GATEX

FOUR CHANNEL NOISE GATE/EXPANDER

OPERATING INSTRUCTIONS

USAudio

USAudio Inc. P.O. Box 40878 NASHVILLE. TN 37204 (615) 297-1098

GATEX NOISE GATE/EXPANDER

1. General Information

1.1 DESCRIPTION

The US Audio, Inc. Gatex consists of four independent channels, each capable of performing noise gating, expansion, keying, and envelope following.

Selection of operating modes is very straightforward thanks to the 3-position Mode switch. "Hard" noise gating is achieved by placing the switch in the gate position, while 1:2 expansion is accomplished in the exp 1 position. "Soft" 2:3 expansion may be selected for apparent noise reduction purposes by placing the switch in the exp 2 position.

Full parametric control is provided by three continuously variable front panel controls. Therefore, while remaining easy to operate, the Gatex offers sophisticated control capability to allow successful application for the most demanding situations.

The Gatex will also accept external signal sources in order to accomplish keying. By positioning the Source switch in the key position, an external audio signal will trigger the gating or expansion action of the device.

An easy-to-read three LED display allows the operator to monitor the operation of the Gatex at a glance. The green LED indicates a "full on" or unity gain condition. Yellow provides visual indication of ongoing expansion, while red shows maximum attenuation as determined by the range control.

Balanced input circuitry capable of operation to levels of +24 dB is employed to assure compatability with professional recording and broadcast equipment. The output line driver circuit can deliver +21 dB into 600 ohm resistive loads or transformers. Excellent RFI suppression is incorporated on all inputs and outputs.

The package design of the Gatex allows instant rack installation. Hook-up is quickly accomplished thanks to use of 1/4" ring/tip/sleeve connectors for all inputs and outputs. The package provides excellent RF attenuation by virtue of its steel and aluminum construction. RF and transient suppression is also incorporated in the Gatex power supply.

1.2 SPECIFICATIONS

Note: The designation dB refers to 0 dB ≈ 0.775 Vrms. Noise measurements made with rms-responding meters in 20 kHz noise bandwidth. Specifications subject to change without notice.

Input

Input Impedance:	>90 kohm balanced, >45 kohm unbalanced
Maximum Input Level:	+24 dB
External Input Impedance:	>90 kohm balanced, >45 kohm unbalanced

External Input Sensitivity:	-40 dB minimum for keying
Output	
Output Impedance:	≤40 ohm, unbalanced
Maximum Output Level:	+21 dB into 600 ohm or greater
Quiescent Distortion:	<0.04% 1 kHz THD @ unity gain with 0 dB input <0.1% SMPTE IMD @ unity gain with 0 dB input
Output Noise and Hum:	@ unity gain <-83 dB 20 Hz to 20 kHz @ shut off <-110 dB 20 Hz to 20 kHz
Expander Attack Times:	Program dependent, nominally 100 us, 5 ms, 10 ms
Expander Slopes:	Nominally 1:10 (gate), 1:2 (exp 1), 2:3 (exp 2)
Threshold Range of Adjustment:	-40 dB to +20 dB
Range,or Maximum Attenuation:	0 dB to -80 dB
RFI Rejection:	@ unity gain, RF applied to signal input differentially, 100 mV pk w/50% AM @ 1 kHz. Output noise increase <3 dB in 20 kHz noise bandwidth, AM 1 kHz tone ≤-70 dB at output
Electrical	
Power Supply Mains Requirement:	95-140 Vac 43-62 Hz; 190-250 Vac 43-62 Hz; 12 VA max.
Mechanical	
Front Panel Controls:	THRESHOLD -40 dB to +20 dB RELEASE 0.05 s to 5s/20 dB RANGE 0 dB to -80 dB
Front Panel Switches:	in/out/key (Source) gate/exp 1/ exp 2 (Mode)
Metering:	Three LED display indicates "on" (green), "expand" (yellow), and maximum gain reduction (red), as determined by the RANGE control
Connectors:	1/4" diameter, 3 conductor jacks; requires MIL-PJ 051, Switchcraft #482 or equivalent, or Switchcraft #260 or equivalent mating plugs

Packaging

Case and Rack:	Painted steel and anodized aluminum rack package 1.75"H x 19"W x 8.5"D (44mmH x 482mmW x 216mmD)
RF Attenuation (package):	0.100 MHz to 400 MHz electrical field, >50 dB
Weight:	7 lb. (3.18 kg)
Shipping Weight:	12.5 lb. (5.7 kg)

1.3 INTRODUCTION TO NOISE GATING AND EXPANSION

A noise gate is an audio signal processing device that turns off or greatly attenuates a signal when the level falls below a user adjustable threshold; therefore when the signal level is below threshold, it will pass through the device greatly attenuated that low-level hiss, noise, or leakage will not be heard. When the signal is above threshold, the noise gate will have no effect on the signal, and passes it through at unity gain.

Because a noise gate can be set, according to its level sensitive nature, to discriminate between desired audio signals and unwanted audio and ambient noise such as tape recorder hiss, ground hums, background room noise and leakage from other instruments, when properly adjusted the device passes what you want to record or to be heard in a live situation, and reduces the volume of or eliminates undesired signals.

Percussive signals, due to their typically short decay time, are the easiest to process with a noise gate, while sustained signals, due to their unpredictability and wide dynamic range, will generally be more difficult to process. Consider that a snare drum produces a series of high-level transients that normally fade away very quickly. Subjective "tightness" will not be achieved if the drum resonance lasts too long. A noise gate with the threshold set at a relatively high level will bring the decay down quickly after each impact, thereby achieving the desired "tight" sound.

During the attack or "turn on" period, the noise gate cannot remove background noise, because it reacts to overall level. Due to this fact, a noise gate may be only marginally effective on sustained instruments, such as an organ or strings, where unwanted noise may be heard through the music. And, its appearance in time with the music will most assuredly prove more displeasing than its presence in an unprocessed form.

Such "modulation" of the noise floor is a common shortcoming of dedicated noise gates when used on instruments with substantially long sustain and decay times. The problem may be partially overcome by the use of relatively long release times. The release time of a noise gate is defined as the rate at which the device falls to maximum attenuation after the signal which caused the device to "attack", or turn on, is removed. The major disadvantage of using a gate with long release times on sustained instruments is that a large portion of the extraneous sounds and noise which the gate is employed to eliminate is passed through unaffected.

The most effective method of reducing unwanted noise from signals which exhibit long sustain and decay times is expansion. Expansion is so named

because the processor used is configured to expand the dynamic range of the signal, or the ratio of the signal's highest level to its lowest perceptible level. This is accomplished by increasing the gain of the expander by a fixed amount in response to an increase in the level of the signal being directly expanded. For example, if the signal exhibits a relative increase in level of 10 dB, the expander may increase its gain by 20 dB. This scheme obviously will increase the dynamic range of the signal being processed, but it just as obviously has a serious drawback: the electrical constraints of any audio system will simply not allow unlimited headroom , thus the processing device, or expander, will quickly run out of available gain having reached a point after which additional increases in input signal level can no longer cause an increase in output signal level because the device is already operating at its maximum output level capacity. Thus the headroom, or reserve available signal level above the normal operating level, is exhausted. The solution to this dilemma is a process called downward expansion. Let us asume that the expander is adjusted so that its threshold is set at 0 dB. Any signal appearing at the input with a level of 0 db or greater will cause the expander's gain control element to exhibit unity gain, thus the signal passes through the device unaffected. Now, assume the signal falls below 0 dB. The expander control circuitry directs the gain control device to reduce its gain, or to attenuate the signal by some preset amount for each 1 dB decrease of the input signal level below the threshold setting of 0 dB. This results in the output level of the device decreasing proportionally more than the corresponding decrease in input signal level. If the control circuitry directs the gain control element to attenuate the signal by 1 dB for each 1 dB of decrease in input signal level below the threshold, the result is, predictably, a 2 dB decrease in output level (1 dB input decrease minus 1 dB due to attenuation) for each decibel decrement in the signal below threshold. The ratio of decrease below threshold of the input signal level to the decrease in output signal level is the characteristic slope of the expander. In the example stated, the expansion slope is 1:2 ("one to two") since a 1 dB decrease in input signal level below the threshold setting results in a 2 dB reduction in output signal level.

In this manner, the Gatex, as well as all other top quality expanders, increases the dynamic range of the processed signal without the serious limitations of direct expansion.

It must be noted that there exists a vast difference between expanding the dynamic range of the processed signal, and eliminating noise. No existing "noise reduction" system can discriminate between signal and noise, passing only the signal while eliminating noise in real time. All noise reduction schemes use expansion or a combination of expansion and compression to "stretch" the dynamic range of the input signal, thus resulting in a perceived or "apparent" reduction of noise level in the processed material. The effective use of a noise gate or an expander is contingent upon the existence of acceptably high signal-to-noise ratio between the nominal operating level of the system used and its quiescent, or residual noise level: Employment of expanders or "gates" provides a very useful method of extending the dynamic range of the processed program thus resulting in a noticeable reduction in perceived noise levels, but no device will "eliminate" noise. The incorrect use of these devices often results in objectionable and obtrusive modulation and "pumping" of the undesired noise and extraneous signals which these devices are intended to eliminate. Bearing this warning in mind, please carefully study the following instructions.

2. Installation and Use of Gatex

2.1 CONNECTION OF GATEX

The Gatex quad noise gate/expander incorporates quasi-balanced (ground sensing) inputs for each channel to assure easy interfacing to both balanced and unbalanced sources. The output line driver sections provide sufficient power capability to drive resistive loads or transformer networks with impedances of 600 ohm or greater to a maximum average level of +21 dB (ref. 0.775 Vrms) thus allowing Gatex to be connected to all types of professional and semi-pro equipment. Use of commonly available 1/4" 3-circuit phone jacks for all inputs and outputs permits the Gatex to be quickly and easily incorporated in any audio system.

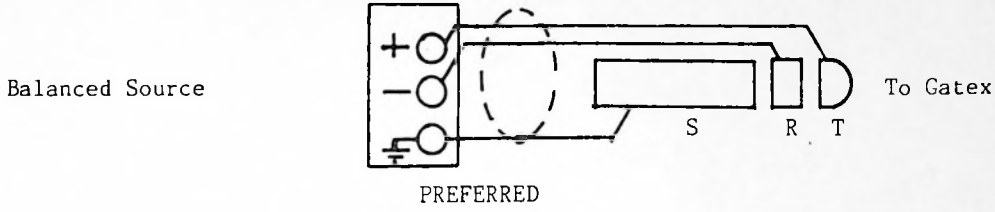
Illustrations 2-1 and 2-2 show preferred methods of connecting Gatex to balanced and unbalanced sources. It should be noted that Gatex is not designed to be driven by devices incorporating line levels less than -10 dB, such as musical instruments and microphones. When using Gatex to expand or gate musical instruments or microphones, the device should be inserted after the preamplifier to assure best signal-to-noise performance.

In order to eliminate ground current hum loops, the Gatex 0 Vdc reference, or signal ground, is isolated from the ac mains safety ground. The operator should be aware that the 0 Vdc references of all four channels are connected internally, thus care should be taken if Gatex is used to interconnect several signal chains exhibiting different ground potentials. If the signal sources feeding Gatex exhibit hum due to ground current loops when directly interconnected, the operator should experiment by disconnecting shield grounds at the Gatex inputs or at the outputs of the sources feeding Gatex to achieve best results when Gatex is in the signal chain. The preferred method is to allow the output device of the system (console, power amp, etc.) to become the central ground point and then to disconnect the shields at the outputs of devices feeding Gatex, keeping in mind that, due to the unbalanced output line driver circuitry used in Gatex, the 0 Vdc reference of Gatex will assume the potential of the ground exhibited by the device or devices sourced by Gatex.

2.2 USE OF GATEX AS A NOISE GATE

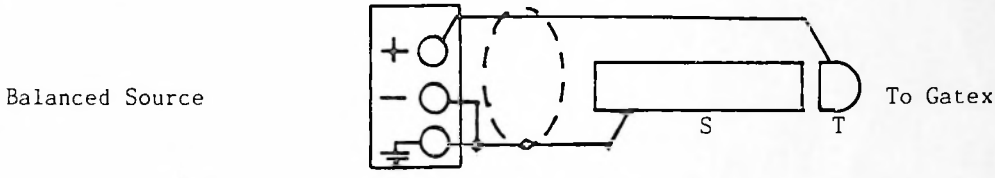
Perhaps the most common use of noise gates is in "tightening" percussion instruments. Most recording engineers prefer to mike individual components of a drum kit in such a manner as to record the kick drum on a single track, the snare on another, and so on, so that the sound of the kit may be tightly controlled during mixdown. While in theory the multi-source technique provides the engineer and producer with a valuable tool to control the sound of the kit despite the vagaries of room or booth acoustics, in practice the leakage between microphones used to individually record the various components of the drum kit propels the science of recording the kit on multiple integral tracks into the realm of arcane arts. After such extreme measures such as feather pillows, baffles, clip-on microphones, etc. fail, the recording engineer is faced with two distinct choices: he may either accept the problems and hope that, by some quirk of fate, the final mix is acceptable, or he may use noise gates to minimize the leakage. A knowledgeable recording engineer will invariably choose the latter alternative: experience in the field proves conclusively that engineers and producers develope white hairs and ulcers in inverse proportion to the number of noise gates available to mike and/or mix the drum kit. Because drums

GATEX INPUT CONNECTIONS



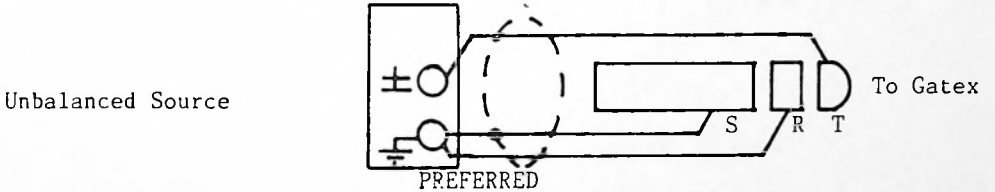
PREFERRED

3 CIRCUIT PLUG



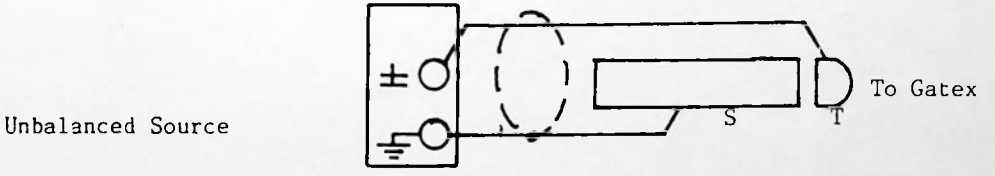
ACCEPTABLE 2 CIRCUIT PLUG

FIGURE 2-1 CONNECTION OF GATEX TO BALANCED SOURCES



PREFERRED

3 CIRCUIT PLUG



ACCEPTABLE 2 CIRCUIT PLUG

FIGURE 2-2 CONNECTION OF GATEX TO UNBALANCED SOURCES

possess both an extremely high transient content and a very short decay time, they lend themselves well to noise gating, or expansion at exaggerated slopes.

The Gatex, in its "gate" mode, is an ideal processor for isolating the microphones used to record a drum kit. The attack circuitry compensates for slight differences in rise time and peak level inherent in the style of the drummer, and the exclusive Program Controlled Sustain allows the engineer to either follow the natural decay of the drum, or to shorten the decay time to practically nothing. By manipulation of the threshold and release controls the engineer or producer may accentuate, for the example the "clap" of the kick drum, or soften the sound to a dull thump. To gate a drum kit microphone, the operator should insert Gatex in the signal chain following the microphone preamp and EQ, if used, select gate on the Mode switch, and in on the Source switch. The Range control should be turned fully counter-clockwise to 80 dB. Set the Release control to .5 s/20 dB (mid-range) initially, and while listening to the monitors, adjust the Threshold control until the desired sound is obtained. The Release control may now be adjusted to retain or eliminate the natural decay of the drum. In mixdown, the Gatex may be inserted either in the pre-fader patch point, or between the line patch output of the mixing console and the recording ACN. In use for live performances, the Gatex may be inserted either in the pre or post-fader patch point in the live console, or directly following the microphone preamplifier section.

When gating during multi-track mixdowns, some pumping of tape hiss may be evident as each single track is monitored, however when the entire mix is heard, the effect will probably not be noticeable. Somewhat less dramatic "shut-off" maybe obtained, if desired, by re-adjusting the Range control, thus limiting the maximum attenuation to some value other than the 80 dB shut-off attenuation which the Gatex is capable of performing.

2.3 USE OF 1:2 EXPANSION (exp 1)

When general noise reduction is required to eliminate ambient noises such as musical instrument amplifier buzz, air conditioning rumble, and other low level sounds such as tape hiss and leakage, it is usually desirable to gently attenuate the unwanted sounds by use of 1:2 expansion. This Gatex operating mode is of particular interest to those who record live performances, or operate sound reinforcement systems in a concert environment. In such applications, the use of noise gates, with their well-defined "turn-on" points and high slopes, contributes to the sensation that the signal is being turned on and off. This effect, while perfectly innocuous when processing highly transient sounds such as those produced by percussion instruments, is very annoying when accompanying a vocal or string sound. By allowing unobrusive attenuation of low-level in the absence of the desired signal, 1:2 expansion can greatly enhance the signal-to-noise ratio of a multi-track mix or multi-microphone live system without creating the sensation that each source is being "switched" off and on.

To configure the Gatex for 1:2 expansion, select expl with the Mode switch, in with the Source switch, and set the Release control initially to .5 s/20 dB. Adjustment of the Threshold control will determine which signals are passed through Gatex at unity gain, and which signals are attenuated. Because the characteristic slope of the Gatex in exp 1 is 1:2, as the input signal level falls below the Threshold setting, it will be attenuated so that for each 1 dB of level decrease below threshold, a 2 dB decrease

will occur in the signal level appearing at the output. The Range control setting will determine the point at which the attenuation of the signal will stop. After first setting the Threshold control so that the average level of the desired signal passes unattenuated, the operator should adjust the Range control and Release control for the most pleasing sound. The best release time setting will provide attenuation of unwanted sounds without creating the sensation that the signal is being "pumped" up and down in level. As in all audio processing, the highest authority on proper operation of the device is the ear! Only experience gained through experimentation will yield completely satisfactory results. The operator should note that when performing 1:2 expansion, both the Threshold control setting and the Release time setting will have a pronounced effect on both the amount of noise reduction obtained, and the audibility of the process. There is no single optimum setting of the controls to effectively and unobtrusively process all types of signals. Strings and horns, for example, will require different control settings than will vocal mikes or plucked instruments, such as guitars.

2.4 USE OF 2:3 EXPANSION (exp 2)

The subtle application of expansion provides many benefits to the recording engineer or broadcast operator. While noise gating, or expansion at exaggerated slopes of 1:100, 1:20, etc, and "soft" gating, or expansion at gentler slopes of 1:4 and 1:2 offer highly effective noise reduction during multi-track recording and live performances, these schemes offer little advantage when used on mixed program material. To achieve apparent noise reduction in mixed program material, the action of the processor must be unobtrusive. It cannot noticeably alter the perceived dynamic range of processed material, yet it should substantially attenuate unwanted low-level signals such as tape hiss, record surface noise, etc. during quiet passages in the program material. By unobtrusively "stretching" the dynamic range of mixed material, Gatex, when used in the exp 2 mode, can provide 10 to 20 dB of apparent noise reduction for mixed sources without the inconvenience of "encode/decode" systems. The gentle expansion slope in conjunction with the Program Controlled Sustain allows the Gatex to expand material with long decay times without perceptibly shortening the natural sustain or reverberation times found in material containing, say, a piano, or in mixed material. Expanders not incorporating release circuitry which modifies release time according to the content of the material processed tend to impart a certain "artificial" sound to the processed material due to the fixed release rate.

To perform apparent noise reduction by use of gentle expansion, the operator must select exp 2 with the Mode switch, and in with the Source switch. The Threshold control should be set initially to just below the nominal line operating level, for example, at 0 dB for a +4 dB line feed. The Release control should be initially set to .5 s/20 dB, and the Range control may be set between 10 and 15 dB.

While monitoring the output of the Gatex, the operator should now adjust the Threshold and Release controls to obtain the most pleasing sound. The amount of apparent noise reduction occurring due to expansion may be judged by alternately selecting the in and out positions of the Source switch, thus engaging and disengaging the expander control circuitry. When the Source switch is in the out position, the signal is passed through the VCA at unity gain, thus the processor is effectively "bypassed" since no dynamic processing is taking place. It should be noted that the setting of the Threshold and Release controls will determine the

most effective apparent noise reduction. While the Range control setting will affect the audibility of the processing. Best results will generally be obtained when a moderate amount of expansion, as indicated by the yellow LED status indicator, is taking place, and when 10-15 dB of maximum attenuation is allowed as determined by the Range control setting.

2.5 KEYING, ENVELOPE FOLLOWING, AND OTHER SPECIAL FUNCTIONS

Keying is defined as operation of a noise gate in such a manner that the presence of an external audio signal is used to "turn on" the signal being processed. For example, if a bass guitar track is required to appear in synchronization with the appearance of the kick drum in the mix, this effect may be obtained by inserting the Gatex in the bass guitar signal chain, then "multing" the kick drum track line to the key input of the Gatex. The operator then selects the gate position of the Mode switch, and the key position of the Source switch. The Threshold control is adjusted so that the kick drum turns on the bass guitar signal. The Release control is adjusted to impart the desired decay characteristics to the bass guitar signal. The Range control will usually be set at or near maximum attenuation for best isolation.

Envelope Following is defined as a process in which the level and dynamic characteristics of a signal are made to follow, or duplicate those of another external signal. Envelope following may be considered "soft" keying, and is frequently used as such, but its greatest usefulness is found in electronic music and in the creation of special effects wherein an instrument having limited dynamics, such as an organ or polyphonic synthesizer is caused to follow the dynamics of a vocal track or drum track.

Envelope following is performed with Gatex by inserting Gatex in the signal chain of the instrument being processed. The external signal whose dynamics are to be duplicated is fed to the key input. The operator then selects exp 1 with the Mode switch, and key with the Source switch. The Threshold control is adjusted so that the external signal causes a full on condition on high level peaks, as indicated by the green LED status indicator. The Release control initially is set fully counter-clockwise, or to .05 s/20 dB, and the Range control is set for 60-80 dB. While monitoring the output of Gatex while in operation, the Threshold and Release controls are then adjusted to achieve the desired effect.

Control of Reverb Decay Times

By inserting the Gatex in the echo return line of a recording console, denser returns may be achieved by offering precise control of the reverberation decay time. This application enhances the sound of less expensive reverberation systems. The reverberation system is set for a reasonably long decay time, and the Gatex is used in either the exp 1 or exp 2 mode. The Source switch is set to the in position. The Threshold control is adjusted to a point near the nominal operating level of the return line. The Range control is initially set to 60 dB. By monitoring the processed return at the output of Gatex, the Release control is adjusted to provide the desired decay rate. The Threshold and Range controls may require readjustment to result in a more pleasing sound. Correct control settings will be determined by experimentation, the desired effect being that the return decay may be varied by adjusting the Release control without altering the tonal quality of the processed return signal.

3. Circuit Operation

Figure 3-1 illustrates the functional block diagram of one channel of the Gatex. The rectifier and converter section produce a dc voltage that is analogous to the log of the signal level present at its input. This dc voltage is processed by the control circuitry which determines the slope of the expander and the attack time. The control circuitry charges the capacitor associated with the track and hold circuit. The capacitor is discharged via the release current sink. The release current sink is controlled by a two quadrant multiplier circuit which derives its inputs from the release control potentiometer and the program controlled sustain circuitry. After appropriate algebraic operations are performed with the dc control voltage and the voltage derived from the range control potentiometer, the algebraic sum of the two sources is applied to the appropriate port of the Valley People TA-104 voltage controlled amplifier. All front panel controls and switches affect only dc voltage levels applied to the control circuitry, thus the only elements in the audio signal chain are the input amplifier, the Valley People VCA, famous throughout the professional audio world for its transparency and trouble-free performance, and the line driver circuitry. The result is unsurpassed functionality and performance in a convenient, cost effective package; noticeably absent are the distortion and lackluster performance exhibited by other "low-cost" gates using FET or photo-resistor technology.

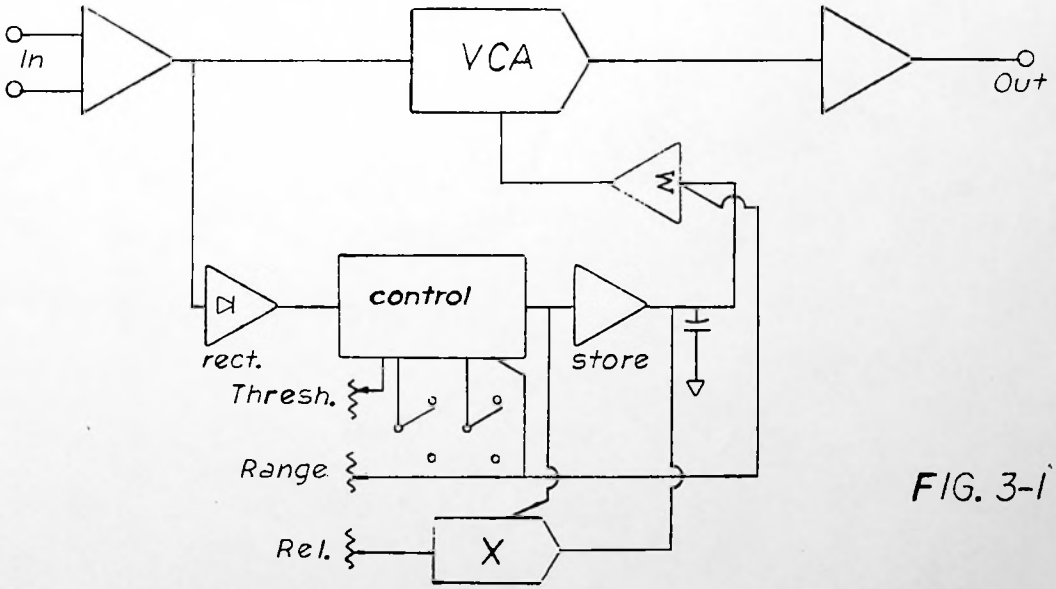


FIG. 3-1

4. Maintenance

4.1 REPAIRS

There are no user serviceable parts in Gatex. Repairs should be referred to a competent electronic technician. A schematic diagram and parts overlay are included in Section 5 of this manual as a troubleshooting aid to those users with sufficient technical background to perform field service.

CAUTION: Disassembly of the enclosure will expose hazardous line voltages. Refer servicing to competent technical personnel.

4.2 ADJUSTMENT OF CONTROL REJECTION

The trimmer potentiometer, which adjusts the amount of control voltage feedthrough in each VCA, is accessible through the rear panel, and is labelled Cntl. Rej. The control rejection characteristics of the Valley People TA-104 VCA are quite good, but the long-term stability of the adjustment depends to some degree on component aging and temperature, therefore the operator may desire to re-adjust this control periodically. Degraded control rejection will result in a "thump" in the audio signal when the Gatex "attacks"; it will be especially noticeable in the gate and exp 1 modes.

To adjust the control rejection in the field, the operator should disconnect the audio input from Gatex. A high level (+4 dB to +20 dB) signal, preferably a kick drum or snare track, is fed to Gatex via its Key Input. The Gatex Source switch is placed in the key position, the Mode switch in gate. Set the Release time control fully counter-clockwise (.05 s/20 dB), the Range control fully counter-clockwise (80 dB) and adjust the Threshold control for maximum ongoing expansion as indicated by flashing of the three status indicator LED's. While monitoring the audio output, adjust the control rejection trimmer potentiometer for minimum signal level. Note that the signal present at the output in the configuration will sound very badly distorted: that is normal.

Bench adjustment of control rejection requires the same set-up, but a low-frequency signal (50-100 Hz) is fed to the Key Input, and the audio output is measured either with an oscilloscope or ac voltmeter, and the control rejection trimmer is adjusted for minimum output voltage level.

4.3 WARRANTY

US AUDIO, INC. warrants its products and their related enclosures and power supplies to be free from defects in workmanship and material under normal use and service. Said warranty is to extend for a period of twelve months after date of purchase. In the case that a US AUDIO, INC. product or any of its related enclosures or power supplies is believed to be defective, same may be returned with transportation prepaid to US AUDIO, INC., within twelve months after date of purchase, accompanied by proof of purchase. If the product is found by US AUDIO, INC.'s inspection to be defective in workmanship or material, it will be repaired or replaced (at US AUDIO, INC.'s election) free of charge and returned, transportation prepaid, to any point in the United States. If inspection by US AUDIO, INC. of such products does not disclose any defect in workmanship or material, US AUDIO, INC.'s regular charges will apply.

This warranty is expressed in lieu of any and all other warranties, whether

expressed or implied, and the sole liability of US AUDIO, INC. under this warranty is to either repair or replace (at US AUDIO, INC.'s election) the product or its related enclosure or power supply. Any incidental damages are expressly excluded.

The foregoing warranty is US AUDIO, INC.'s sole warranty, and other warranties, expressed, implied, or statutory, are negated and excluded.

NOTE: All items for repair, either in or out of warranty, should be returned transportation prepaid to the following address:

US AUDIO, INC.
2817 Erica Place
Nashville, TN 37204