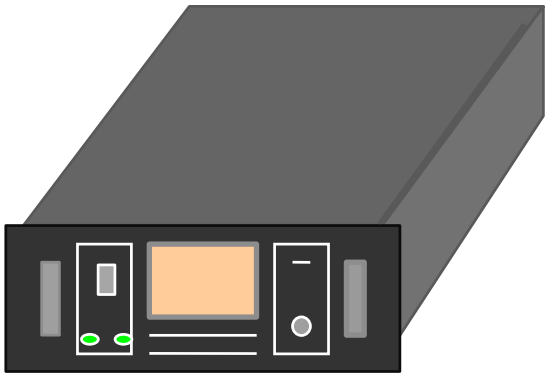

OWNER' S MANUAL

THE DAVID BERNING COMPANY

ZH270

POWER AMPLIFIER

The David Berning Company
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USA
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WARNING: For safety, the cover of this amplifier should be secured at all times. DC voltages as high as 1700 V and peak ac voltages as high as 3000 V are present inside. The service information in this manual is intended for trained service personnel. Furthermore, this amplifier generates radio-frequency energy that can interfere with communications equipment if the cover screws are not tightly secured.

Abbreviated Operating Guide

The hook-up and use instructions provided in this short introductory section of your manual are all that are needed to place the ZH270 into operation. Once the music is playing, you can sit back and read about the many features described later in this manual that make the ZH270 such a revolutionary amplifier.

If a pre-amp is being used, connect a left-right pair of RCA-type phono cables from the main-out jacks of the pre-amp to the left-right pair of input jacks marked "A" on the ZH270. Set the input selector switch on the front panel of the ZH270 to "A". Set the feedback switch to "NORM". Rotate the "LEVEL" control to full clockwise position. Use the volume/level control on the pre-amp to obtain the desired volume. *DO NOT* set the pre-amp volume/level control at a high setting, and then use the LEVEL control on the ZH270 to control volume. Doing so may overload the high-level stages in the pre-amp. At a later time you will want to experiment with other feedback settings. At this time you may find that there is too much noise in the high-level stages of your pre-amp for the lower feedback settings because the sensitivity of the ZH270 is higher for the lower feedback settings. For the "MED" feedback setting on the ZH270, the LEVEL control can be set to the 2 o'clock position to achieve the same sensitivity as operation in the NORM feedback mode with the LEVEL control set at the full clock-wise position. Likewise, the 12:45 o'clock position of the LEVEL control provides the same sensitivity with the "LOW" feedback setting as a full clock-wise setting of the LEVEL control does in the NORM feedback mode. For versions of the ZH270 with the upgraded step attenuator, these settings are 3:30 for the “LOW” and 4:30 for the “MED” positions.

If a high-level source like a CD player is being used without a pre-amp, connect a left-right pair of RCA-type phono cables from the output jacks of the source to the left-right pair of input jacks marked "A" on the ZH270. Set the input selector switch on the front panel of the ZH270 to "A". Set the feedback switch to "NORM". Rotate the "LEVEL" control to full counter-clockwise position. Once everything is powered up and running, the LEVEL control can be rotated clockwise to obtain the desired volume.

Connect the speaker cables to the outputs on the ZH270. The ZH270 has been optimized for load impedance in the 4 ohm to 16 ohm range. Momentary shorts or opens at the outputs of the ZH270 will not damage the amplifier, however, a sustained short circuit at the output may cause the output tubes to overheat. The ZH270 can be operated unloaded; however, successful power-up of the ZH270 may require that both speaker loads be connected. During warm-up, sufficient dc-offset voltage may appear at one or both of the outputs to trip the dc-offset protection if the speaker loads are not connected. If the protection is activated, the power supply will be cut back and the amplifier will latch in a "stuck" mode. Connecting the speakers at this point will not unlatch it, but turning the power off, waiting at least five seconds, and then turning the power on again (with the speakers connected) will re-start the turn-on sequence.
Connect the ZH270 to the ac power mains with the supplied power cord. It is not necessary to use a power conditioner as both a surge surpressor and a 4-stage line filter

are built into the ZH270. Turn the power switch on. The auto-bias lights should change from red to mostly green after about 75 seconds, after which the ZH270 is properly biased and ready to play.

Features and Operation

Although the ZH270 is best described as a basic amplifier which would normally be used with a pre-amp, it does offer some basic control features of its own. Two sets of inputs are included, along with an A-B selector switch. A high-quality volume control is also provided, and the ZH270 has sufficient gain to boost many high-level signal sources to full power without pre-amplification. One possible use of the A-B selector feature might be to feed the signals from a CD player into the A inputs, and to feed the signals from a pre-amp into the B inputs. This configuration would simplify the signal path for the CD player and should provide the best sound reproduction of CDs. Stereo systems having only one or two high-level signal sources may not even need to include a pre-amp.

A three-position feedback switch is included on the ZH270. The "NORM" position provides about 12 dB of feedback with an eight ohm speaker load, while the "MED" position and the "LOW" position provide about 7 dB and 3 dB respectively. The most significant effects of this switch are to change both the output impedance and the speaker damping. While many amplifiers have greater than 12 dB of negative feedback and high damping, this is not always optimum. The impedance of many speakers varies with frequency, and often this shows up most dramatically with a rise in impedance near the bass resonance frequency. The feedback switch can be used to reduce the feedback and thus raise the output impedance of the amplifier, and this affects the system frequency balance by coupling more power into the speaker at those frequencies where the impedance is higher. Speaker designers generally try to design for a flat frequency response using an anechoic chamber. Home listening environments generally fall far short of the ideal acoustic properties of the anechoic chamber, and the feedback switch gives you, the amplifier user, a means to modify the normal speaker response to compensate for room acoustics and personal preference.

Speaker damping relates to the control that the amplifier has over the position of the speaker diaphragm. High damping has the effect of causing the speaker diaphragm to start and stop quickly, and its sonic attributes also show up most dramatically in the bass. High damping is likely to give a tighter, dryer, and more analytical sound, and low damping is likely to give a more open and resonant sound.

In addition to the user features included with the ZH270, there are a number of internal house-keeping features too. All tube biasing is done automatically with peak-holding sampling and servo-control circuits. Biasing is updated on a cycle by cycle basis, even when the amplifier is being driven hard. A pair of LED indicators on the front panel indicate proper biasing by turning from red to mostly green during amplifier warm-up. The LEDs flicker almost completely green when the amplifier is driven hard. The warm-up period is about 75 seconds, and if the amplifier is played before the LEDs indicate proper biasing, it will still be able to set its bias, but it will sound very distorted until

biasing is completed. Should the ZH270 not be able to set the bias on all of the tubes, one of several error sensing circuits will place the power supply in a fold-back mode, whereby it may try to restart the biasing several times before shutting down. Once the power supply shuts down, it can be restarted by turning the power switch off and on.

Another pair of servo-loops perform automatic dc-offset-null functions so that no dc voltage is fed to the speakers. These servos are also tied into error sensing so that the power supply is cut back or shut down if dc-offset cannot be nulled. The time to cut back the power supply is proportional to the amount of dc appearing at either of the outputs. A special current-imbalance sensing transformer in the power supply overrides the slower voltage error-sensing at the amplifier outputs if a large dc output current is detected. This extra protection is included to protect the speaker in the event that a tube or other component in the signal path should fail catastrophically. This protection acts in a quarter of a second, and places the power supply in a fold-back mode. It should be noted that none of these protection circuits are in the audio signal path or act as the result of any instantaneous output condition. Like other tube amps, a momentarily shorted output will not hurt the ZH270, and the protection circuits will not be activated by a momentary short. The current output sensing protection will act if the amplifier is driven to full power with a repetitive waveform at a frequency of several hertz; this would be sensed as a dc fault, and such a signal at full power would destroy most speakers.

The Zero-Hysteresis (ZH) 270--A New Kind of Amplifier

The design of the Berning ZH270 power amplifier represents a radical departure from that of other amplifiers. The ZH270 is the first amplifier using all-tube amplification that properly matches the high-voltage, low-current operating parameters of vacuum tubes to the low-voltage, high-current drive requirements of dynamic loudspeakers without using audio-output transformers.

Audio-amplifier design engineers have long sought to eliminate the audio-output transformer because of the restrictions that it has always imposed on amplifier performance. Both leakage inductance and interwinding capacitance limit the high-frequency response of the transformer, while core saturation and magnetizing current limit its low-frequency response. Transformer-core hysteresis causes certain kinds of distortion of the non-symmetric and transient waveforms so characteristic of musical reproduction.

Tube Amplifiers have been previously made that drive dynamic loudspeakers without output transformers. These amplifiers are called output-transformerless (OTL) amplifiers. A well-known pioneer of this type of amplifier was Julius Futterman, and there have been many amplifiers made by various companies over the years that are based on the Futterman principles. The Futterman design incorporates two separate banks of parallel-connected tubes. The two banks are joined in series by connecting the effective cathode of one tube bank to the effective plate of the other tube bank, and driving the loudspeaker in a push-pull fashion from this junction point directly without a

transformer. Given a sufficient number of parallel-connected tubes in each bank, enough drive current can be obtained to drive the speaker.

There are several problems associated with the OTL amplifier which have limited its application. The OTL amplifier is a "brute-force" methodology, whereby the banks of tubes are forced to deliver the required drive-current by high-feedback techniques. The natural impedance of the cathode "push" is much lower than the plate "pull", and neither one is anywhere near the actual speaker impedance. A large amount of negative feedback is required to force the push and the pull to work together properly, and to provide sufficient damping for the speaker. Because of the basic impedance mismatch between the tubes and the speaker in the OTL circuit, the success of mating OTL amplifiers to dynamic speakers is very dependent on the characteristics of individual speakers. Major reliability issues surround OTL amplifiers, not only because a large number of power tubes are required, but also it is necessary that the tubes need to be driven hard to obtain the required output current. Power consumption is high for OTL amplifiers, often exceeding one kilowatt for a stereo pair. Noisy fans are often needed in the amplifiers. Additional room air-conditioning may be needed, further increasing the listening-room noise level.

The ZH270 takes advantage of new technology in order to eliminate the audio-output transformer. The application of this technology is the subject of a pending patent. The ZH270 uses radio-frequency to change the voltage-current transfer characteristics of the output tubes from their normal impedance-plane to one suitable for driving a dynamic loudspeaker. The radio-frequency re-mapping is implemented using special high-frequency power conversion techniques. The high-voltage, low-current tube impedance-plane is re-mapped to the high-current speaker impedance-plane through a special transformer at a constant RF carrier frequency of 250 kHz. Because the audio signal is riding on a carrier, it is not subject to parasitic elements of the transformer that would otherwise distort the audio signal. There is no low-frequency limit for this impedance conversion, and the ZH270 is dc-coupled, with the exception of a small, high-quality, dc-blocking capacitor at the input of the amplifier.

The impedance matching in the ZH270 is precisely determined by the effective turns ratio of the RF conversion transformers. Both the push and pull portions of the amplifier are handled in a symmetric fashion, as they are in a conventional transformer-coupled amplifier, and negative feedback is not required to force the positive-output current capability to be similar to the negative-output current capability.

Audio-output transformers have a limited impedance conversion range imposed by the parasitic elements. Audio-output transformers also have limits imposed by voltage breakdown between primary and secondary, and required insulation also affects the parasitic elements adversely. It is difficult to make a high-fidelity transformer with much more than a 25:1 overall primary-to-secondary turns ratio for the above reasons. These restrictions are eliminated in the ZH270, and an effective overall turns ratio of 64:1 is used. The effective plate to plate primary impedance is 32 k ohms (with an 8 ohm load), rather than the 4.5 k ohms used in previous Berning products. One implication of this

change is that the reflected plate resistance is brought from 140 ohms down to 20 ohms for the push-pull pair of 6JN6 output tubes used in the ZH270, making the tubes appear more like triodes to the speaker. All Berning amplifiers, including the ZH270, use a special triode-connected screen-drive arrangement (patent no. 3,995,226) that offers greatly enhanced reliability and also improved linearity at low idle currents. The reflected plate resistance of both the Berning EA-2100 and the EA-2101 is about 70 ohms by virtue of the EA-2100's use of the larger 6LF6 output tubes, and the EA-2101's use of paralleled sets of 6JN6 tubes.

Another implication of using a higher-effective turns ratio is that the output tubes operate at lower current and higher voltage than they otherwise would. As tubes become weak with age, the current capability is reduced, but the voltage capability is not affected. Longer useful tube life is expected because less current is required for a given output power. The opposite situation applies to the traditional OTL amplifier. The required current for each 6JN6 tube in the ZH270 to achieve a given current to the speaker is 1/32nd of that required for each bank of output tubes in the traditional OTL amplifier for the same speaker current. It is easy to see why traditional OTL amplifiers have difficulty driving low-impedance speakers.

The higher effective-turns ratio also means that distortion is reduced for a given amount of negative feedback because the current loading of the output tubes is reduced. The higher-voltage, lower-current tube operation afforded by the higher effective-turns ratio also operates the tubes with greater efficiency, and the push-pull pair of 6JN6 output tubes in the ZH270 can develop over 100 watts into 4 ohms without the plates showing color.

Audio-output transformer-coupled amplifiers should not be operated without a load connected because the inductance of the transformer's primary can cause the plate voltage to reach a sufficiently high voltage to break down insulating materials, resulting in amplifier failure and even fire. Some amplifiers are even unstable without a load. Unlike output-transformer-coupled amplifiers, the ZH270 can be operated safely without a load, as the voltage can not exceed its normal designed-in operating voltage.

Other Features and Specifications

Like other recent Berning products, the ZH270 incorporates a fully-regulated, resonant-type, switching power supply. The power supply in the ZH270 does include several performance and reliability enhancements that have been added to the basic designs of the power supplies used in earlier Berning products. The ZH270 abandons the packaged power-line filter used in previous Berning products in favor of a custom-designed one that has better noise suppression characteristics. Over-voltage protection has been included to add redundancy to the regulator control. Full-bridge switching transistors and a balanced resonant inductor replace the half-bridge and simple resonant inductor of the previous power-supply designs in order to reduce noise. The soft-start portion of the power-supply has been re-designed to improve uniformity and robustness. A re-design of the oscillator has eliminated two heat-producing power resistors and simplified the

procedure for converting the amplifier for overseas line-voltage operation so that only a jumper is inserted or removed to make the conversion. And finally, changes have been made that cause all of the power-supply output voltages to track one another very tightly, resulting in improved transient performance of the amplifier.

The use of regulated switching power-supplies in Berning amplifiers over the years has resulted in these amplifiers obtaining a reputation for having better control in the bass than tube amplifiers with conventional power supplies. The use of these supplies has also resulted in unusually light-weight and compact amplifiers for their power capability because there was no line-frequency power-transformer in these units. Some people with traditional ideas found it difficult to believe that improved bass reproduction could be obtained with a lighter-weight design.

The ZH270 takes another giant step forward in improved control in bass reproduction, this time with the elimination of the heavy output transformers. The ZH270 weighs only 4.5 kg (10 lb.), and reproduces frequencies, at full power, a factor of ten lower than typical transformer-coupled amplifiers.

The ZH270 follows other Berning designs in that the tubes are operated at relatively low temperatures for long life. The idle plate-dissipation for the 6JN6 output tubes is seven watts each, and their heaters are operated below their normal rated voltage.

While the entire ZH270 is built on a circuit board, selected portions of the audio- signal path are constructed using point-to-point hand-wiring. This extra step is necessary because it was found that high-impedance audio signals are sonically degraded when they travel on the circuit board.

Other features and specifications include:

- Single ended inputs only, all balanced amplification.
- Special triode output stage.
- Low negative feedback, no phase compensation used.
- Constant output impedance over entire audio spectrum.
- Unique brown-out protection circuitry.
- Built-in four-stage power-line filter and surge suppressor.
- Non-magnetic chassis prevents skin-effect induced distortion.
- Visually attractive red window in front panel displays tubes.
- Power consumption: idle-100 W; max-300 W.
- Power required: 100-130 V ac or 200-260 V ac, 50-440 Hz.
- Signal to noise: broadband (typical) 60 dB, all feedback settings. 20 kHz bandwidth (typical): 94 dB, NORM feedback; 91 dB, MED feedback; 85 dB, LOW feedback. All figures unweighted.
- Distortion (typical, both 4 and 8 ohm loads at 70 W): 1%, NORM feedback; 1.5%, MED feedback; 2%, LOW feedback.

- Distortion (typical, 8 ohms at 5 W): 0.2 %, NORM feedback; 0.3 %, MED feedback; 0.5 %, LOW feedback.
- Typical output power (per channel) at onset of clipping: 8 ohms 84 W; 4 ohms 110 W.
- Frequency response at 1 W, 8 ohms; +0, -1 dB: 1.5 Hz to 60 kHz, NORM feedback; 1.5 Hz to 35 kHz, MED feedback; 1.5 Hz to 21 kHz, LOW feedback.
- Full power bandwidth (-3 dB), 8 ohms: 2 Hz to 80 kHz, NORM feedback; 2 Hz to 50 kHz, MED feedback; 2 Hz to 35 kHz, LOW feedback.
- Typical crosstalk: At 1 kHz; -62 dB, NORM feedback; -55 dB, LOW feedback; At 10 kHz; -58 dB, NORM feedback; -48 dB, LOW feedback.
- Typical output impedance (measured at 1 amp, 60 Hz): 1.8 ohms, NORM feedback; 3.8 ohms, MED feedback; 8.7 ohms, LOW feedback.
- Sensitivity, 70 W, 8 ohms: 0.7 V, NORM feedback; 0.35 V, MED feedback; 0.2 V, LOW feedback.
- Input impedance: 25 k.
- Size: 32 cm wide, 38.6 cm deep, 11.5 cm high, (12.5 X 15 X 4.5 inches), not including handles, connectors, and feet.
- Net weight: 4.5 kg (10 lb.).
- Finish: black anodized aluminum.

240 Volt / 120 Volt Operation

The ZH270 is normally supplied for 120 V operation. Conversion to 240 V operation is done by removing the jumper on the circuit board labeled "120 V JUMPER". This jumper is located near the rear of the circuit board, and slightly left of the center. Conversion back to 120 V is done by replacing the jumper.

Amplifier Channel Strapping

The two channels of the ZH270 can be wired in parallel to make a mono-block unit if more power is desired. To strap the channels together, the plus speaker terminals are connected together and the left and right inputs are connected together. The minus speaker terminals are internally connected together. Both the input impedance and the output impedance are cut in half by the strapping operation.

The strapping procedure results in an amplifier that delivers typically 100 W into 8 ohms and 140 W into 4 ohms. The amplifier can deliver higher peak wattage into 2 to 4 ohm impedance, but the power supply is not large enough to furnish this power on a continuous basis. For typical high-fidelity sound reproduction applications, the peak-to-average power ratio is quite high, even when the amplifier is occasionally driven into clipping. For this usage, the power supply size limit is unlikely to be reached, and building unnecessary reserve into the power supply adds considerable expense with no significant gain in performance.

If this amplifier is to be used for musical instrument amplification, or for D-J use, it is recommended that the channels be strapped and be used to drive an eight ohm speaker.

Limited Two-Year Warranty *

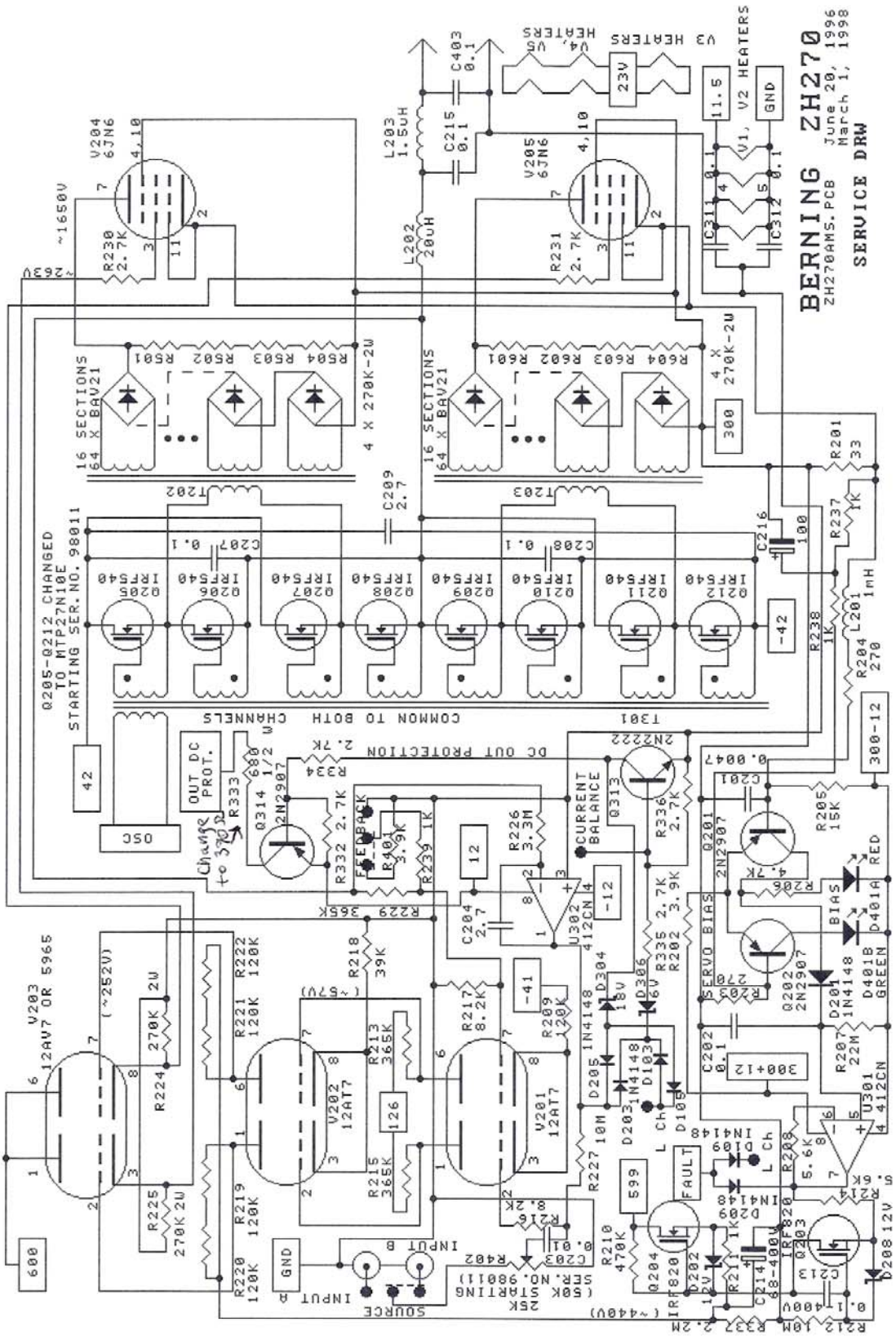
1. Your new Berning product is covered by a limited two-year warranty against defects in material and workmanship. Any repairs required will be made at no charge within the first two years after purchase as a new unit.

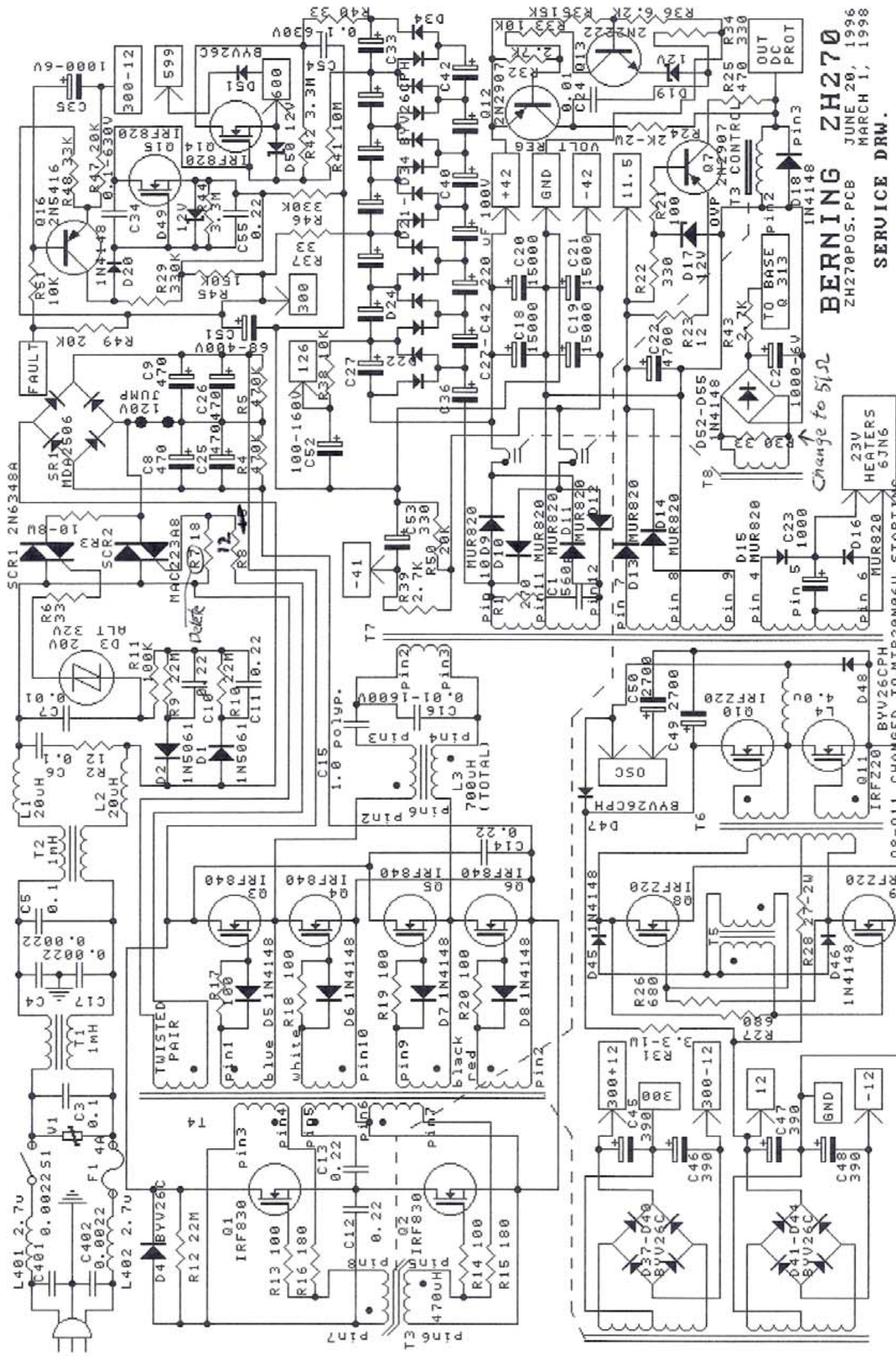
2. Any units returned for warranty repair must be shipped prepaid after receiving return authorization from the David Berning Company. For safe handling, and if at all possible, the unit should be shipped in its original carton. If such is not possible, the unit should be well packed with particular attention paid to protection of all corners and avoidance of any looseness in the carton. If desired, a new shipping carton can be purchased from the David Berning Co. Return transportation will be paid by the David Berning Co.

3. This warranty does not apply to damage resulting from physical abuse or unauthorized alterations or repairs; or damage to exterior finish resulting from careless use. The warranty is void if the serial number has been removed, altered, or defaced.

4. The David Berning Co. reserves the right to improve or change its products without obligation to modify previously manufactured units.

- Applicable for domestic sales only. Handling and shipping costs preclude extension of this warranty to overseas sales.


BERNING ZH270
ZH270AMS.PCB June 20, 1996
March 1, 1998
SERVICE DRW
V204 6JN6
V205 6JN6
V203 12AV7 OR 5965
V202 12AT7
V201 12AT7
V1, V2 HEATERS
V3 HEATERS
V4, V5 HEATERS
23V
11.5
GND
~1650V
~263V
R230 2.7K
R231 2.7K
L203 1.5uH
L202 20uH
C403 0.1
C215 0.1
C311 0.1
C312 0.1
16 SECTIONS 64 X BAV21
4 X 270K-2W
R501 R502 R503 R504
R601 R602 R603 R604
300
T202
T203
C209 2.7
C207 0.1
C208 0.1
C216 100
R201 33
R237 1K
L201 1mH
R238 1K
R204 270
IRF540
Q205 Q206 Q207 Q208 Q209 Q210 Q211 Q212
-42
Q205-0212 CHANGED TO MTP27N10E STARTING SER.NO. 98011
COMMON TO BOTH CHANNELS
T301
42
OSC
OUT DC PROT.
R333 680 1/2 W
Change to 370
Q314 2N2907
R332 2.7K
FEEDBACK
R401 3.9K
R235 1K
R234 2.7K
DC OUT PROTECTION
2N2222
R336 2.7K
CURRENT BALANCE
Q313
R226 3.3M
12
-12
U302 412CN
C204 2.7
R229 365K
R335 2.7K
R202 3.9K
D304 18V
D306 6V
D205 1N4148
D203 1N4148
D103 1N4148
D105 1N4148
D109 1N4148
D209 1N4148
R227 10M
R209 120K
-41
R217 8.2K
R218 39K
R213 365K
126
R215 365K
R216 8.2K
C203 0.01
R402 (50K STARTING SER.NO. 98011)
25K
INPUT A
INPUT B
SOURCE
GND
600
R220 120K
R219 120K
R225 270K 2W
R224 270K 2W
R221 120K
R222 120K
(~252V)
(~67V)
(~440V)
599
FAULT
L Ch
R210 470K
Q204 IRF820
Q202 IRF820
Q203 IRF820
R211 1K
C214 68-400V
C213 0.1 400V
R212 10M
R337 2.2M
D208 12V
R208 5.6K
R214 6K
U301 412CN
C202 0.1
300+12
R207 22M
D201 1N4148
D401B GREEN
D401A RED
BIAS
SERVO BIAS
Q202 2N2907
R203 270
Q201 2N2907
R206 4.7K
C201 0.0047
R205 15K
300-12


BERNING ZH270
ZH270POS.PCB
JUNE 20, 1996
MARCH 1, 1998
SERVICE DRW.