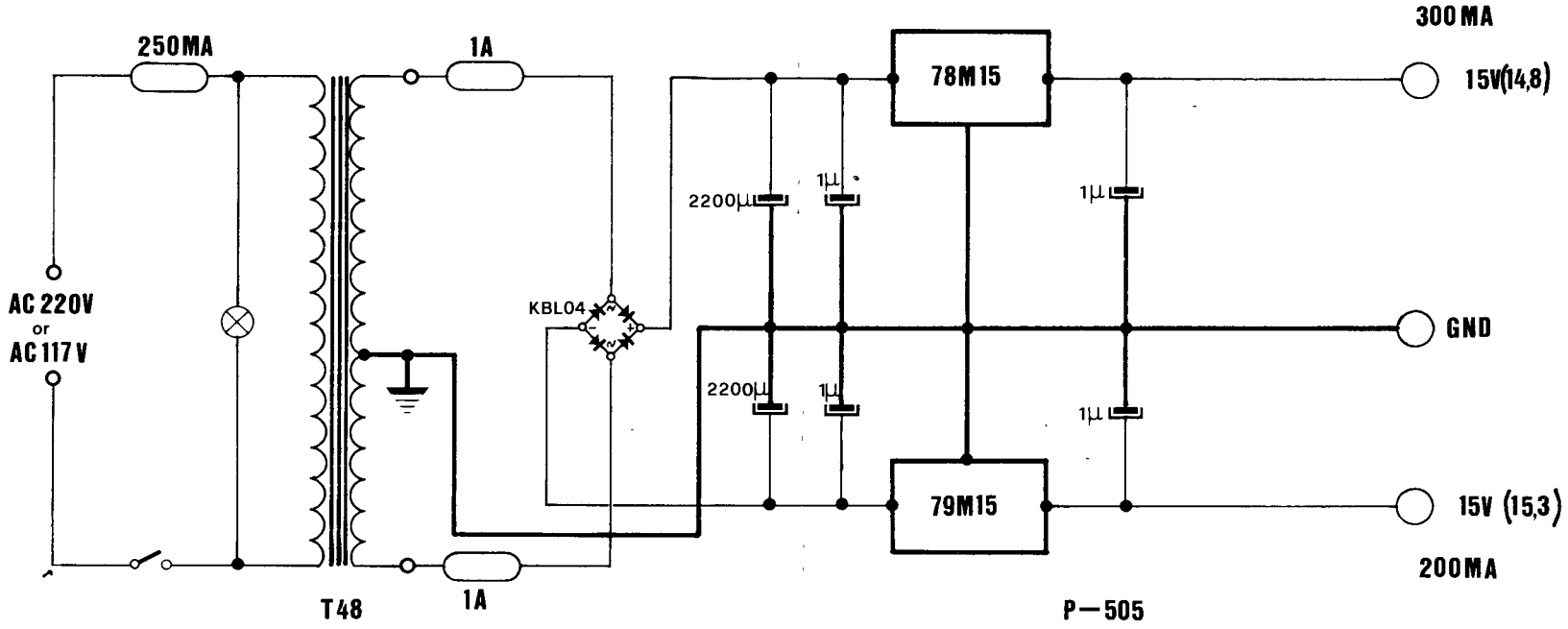


P—502

MODEL T1			REVISION			
DATE	DRAWN BY Bordai S	DESIGNED BY R Bordai	DATE			

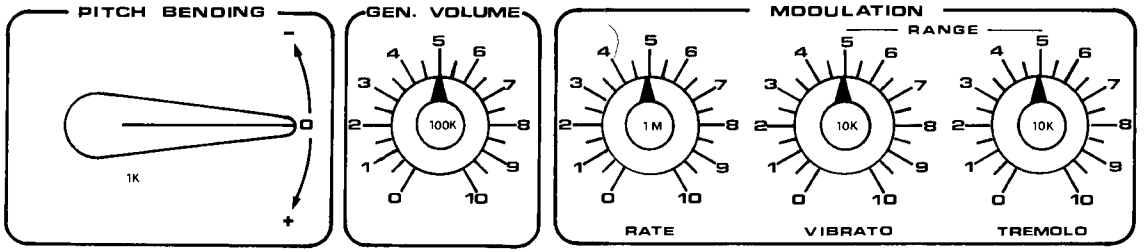

+15V
Adjust for 0V at fet sources
1K
100K
RESONANCE
50K
100K
100K
+15V
BF245(2N5457)
100Ω
2
CA3080
6
470n
100K
+15V
100Ω
2
CA3080
6
470n
+15V
470n
−15V
BASS INPUT
470n
15K
3
5
220K
3
5
1,5n
1,5n
220Ω
12K
≈0V
220Ω
12K
−15V
−15V
+15V
GATE
22K
100K
VOLUME
OUT
BASS
1K
5
1458
7
BC308
6
47K
47K
2
1458
1
39K
470
3K9
10K
3
10µF
470K LOG
DECAY
RANGE
10K
P—491
MODEL T1
REVISION
DATE
DRAWN BY Bordai G.
DESIGNED BY R Boran
DATE

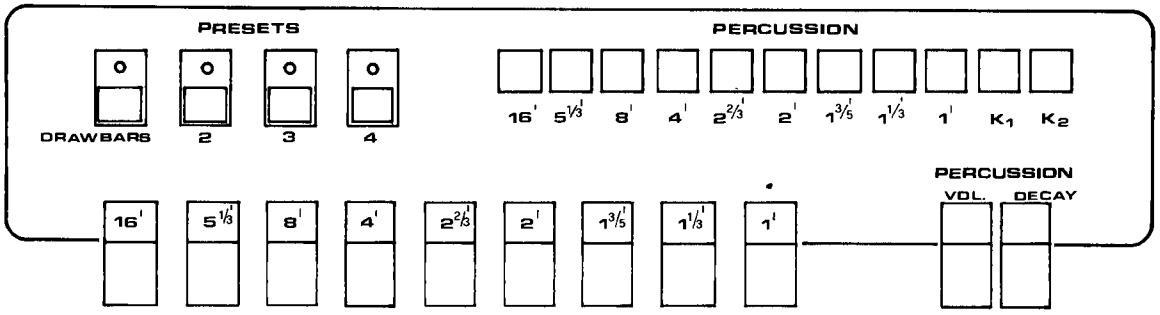
DWG 10

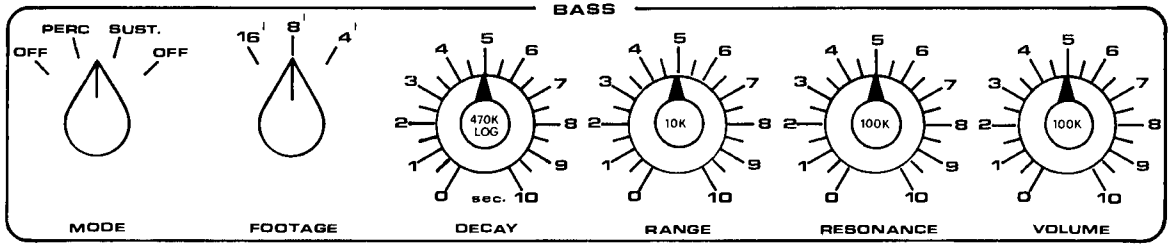


MODEL T1			REVISION			
DATE	DRAWN BY Baolan	DESIGNED BY R Ryan	DATE			

DWG 11







MODEL	T1	REVISION			
DATE	DRAWN BY: Bordowitz	DESIGNED BY: R. Brian	DATE		

DWG12